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New England Wind Project

Final Environmental Impact Statement

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BOEM
Bureau of Ocean Energy Management

COVER SHEET

ENVIRONMENTAL IMPACT STATEMENT FOR THE NEW ENGLAND WIND PROJECT

Draft ()   Final (X)

Lead Agency:	U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs
Cooperating 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. Department of the Interior, U.S. Fish and Wildlife Service U.S. Environmental Protection Agency
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Area of Potential Impact:	Renewable Energy Lease Area OCS-A 0534

ABSTRACT

This Environmental Impact Statement (EIS) assesses the reasonably foreseeable impacts on physical, biological, socioeconomic, and cultural resources that could result from the construction and installation, operations and maintenance, and conceptual decommissioning of the New England Wind Project (Project) proposed by Park City Wind, LLC (Park City Wind), in its Construction and Operations Plan (COP). The proposed Project described in the COP and this Final EIS would be at least 2,036 megawatts in scale (and up to 2,600 megawatts) approximately 20 miles from the southwest corner of Martha's Vineyard and approximately 24 miles from Nantucket at its closest point, within the area of Renewable Energy Lease Number OCS-A 0534 (Lease Area). The proposed Project would serve demand for renewable energy in one or more New England states. This Final EIS was prepared in accordance with the requirements of the National Environmental Policy Act (42 U.S. Code 4321–4370f) and implementing regulations of the Council on Environmental Quality and the Department of the Interior. This Final EIS will inform the Bureau of Ocean Energy Management's decision on whether to approve, approve with modifications, or disapprove the proposed Project's COP. Publication of the Draft EIS initiated a 60-day public comment period, after which all the comments received were assessed and considered by the Bureau of Ocean Energy Management in the preparation for this Final EIS. Comments on the Draft EIS can be found in Appendix O.

Additional copies of this Final EIS may be obtained by writing the Bureau of Ocean Energy Management, Attn: Lindy Nelson (address above); by telephone at (571) 789-6485; or by downloading from the BOEM website at https://www.boem.gov/renewable-energy/state-activities/new-england-wind-formerly-vineyard-wind-south.

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Abbreviations and Acronyms

Abbreviation	Definition
§	Section
°C	degrees Celsius
°F	degrees Fahrenheit
24/7	24 hours per day, 7 days per week
µPa	micropascal
µPa2 s	micropascal squared second
µT	microtesla
AC	alternating current
ACP	American Clean Power
A.D.	Anno Domini
ADLS	aircraft detection lighting system
AEP	auditory evoked potential
AFS EWR	Air Force Station Early Warning Radar
AIS	automatic identification system
AMSL	above mean sea level
APE	area of potential effect
ARSR	Air Route Surveillance Radar
ASR	Airport Surveillance Radar
ASMFC	Atlantic States Marine Fisheries Commission
ATON	aids to navigation
B.P.	before present
BA	Biological Assessment
BMP	best management practice
BO	Biological Opinion
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
COP	Construction and Operations Plan
COVID-19	coronavirus disease 2019
CPT	cone penetrometer testing
CTV	crew transfer vessel
CWA	Clean Water Act
CZM	Massachusetts Office of Coastal Zone Management
DAS	distributed acoustic sensing
dB	decibel
dB re 1 µPa	decibels referenced to 1 micropascal
dB re 1 µPa m	decibels referenced to 1 micropascal at 1 meter
dB re 1 µPa2 s	decibels referenced to 1 micropascal squared second
dBA	A-weighted decibel
DC	direct current
DHS	Department of Homeland Security
DoD	Department of Defense
DP	dynamic positioning
DPS	distinct population segment
EFH	essential fish habitat
EIS	Environmental Impact Statement
EMF	electromagnetic fields
EO	Executive Order
ER95%	95 percentile exposure-based range
ESA	Endangered Species Act
ESP	electrical service platform
FAA	Federal Aviation Administration
Fed. Reg.	Federal Register

Abbreviation	Definition
FMP	Fisheries Management Plan
FTE	full-time equivalent
G&G	geological and geophysical
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt
HAPC	habitat area of particular concern
HCA	Host Community Agreement
HDD	horizontal directional drilling or drill
HF	high frequency
HFC	high-frequency cetacean
HMS	highly migratory species
HRG	high-resolution geophysical
Hz	hertz
IFR	instrument flight rules
IHA	incidental harassment authorization
IOOS	Integrated Ocean Observing System
IPF	impact-producing factor
ITA	Incidental Take Authorization
ITS	Incidental Take Statement
kHz	kilohertz
kJ	kilojoule
km	kilometer
km_2	square kilometers
kV	kilovolt
KOP	key observation point
Lpk	peak sound pressure
LFC	low-frequency cetacean
LME	Large Marine Ecosystem
LOA	Letter of Authorization
LRR	long range radar
M/SI	mortality and serious injury
m	meter
m_2	square meter
MA DMF	Massachusetts Division of Marine Fisheries
MAB	Mid-Atlantic Bight
SouthCoast Wind	SouthCoast Wind Project
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
MCT	Marine Commerce Terminal
MEC	minimum explosible concentration
MFC	mid-frequency cetacean
MLLW	mean lower low water
mG	milligaus
MMS	Minerals Management Service
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MVA	minimum vectoring altitudes
MVR	marine vessel radar
MW	megawatt
NA	not applicable
NARW	North Atlantic right whale
NAS	National Academies
NC	not conclusive
ND	no data
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar
NHL	National Historic Landmark
NHPA	National Historic Preservation Act

Abbreviation	Definition
NMFS	National Marine Fisheries Service
NNL	National Natural Landmark
NOA	Notice of Availability
NOx	nitrogen oxide
NO2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense Command
NORM	Navigational and Operational Risk Model
NRHP	National Register of Historic Places
NSRA	navigational safety risk assessment
NVIC	Navigation and Vessel Inspection Circular
NWS	National Weather Service
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OECC	offshore export cable corridor(s)
OECR	onshore export cable route
OEM	original equipment manufacturer
OSRP	oil spill response plan
PAM	passive acoustic monitoring
PATON	private aid to navigation
PAVE/PAWS	precision avionics vectoring equipment / phased array warning system
PBR	potential biological removal
PDE	Project design envelope
$PM_{2.5}$	particulate matter smaller than 2.5 microns
PM_{10}	particulate matter smaller than 10 microns
PPA	power purchase agreement
PPW	phocid pinniped in water
ProvPort	Port of Providence
Project	New England Wind Project
PSO	protected species observer
PST	Preliminary Screening Tool
PTS	permanent threshold shift
RCS	reactive compensation station
RHA	Rivers and Harbors Act of 1899
RI/MA Lease Areas	Rhode Island and Massachusetts Lease Areas
ROD	Record of Decision
ROV	remotely operated vehicle
ROW(s)	right(s)-of-way
SAR	search and rescue
SB	Senate Bill
SCADA	supervisory control and data acquisition
SCV	South Coast Variant
SEL	sound exposure level
SEL_{24h}	sound exposure level over 24 hours
SLIA	Seascape and Landscape Impact Assessment
SLVIA	Seascape and Landscape Visual Impact Assessment
SMAST	School for Marine Science and Technology
SO_2	sulfur dioxide
SOV	service operation vessel
SPL	sound pressure level
SPUE	sightings per unit effort
SSU	special, sensitive, and unique
SWDA	Southern Wind Development Area
TCP	traditional cultural property
TDWR	Terminal Doppler Weather Radar
TRACON	Terminal Radar Approach Control
TSHD	trailing suction hopper dredge
TTS	temporary threshold shift

Abbreviation	Definition
UME	unusual mortality event
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
USC	U.S. Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
VFR	Visual Flight Rules
VIA	Visual Impact Assessment
Vineyard Wind 1	Vineyard Wind 1 Project
VMS	vessel monitoring system
VTR	vessel trip report
WMA	Wildlife Management Area
WSR	Weather Surveillance Radar
WTG	wind turbine generator
ZBW	Boston
ZVI	zone of visual influence

Executive Summary

ES.1 Introduction

This Final Environmental Impact Statement (EIS) assesses the reasonably foreseeable impacts on physical, biological, socioeconomic, and cultural resources that could result from the construction and installation (construction), operations and maintenance (operations), and conceptual decommissioning (decommissioning) of a commercial-scale offshore wind energy facility and transmission cable to shore known as the New England Wind Project (Project) proposed by Park City Wind, LLC (Park City Wind, the applicant). The proposed Project consists of two phases: Phase 1, which is also known as the Park City Wind Project, and Phase 2, which is also known as the Commonwealth Wind Project. The proposed Project described in the applicant's Construction and Operations Plan (COP) and this Final EIS would occupy all of the Bureau of Ocean Energy Management's (BOEM) Renewable Energy Lease Number (Lease Area) OCS-A 0534 and potentially a portion of the area covered by Lease Area OCS-A 0501 (Southern Wind Development Area [SWDA]).[1]

BOEM has prepared the Final EIS under the National Environmental Policy Act (NEPA) (U.S. Code, Title 42, Sections 4321–4370f [42 USC §§ 4321–4370f]). This Final EIS informs BOEM's decision on whether to approve, approve with modifications, or disapprove the proposed Project's COP. Cooperating agencies may rely on this Final EIS to support their decision-making. In conjunction with submitting its COP, Park City Wind applied to the National Marine Fisheries Service (NMFS) for an Incidental Take Authorization under the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 USC § 1361 et seq.), for incidental take of marine mammals during proposed Project construction. NMFS needs to render a decision regarding the request for authorization due to NMFS' responsibilities under the MMPA (16 USC § 1371 (a)(5)(A) and its implementing regulations. NMFS intends to adopt the Final EIS if, after independent review and analysis, NMFS determines the Final EIS to be sufficient to support the authorization. The U.S. Army Corps of Engineers (USACE) similarly intends to adopt the Final EIS to meet its responsibilities under Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 (RHA).

ES.2 Purpose of and Need for the Proposed Action

Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, issued January 27, 2021, 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 the Code of Federal Regulations, Title 30, Section 585.211 (30 CFR § 585.211), BOEM awarded Lease Area OCS-A 0501 to Vineyard Wind 1, LLC. On December 14, 2021, BOEM approved Vineyard Wind 1, LLC's assignment of 101,590 acres to the applicant, which were designated as Lease Area OCS-A 0534. Vineyard Wind 1, LLC retained, as Lease OCS-A 0501, the remaining 65,296 acres (Figure ES-1).

[1] The developer of the Vineyard Wind 1 Project (Vineyard Wind 1, LLC) would assign spare or extra positions in the southwestern portion of OCS-A 0501 to Park City Wind for the New England Wind Project if those positions are not developed as part of the Vineyard Wind 1 Project.

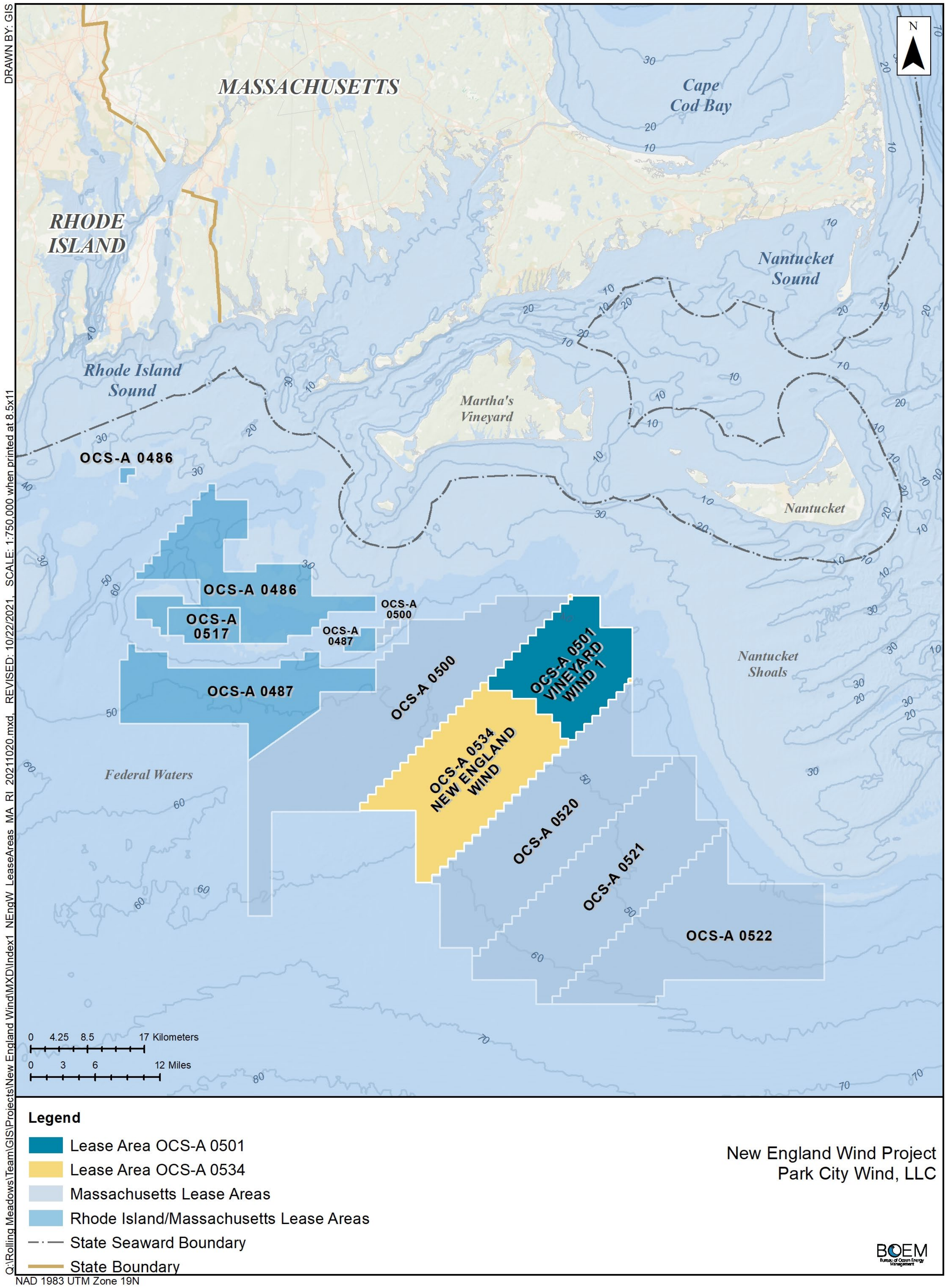

Figure ES-1: Proposed Wind Development Area Relative to Rhode Island and Massachusetts Lease Areas

Under the terms of the lease, the applicant has the exclusive right to submit a COP for activities within the lease area,[2] and it has submitted a COP to BOEM proposing the construction, operations, and decommissioning of an offshore wind energy facility in the lease area in accordance with BOEM's COP regulations under 30 CFR §§ 585.626, et seq. (Figures ES-2 through ES-7).

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 (shared goals of the Departments of Interior, Energy, and Commerce to deploy 30 gigawatts [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 the COP. BOEM will make this determination after weighing the factors in Subsection 8(p)(4) of the OCSLA that are applicable to plan decisions and in consideration of the above goals. BOEM's action is needed to fulfill its duties under the lease, which require BOEM to make a decision on the lessee's plans to construct and operate a commercial-scale offshore wind energy facility within the lease area (the Proposed Action).

In addition, NMFS received a request for authorization (in the form of a Letter of Authorization) under the MMPA to take marine mammals incidental to construction activities related to the proposed Project. NMFS' issuance of an MMPA Incidental Take Authorization would be a major federal action connected to BOEM's action (40 CFR § 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of the applicant's request for authorization to take marine mammals incidental to specified activities associated with the proposed Project (e.g., pile driving)—is to evaluate the applicant's request pursuant to specific requirements of the MMPA and its implementing regulations administered by NMFS, considering impacts of the applicant's activities on relevant resources, and, if appropriate, issue the permit or authorization. NMFS needs to render a decision regarding the request for authorization due to NMFS' responsibilities under the MMPA (16 USC § 1371(a)(5)(A)) and its implementing regulations. If NMFS makes the findings necessary to issue the requested authorization, NMFS intends to adopt, after independent review, BOEM's Final EIS to support that decision and fulfill its NEPA requirements.

The 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 RHA (33 USC § 403) and Section 404 of the CWA (33 USC § 1344). USACE considers issuance of permits under these two delegated authorities a major federal action connected to BOEM's action (40 CFR § 1501.9(e)(1)). The need for the Project as provided by the applicant in the COP and reviewed by USACE for NEPA purposes is to provide a commercially viable offshore wind energy project within the lease area. The basic Project purpose, as determined by USACE for Section 404(b)(1) guidelines evaluation, is offshore wind energy generation. The overall Project purpose for Section 404(b)(1) guidelines evaluation, as determined by USACE, is the construction and operations of a commercial-scale offshore wind energy project for renewable energy generation and distribution to the New England energy grids. USACE intends to adopt BOEM's Final EIS to support its decision on any permits and permissions requested under Section 10 of the RHA and Section 404 of the CWA. USACE would adopt the EIS under 40 CFR § 1506.3 if, after its independent review of the document, it concludes that the EIS satisfies USACE's comments and recommendations. Based on its participation as a cooperating agency and its consideration of the Final EIS, USACE would issue a Record of Decision (ROD) to formally document its decision on the Proposed Action.

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[2] A small portion of the area covered by Lease Area OCS-A 0501 not used for development of the Vineyard Wind 1 Project (Vineyard Wind 1) may also be assigned to the applicant and developed as part of the proposed Project (i.e., the New England Wind Project).

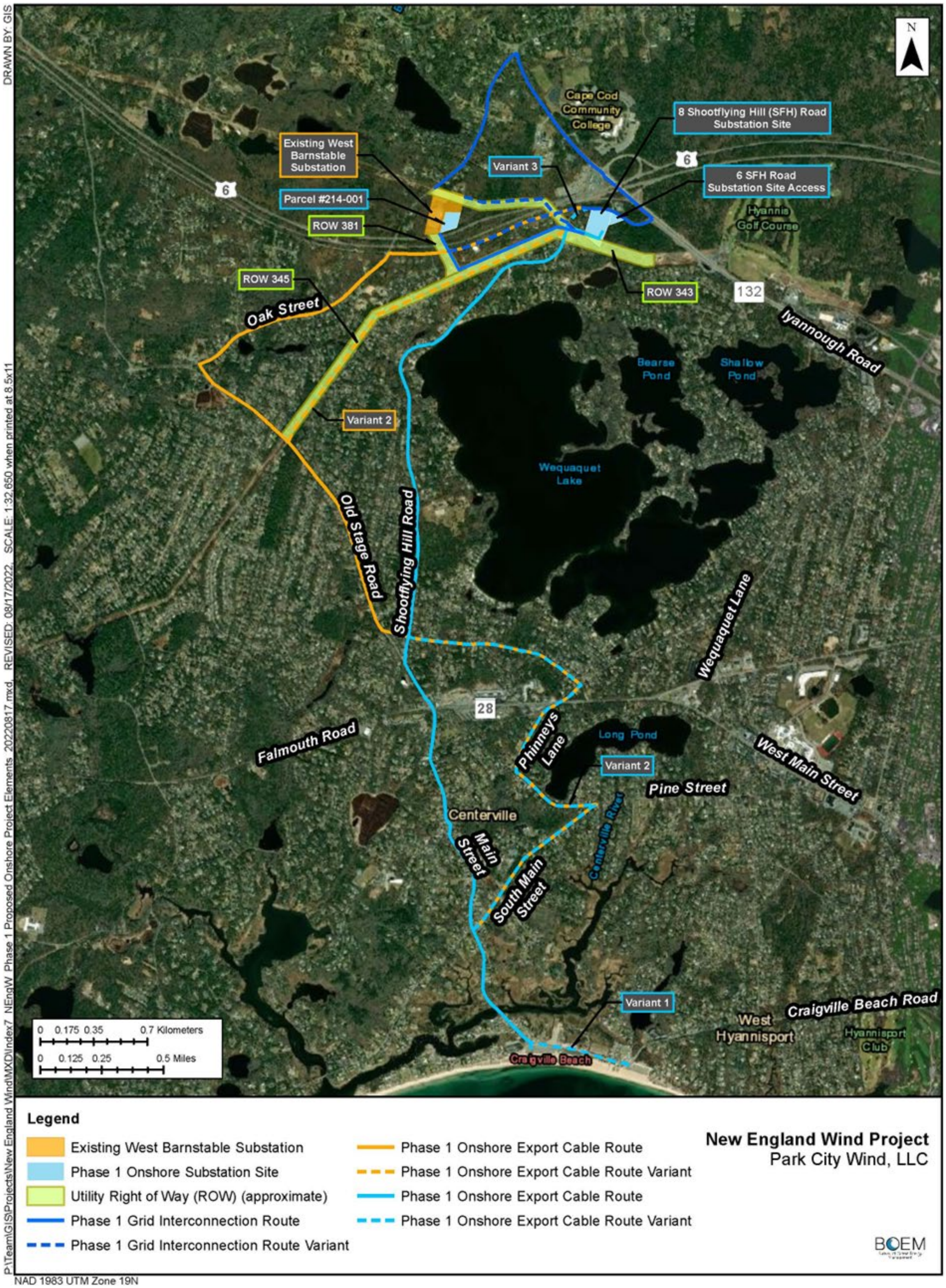


Figure ES-2: Proposed Project Phase 1 Onshore Project Facilities

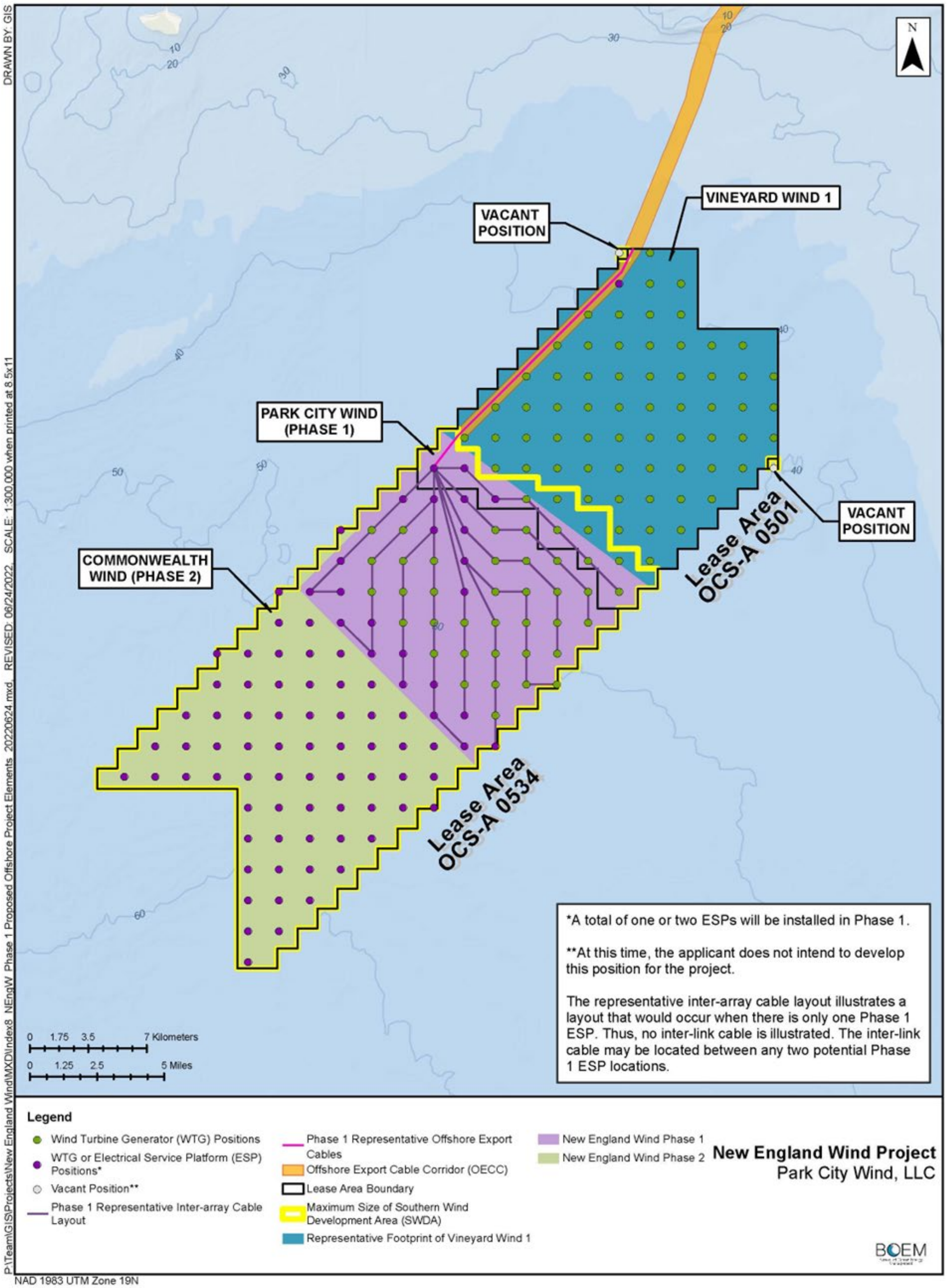


Figure ES-3: Proposed Project Phase 1 Offshore Project Facilities

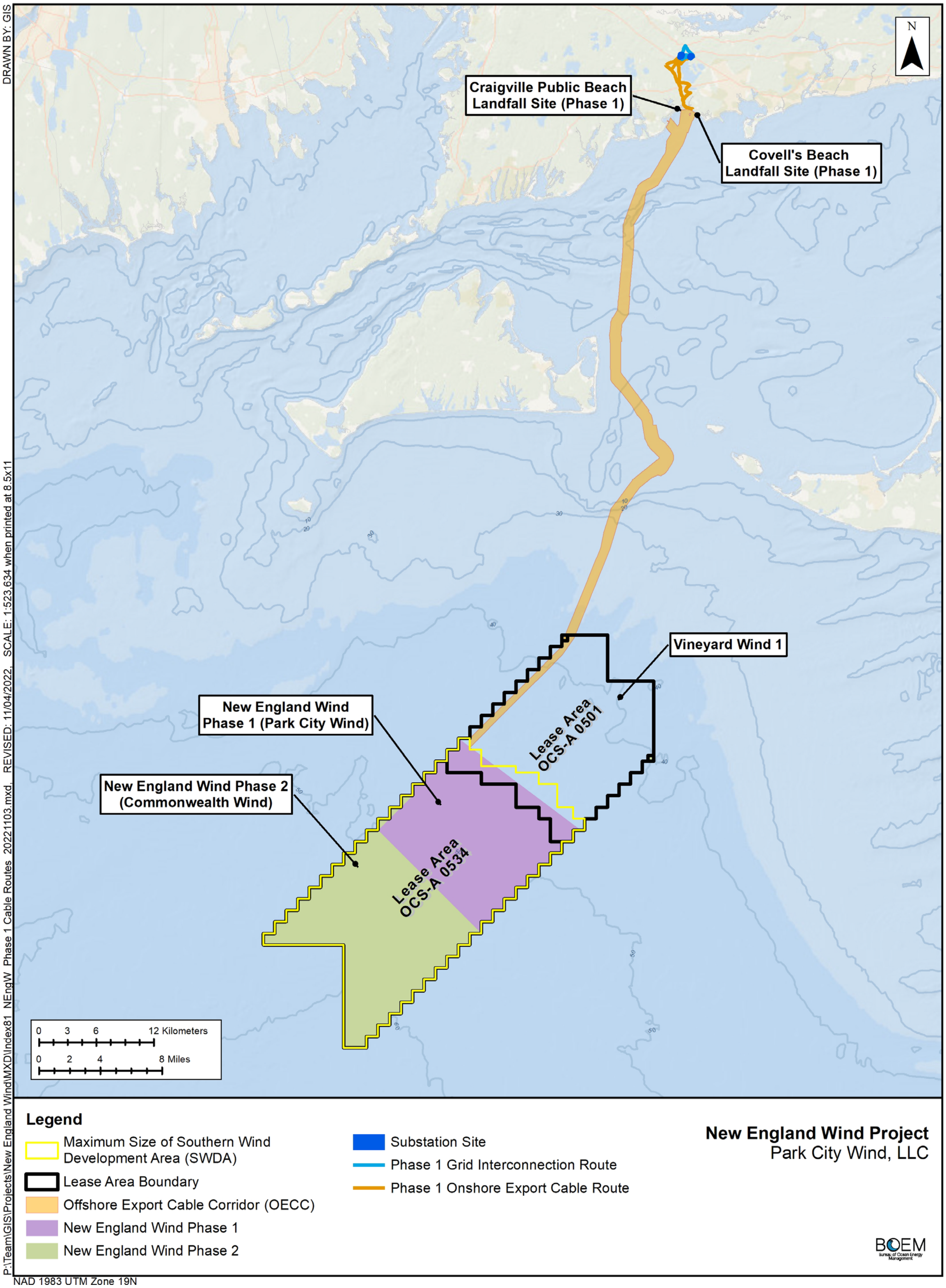
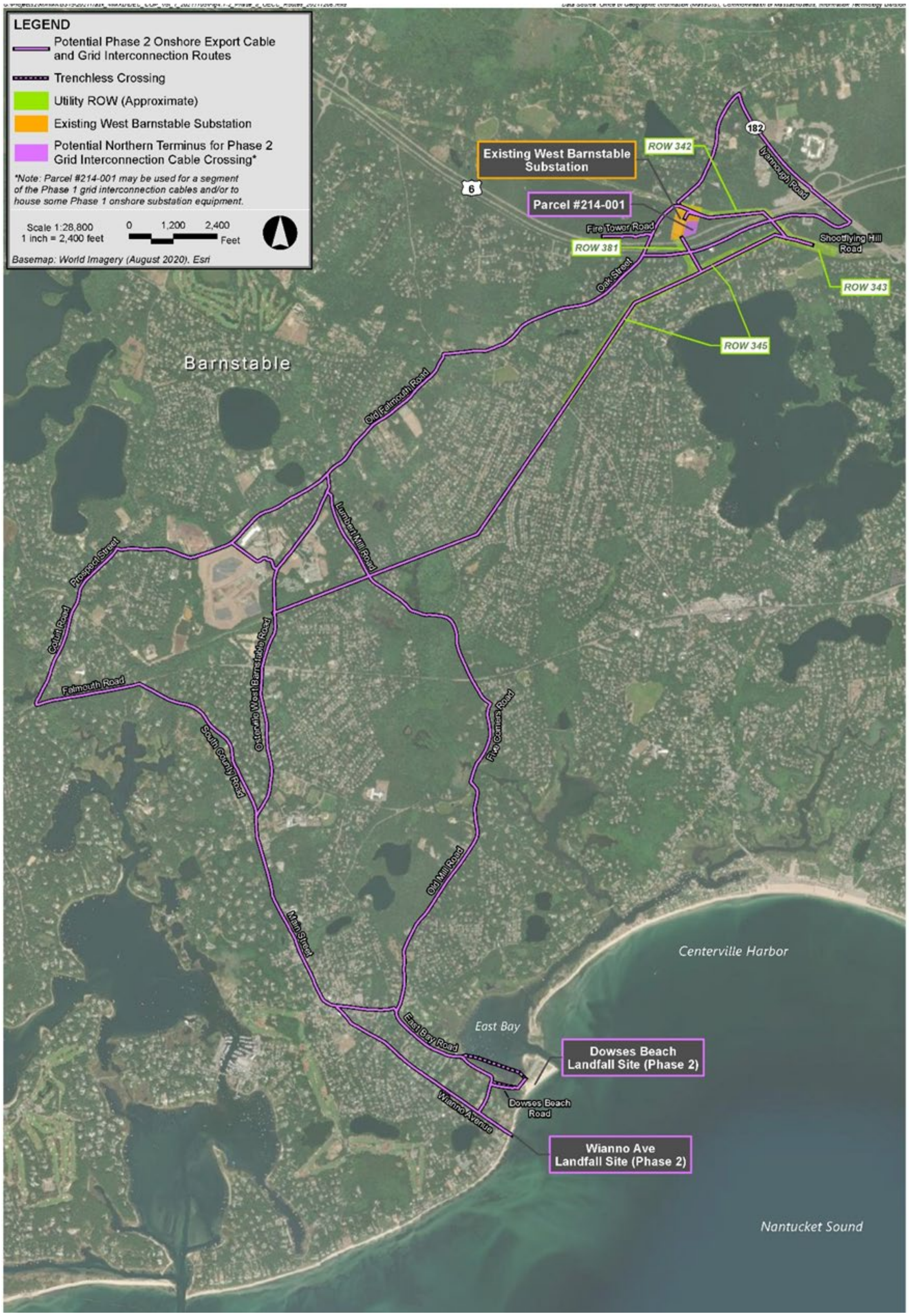


Figure ES-4: Proposed Project Phase 1 Offshore Export Cable Route



ROW = right-of-way

Figure ES-5: Proposed Project Phase 2 Onshore Project Facilities

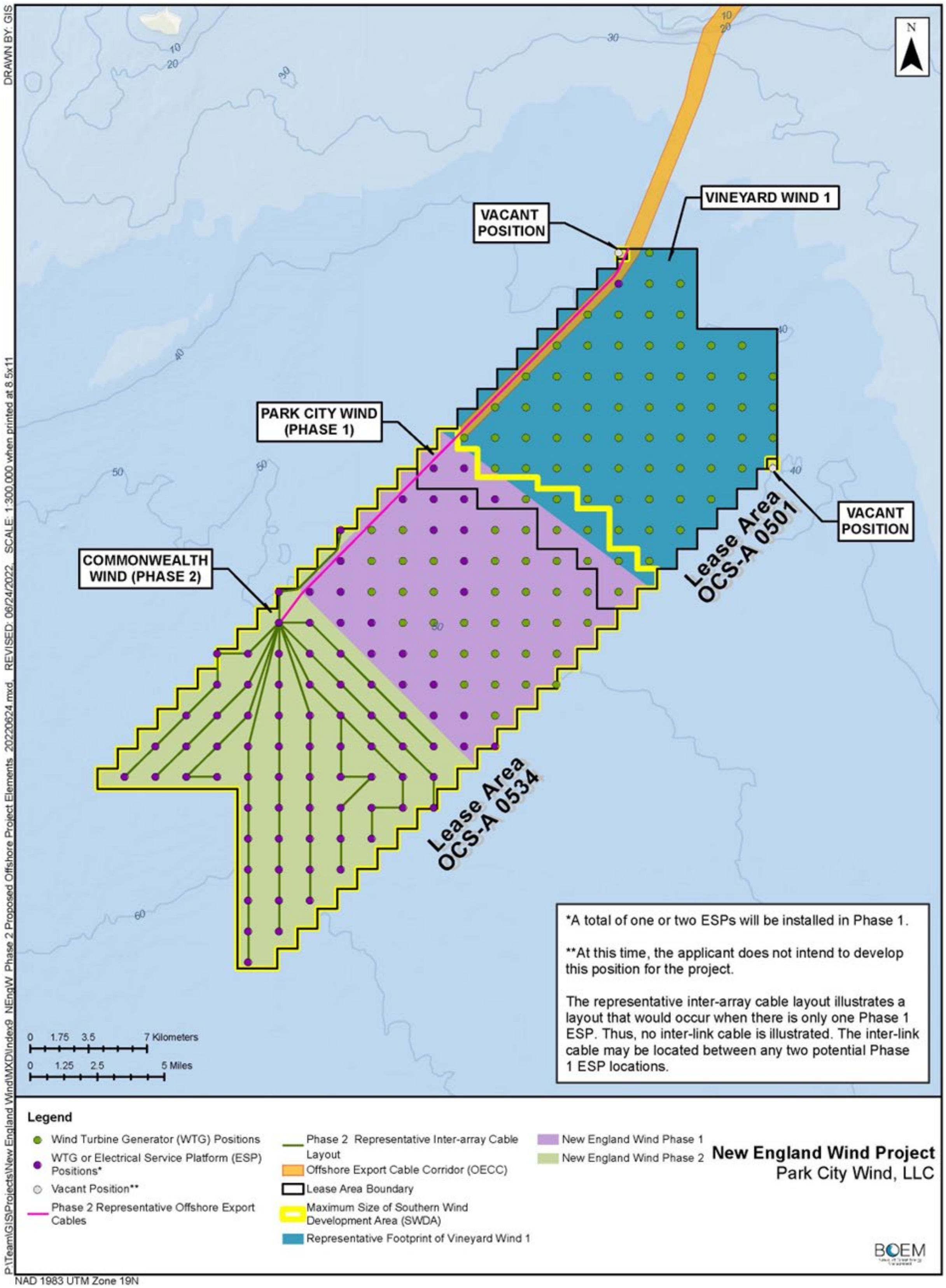


Figure ES-6: Proposed Project Phase 2 Offshore Project Facilities

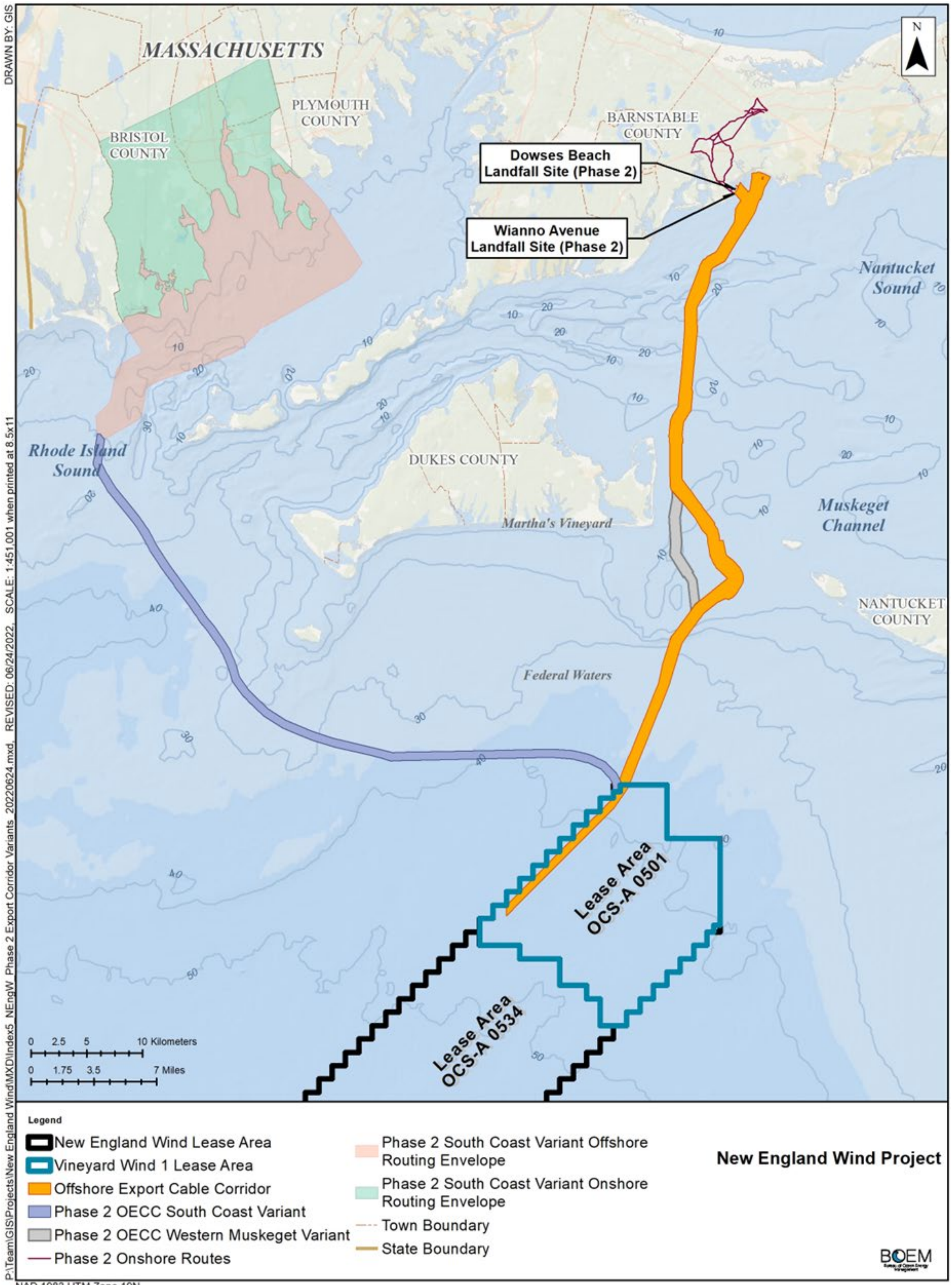


Figure ES-7: Proposed Project Phase 2 Offshore Export Cable Routes

ES.3 Public Involvement

On June 30, 2021, BOEM issued a Notice of Intent (NOI) to prepare an EIS, initiating a 30-day public scoping period from March 30 to April 29, 2021 (86 *Federal Register* [Fed. Reg.] 123 p. 34782 [June 30, 2021]). The NOI solicited public input on the significant resources and issues, impact-producing factors (IPF), reasonable alternatives, and potential mitigation measures to analyze in the EIS. BOEM also used the NEPA scoping process to initiate the Section 106 consultation process under the National Historic Preservation Act (NHPA; 54 USC § 300101 et seq.), as permitted by 36 CFR § 800.2(d)(3), and sought public comment and input through the NOI regarding the identification of historic properties or potential impacts on historic properties from activities associated with approval of the COP. BOEM held three virtual public scoping meetings on July 19, July 23, and July 26, 2021, to present information on the proposed Project and NEPA process, answer questions from meeting attendees, and solicit public comments. Scoping comments were received through Regulations.gov on docket number BOEM-2021-0047, via email to a BOEM representative, and through oral testimony at each of the three public scoping meetings.

On August 19, 2021, Park City Wind (then operating as Vineyard Wind, LLC) notified BOEM of the potential need to establish offshore export cable corridors (OECC) for Phase 2 of the proposed Project, beyond those previously identified in the COP. Park City Wind also notified BOEM of a change in the Project's name, from the Vineyard Wind South Project to the New England Wind Project. On November 22, 2021, BOEM issued a Notice of Additional Public Scoping and Name Change to announce the proposed Project name change and assess the potential impacts of the Phase 2 OECC alternative routes (86 Fed. Reg. 222 [November 22, 2021] p. 66334). This notice commenced a second public scoping process, between November 22 and December 22, 2021, that was similar in intent and purpose to the first scoping process, focusing on the newly proposed Phase 2 OECC alternative routes. Information, including a video presentation, was posted to BOEM's website to provide supporting information on the Phase 2 OECC alternatives.

BOEM received total of 1,160 comment submissions from federal and state agencies, local governments, non-governmental organizations, and the general public during the two scoping periods. The topics most referenced in the scoping comments included birds; marine mammals; NEPA process and public engagement; socioeconomics; planned activities; commercial fisheries and for-hire recreational fishing; purpose and need; finfish, invertebrates, and essential fish habitat (EFH); mitigation; bats; benthic habitat; regulatory framework; alternatives; sea turtles; reference recommendations; impact methodology and definitions; environmental justice; air quality; Proposed Action; decommissioning; and cultural, historical, and archaeological resources. BOEM considered all public comments received during the Draft EIS public comment period while preparing this Final EIS.

On December 23, 2022, BOEM issued a Notice of Availability of the Draft EIS, initiating a 60-day public comment period from December 23, 2022, to February 21, 2023 (87 Fed. Reg. 78993 [December 23, 2022]). BOEM held three virtual public hearings on January 27, February 1, and February 6, 2023. Public comments were received through Regulations.gov on docket number BOEM-2022-0070, via email and mail to a BOEM representative, and through oral testimony at each of the three public hearings. BOEM received a total of 93 comment submissions from federal and state agencies, local governments, non-governmental organizations, and the general public during the comment period. BOEM assessed and considered all the comments received in preparation of the Final EIS. See Appendix A, Required Environmental Permits and Consultations, for additional information on public involvement.

ES.4 Alternatives

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

- Alternative A, No Action Alternative
- Alternative B, Proposed Action
- Alternative C, Habitat Impact Minimization Alternative
    - Alternative C-1, Western Muskeget Variant Avoidance
    - Alternative C-2, Eastern Muskeget[3] Route Minimization

Alternatives considered but dismissed from detailed analysis and the rationale for their dismissal are described in Section 2.2 of the Final EIS.

ES.4.1 Alternative A – No Action Alternative

Under the No Action Alternative, BOEM would not approve the COP. Proposed Project construction, operations, and decommissioning would not occur, and no additional permits or authorizations for the proposed Project would be required. Any potential environmental and socioeconomic impacts, including benefits, associated with the proposed 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, impacts on marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the applicant. The current resource condition, trends, and impacts from ongoing activities under the No Action Alternative serve as existing conditions 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 existing conditions even in the absence of the Proposed Action. The continuation of all other existing and reasonably foreseeable future offshore wind and non-offshore wind activities described in Appendix E, Planned Activities Scenario, without the Proposed Action serves as existing conditions for the evaluation of cumulative impacts of all alternatives.

ES.4.2 Alternative B – Proposed Action

The Proposed Action would construct, operate, and decommission a wind energy facility within the range of design parameters described in Volume I of the COP (Epsilon 2023) and summarized in Table ES-1 and Appendix C, Project Design Envelope and Maximum-Case Scenario. Refer to Volume I of the COP (Epsilon 2023) for additional details on proposed Project design.

If technical, logistical, grid interconnection, or other unforeseen issues prevent all Phase 2 export cables from interconnecting at the West Barnstable Substation, the applicant would develop and use the South Coast Variant (SCV) in place of, or in addition to, the currently proposed Phase 2 OECC and onshore export cable route (OECR) (Figure ES-6). Because the SCV is a contingency, the applicant has not provided information on grid interconnection routes, onshore cable routes, landfall locations, and

[3] The Eastern Muskeget route for Phase 2 is depicted as the OECC on Figure ES-7 and follows the eastern route through Muskeget Channel.

nearshore cable routes necessary to prepare a sufficient analysis of the SCV at the time of publication of this Final EIS. Therefore, the analysis of the SCV in this Final EIS includes available information but reflects some uncertainty. If the applicant determines that the SCV is necessary, the applicant would be required to file a COP revision per 30 CFR § 585.634, describing the need for the SCV and providing the information necessary to complete a sufficient analysis. Table ES-2 summarizes scenarios for Phase 2 export cable installation.

Table ES-1: Summary of Project Design Envelope Parameters

Project Parameter	Details
Layout, size, and capacity	Phase 1: • Up to 62 WTGs • One or two ESPs • 37,066 to 57,081 acres in the SWDA • At least 804 MW Phase 2: • Up to 88 WTGs • One to three ESPs • 54,857 to 74,873 acres in the SWDA • 1,232 to 1,725 MW Overall: • Up to 130 WTG/ESP positions (129 maximum WTGs) • Two to five ESPs • 101,590 to 111,939 acres in the SWDA • 2,036 to 2,600MW • All WTG and ESP positions arranged in a grid with 1 nautical mile (1.9 kilometers, 1.15 miles) between positions in the north-to-south and east-to-west directions[a]
Schedule	• Phase 1 anticipated to be in service as early as 2028 • Portions of Phase 2 construction are anticipated to being immediately following construction of Phase 1, with the remainder following by a number of years.[b]
Foundations (WTGs and ESPs)	Phase 1: • All foundations could be either monopile foundations (with or without a transition piece) or piled jacket foundations with 3 to 4 legs Phase 2: • WTG foundations could be either monopile (with transition piece, or one-piece monopile/transition piece), jacket (3 to 4 legs) or bottom-frame foundations • ESP foundations could be either monopile (with transition piece, or one-piece monopile/transition piece) or jacket (3 to 4 legs) • Jacket or bottom-frame foundations could have piles or suction bucket bases Overall: • Foundation piles would be installed using a pile-driving hammer • Scour protection would be placed around all foundations

WTGs	Both phases:
	• Rotor diameter up to 935 feet
	• Hub height up to 702 feet above MLLW
	• Top of nacelle height up to 725 feet above MLLW
	• Maximum vertical blade tip extension up to 1,171 feet above MLLW
	• Minimum blade tip clearance 89 feet above MLLW
	• All WTGs painted off white or light grey (no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey)
	• Nighttime lighting that complies with FAA and USCG lighting standards and consistent with BOEM best practices (BOEM 2021):
	  o USCG-required navigation warning lights mounted on each WTG foundation (no higher than 148 feet above MLLW), visible to at least 5 nautical miles (5.8 miles) during low visibility conditions
	  o Red, flashing FAA aviation hazard lighting on the top of each WTG nacelle and at intervals on each WTG tower

Project Parameter	Details
	o All FAA aviation hazard lights would use an ADLS that would automatically activate lights only when aircraft approach, estimated to be approximately 13 minutes per year (COP Appendix III-K; Epsilon 2023)
Inter-array cables (cables connecting WTGs to ESPs)	• Target burial depth: 5 to 8 feet • Voltage: 132 kV AC • Maximum total cable length: o Phase 1: 139 miles o Phase 2: 201 miles
ESPs	• Total structure height up to 230 feet above MLLW • Maximum topside dimensions: 238 feet × 197 feet × 125 feet • Nighttime lighting (USCG navigation lighting and FAA aviation hazard lighting) similar to WTGs, including use of ADLS
Inter-link cables (cables connecting ESPs to each other)	• Maximum 275 kV (Phase 1) or 345 kV (Phase 2) AC • Target burial depth of 5 to 8 feet • Maximum total cable length: 11 nautical miles (12.7 miles) (Phase 1) and 32 nautical miles (36.8 miles) (Phase 2) o Phase 1: 12.7 miles o Phase 2: 36.8 miles
Offshore export cables	• Phase 1: o Two cables with maximum 275 kV AC o Maximum cable length (all cables combined) of 125 miles • Phase 2: o Three cables with maximum 345 kV AC o Maximum cable length (all cables combined) of 221 miles • Target burial depth of 5 to 8 feet • Two OECCs variants for Phase 2 (Figure ES-7): o Western Muskeget Variant o SCV
Landfall for the offshore export cable	• Phase 1: Craigville Public Beach (preferred) or Covell's Beach (Figure ES-4) • Phase 2: Dowses Beach (preferred) or Wianno Avenue (Figure ES-7) • All landfalls installed using HDD; no surface disturbance
Onshore export cables	• Separate Phase 1 (Figure ES-2) and Phase 2 (Figure ES-5) OECRs with variants • Onshore cables would generally be installed within public roadway layouts or existing utility easements • Total onshore export cable length o Phase 1: up to 6.5 miles o Phase 2: up to 10.6 miles
Onshore substation and grid interconnection cable	• New 6.7-acre substation at 6 Shootflying Hill Road • Potential use of 2.8-acre parcel adjacent to existing West Barnstable Substation • Grid interconnection cable to existing substation: o Up to 1.8 miles long o Generally installed within public road layouts or entirely within existing utility ROWs • Additional equipment installed at existing West Barnstable Substation

AC = alternating current; ADLS = aircraft detection lighting system; BOEM = Bureau of Ocean Energy Management; COP = Construction and Operations Plan; ESP = electrical service platform; FAA = Federal Aviation Administration; HDD = horizontal directional drilling; kV = kilovolt; MLLW = mean lower low water; MW = megawatts; OECC = offshore export cable corridor; OECR = onshore export cable route; ROW = right-of-way; SCV = South Coast Variant; SWDA = Southern Wind Development Area; USCG = U.S. Coast Guard; WTG = wind turbine generator

[a] The COP seafloor disturbance tables (Appendix III-T; Epsilon 2023), acoustic impacts (Appendix III-M; Epsilon 2023), the Navigation Safety Risk Assessment (COP Appendix III-I; Epsilon 2023), Marine Archaeological Resources Assessment (COP Appendix II-D; Epsilon 2023), and air emissions (COP Appendix III-B; Epsilon 2023) incorporate 132 foundations in 130 WTG/ESP positions (Maria Hartnett, Pers. Comm, November 15, 2022). BOEM is reviewing the "co-located foundation" concept to determine whether it is consistent with the uniform, orthogonal, 1- × 1-nautical-mile (1.15-mile) grid that the applicant and all other developers and applicants for projects in the RI/MA Lease Areas agreed to implement, based on USCG's May 2020 Final Massachusetts and Rhode Island Port Access Route Study (USCG 2020). The Final EIS include BOEM's determination regarding this issue.

[b] The full build-out of Phase 2 development is largely dependent upon market conditions and the advancement of WTG technology.

Table ES-2: Offshore Export Cable Corridor Scenarios

Phase 2 OECC Routes	Number of Phase 2 Cables by Scenario					
	1	2	3	4	5[a]	6[a]
Eastern Muskeget OECC[b]	3	2	2	1	1	0
Western Muskeget Variant OECC	0	1	0	2	0	0
SCV OECC[c]	0	0	1	0	2	3

Source: COP Volume I, Table 4.1-2; Epsilon 2023

OECC = offshore export cable corridor; SCV = South Coast Variant
[a] The applicant states that Scenarios 5 and 6 are theoretically possible but unlikely and would require significant delays to Phase 2 due to the need to upgrade substations connected to ISO-NE that are not currently planned for upgrade. Furthermore, the applicant states that Scenario 4 is theoretically possible but unlikely and would be challenging to route even one cable within the Western Musket Variant for engineering and technical reasons (Avangrid 2022a).

[b] The Eastern Muskeget route for Phase 2 is depicted as the OECC on Figure ES-7 and follows the eastern route through Muskeget Channel.

[c] If the SCV is necessary, the applicant would be required to file a COP revision per 30 CFR § 585.634, describing the need for the SCV and providing the information necessary to complete a sufficient analysis. In response, BOEM would complete additional environmental analysis and relevant consultations required by NEPA, NHPA, and other applicable statutes to inform BOEM's decision to approve, approve with conditions, or disapprove the COP revision.

ES.4.3 Alternative C – Habitat Impact Minimization Alternative

Under Alternative C, construction, operations, and decommissioning of the proposed Project's wind turbine generators (WTG) and electrical service platforms (ESP) would occur within the range of design parameters outlined in the COP, subject to applicable mitigation and monitoring measures (Appendix H, Mitigation and Monitoring). Compared to Alternative B, this alternative would minimize impacts on complex fisheries habitats—areas of seafloor that are stable, exhibit vertical relief, and/or provide rare habitat compared to the broad sand flats that characterize much of the Atlantic OCS. Complex habitats include gravel or pebble-cobble beds, sand waves, biogenic structures (e.g., burrows, depressions, sessile soft-bodied invertebrates), shell aggregates, boulders, hard-bottom patches, and cobble beds, among other features (COP Volume II-A, Section 5.2; Epsilon 2023). To minimize impacts on complex fisheries habitats, BOEM would limit the potential OECC construction scenarios described in Table ES-3 through the implementation of one of the sub-alternatives described below:

- Alternative C-1, Western Muskeget Variant Avoidance: This alternative would preclude the use of the Western Muskeget Variant, limiting available scenarios to those that include only the Eastern Muskeget route and SCV, as shown on Figure ES-7.[3] Scenarios 1, 3, 5, and 6 in Table 2.1-2 would be considered under Alternative C-1. Avoiding use of the Western Muskeget Variant would avoid a crossing of a proposed OECC route for the SouthCoast Wind Energy Project (SouthCoast Wind) (Lease Area OCS-A 0521) within the Western Muskeget Channel.
- Alternative C-2, Eastern Muskeget Route Minimization: This alternative would minimize, to the degree practicable, the use of the Eastern Muskeget route and maximize the use of the Western Muskeget Variant and/or the SCV (Scenarios 4, 5, and 6 in Table 2.1-2) for all Phase 2 export cables. Under this alternative, the two Phase 1 cables would be installed in the Eastern Muskeget route, along with a maximum of one Phase 2 cable. This eliminates the option for a total of two to three Phase 2 cables to be installed in the Eastern Muskeget route.

ES.4.4 Preferred Alternative

BOEM has identified the combination of Alternative B and Alternative C-1 as the Preferred Alternative, with the intent of limiting the installation of export cables to the Eastern Muskeget route. In doing so, the proposed Project would reduce the total amount of impacts on complex benthic habitat and limit the total number of potential crossings of the proposed Project's offshore export cables with the proposed SouthCoast Wind export cables to a single crossing south of the Muskeget Channel, where complex benthic habitat is rarer. The Preferred Alternative includes a Western Muskeget Variant Contingency Option, which would allow the use of the Western Muskeget Variant only if the lessee provides adequate written justification to BOEM that its use is necessary for the proposed Project's viability. The Preferred Alternative would also disallow the co-location of ESPs or WTGs resulting in the construction, operations, and eventual decommissioning of up to 130 WTG or ESP positions for 125 to 129 WTGs and 1 to 5 ESPs on the OCS installed within Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501. The Preferred Alternative is identified to let the public know which alternative BOEM, as the lead agency, is leaning toward before an alternative is selected for action when a ROD is issued. No final agency action is being taken by the identification of the Preferred Alternative, and BOEM is not obligated to select the Preferred Alternative.

ES.5 Environmental Impacts

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

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

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

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

Table ES-3: Summary and Comparison of Impacts Among Alternatives

Resources	**Alternative A[a,b]**	**Alternative B[b]**	**Alternative C[b]**	**Preferred Alternative**
Benthic Resources: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Benthic Resources: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Coastal Habitats and Fauna: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Coastal Habitats and Fauna: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Finfish, Invertebrates, and Essential Fish Habitat: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Finfish, Invertebrates, and Essential Fish Habitat: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Marine Mammals: *Alternative Impacts (Without Planned and Ongoing Activities)*[c]	**No impact**	**Minor** for NARW (*Eubalaena glacialis*), **Moderate** for all other mysticetes (except NARW), harbor porpoise (*Phocoena phocoena*), and pinnipeds, and **Minor** for all other odontocetes (except harbor porpoise)	**Minor** for NARW, **Moderate** for all other mysticetes (except NARW), harbor porpoise, and pinnipeds, and **Minor** for all other odontocetes (except harbor porpoise)	**Minor** for NARW, **Moderate** for all other mysticetes (except NARW), harbor porpoise, and pinnipeds, and **Minor** for all other odontocetes (except harbor porpoise)
Marine Mammals: *Alternative Impacts (With Ongoing Activities)*	**Major** for NARW, **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Marine Mammals: *Cumulative Impacts (With Planned and Ongoing Activities)*	**Major** for NARW, **Moderate** on all other mysticetes (except NARW), odontocetes, and pinnipeds,	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Sea Turtles: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Sea Turtles: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**

Resources	Alternative A[a,b]	Alternative B[b]	Alternative C[b]	Preferred Alternative
Commercial Fisheries and For-Hire Recreational Fishing: *Alternative Impacts*	**Major**	**Major**	**Major**	**Major**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Commercial Fisheries and For-Hire Recreational Fishing: *Cumulative Impacts*	**Major**	**Major**	**Major**	**Major**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Cultural Resources: *Alternative Impacts*	**Major**	**Major**	**Major**	**Major**
Cultural Resources: *Cumulative Impacts*	**Major**	**Major**	**Major**	**Major**
Demographics, Employment, and Economics: *Alternative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Demographics, Employment, and Economics: *Cumulative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Environmental Justice: *Alternative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Environmental Justice: *Cumulative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Navigation and Vessel Traffic: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Navigation and Vessel Traffic: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Other Uses: *Alternative Impacts*	**Negligible** for national security and military use, aviation and air traffic, cables and pipelines, radar systems, and marine minerals; **Major** for scientific research and surveys	**Negligible** for cables and pipelines and marine minerals; **Minor** for aviation and air traffic; **Moderate** for national security and military use and radar systems; and **Major** for scientific research and surveys	**Negligible** for cables and pipelines and marine minerals; **Minor** for aviation and air traffic; **Moderate** for national security and military use and radar systems; and **Major** for scientific research and surveys	**Negligible** for cables and pipelines and marine minerals; **Minor** for aviation and air traffic; **Moderate** for national security and military use and radar systems; and **Major** for scientific research and surveys
Other Uses: *Cumulative Impacts*	**Negligible** for aviation and air traffic and marine minerals; **Minor** for cables and pipelines; **moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys	**Negligible** for marine minerals; **Minor** for aviation and air traffic and cables and pipelines; **Moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys	**Negligible** for marine minerals; **Minor** for aviation and air traffic and cables and pipelines; **Moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys	**Negligible** for marine minerals; **Minor** for aviation and air traffic and cables and pipelines; **Moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys
Recreation and Tourism: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Recreation and Tourism: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**

Resources	**Alternative A[a,b]**	**Alternative B[b]**	**Alternative C[b]**	**Preferred Alternative**
Scenic and Visual Resources: *Alternative Impacts*	**Major**	**Major**	**Major**	**Major**
Scenic and Visual Resources: *Cumulative Impacts*	**Major**	**Major**	**Major**	**Major**
Air Quality: *Alternative Impacts*	**Minor** **Moderate Beneficial**	**Minor** **Moderate Beneficial**	**Minor** **Moderate Beneficial**	**Minor** **Moderate Beneficial**
Air Quality: *Cumulative Impacts*	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**
Water Quality: *Alternative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Water Quality: *Cumulative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Bats: *Alternative Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Bats: *Cumulative Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Birds: *Alternative Impacts*	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**
Birds: *Cumulative Impacts*	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**
Terrestrial Habitats and Fauna: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Terrestrial Habitats and Fauna: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Non-Tidal Waters and Wetlands: *Alternative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Non-Tidal Waters and Wetlands: *Cumulative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Land Use and Coastal Infrastructure: *Alternative Impacts*	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**
Land Use and Coastal Infrastructure: *Cumulative Impacts*	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**

COP = Construction and Operations Plan; NARW = North Atlantic right whale; SAR = search and rescue; USCG = U.S. Coast Guard

Impact rating colors are as follows: orange = **major**; yellow = **moderate**; blue = **minor**; white = **negligible**; green = **beneficial** (to any degree). All impact levels are assumed to be adverse unless otherwise specified as beneficial. Where impacts are presented as multiple levels, the color representing the most adverse level of impact has been applied. The details of particular impacts and explanations for ranges of impact levels are found in each resource section.

[a] Planned activities without proposed Project impacts includes the impacts evaluated in Alternative A.

[b] Cumulative impacts include the given alternative in combination with all other ongoing and planned activities.

[c] Consideration of Alternatives A, B, and C without the ongoing and planned activities provides the incremental impact of each alternative without existing conditions (i.e., ongoing) or cumulative impacts from planned activities. Under Alternative A (i.e., the No Action Alternative) without the consideration of planned activities, the COP would not be approved, and the proposed Project would not be developed; this alternative would, therefore, have no incremental impact on marine mammals.

1 Introduction

This Final Environmental Impact Statement (EIS) assesses the potential environmental, social, economic, historic, and cultural impacts that could result from the construction and installation (construction), operations and maintenance (operations), and conceptual decommissioning of the New England Wind Project (Project) proposed by Park City Wind, LLC (Park City Wind, the applicant) in its Construction and Operations Plan (COP; Epsilon 2023). As described in Section 1.1, the proposed Project consists of two phases: Phase 1, which is also known as the Park City Wind Project, and Phase 2, which is also known as the Commonwealth Wind Project. The proposed Project described in the COP and this Final EIS would occupy all of the Bureau of Ocean Energy Management's (BOEM) Renewable Energy Lease Number (Lease Area) OCS-A 0534 and potentially a portion of the area covered by Lease Area OCS-A 0501,[1] hereafter referenced collectively as the Southern Wind Development Area (SWDA) (Figure 1.1-1 and Figure 1.1-2). The SWDA is approximately 20 miles from the southwest corner of Martha's Vineyard and approximately 24 miles from Nantucket at its closest point. The proposed Project would be designed to provide commercially sustainable offshore wind energy to meet the need for clean, renewable energy in the northeastern United States.

This Final EIS was prepared following the requirements of the National Environmental Policy Act (NEPA; 42 U.S. Code Sections 4321–4370 [42 USC §§ 4321–4370]) and its implementing regulations and will inform BOEM in deciding whether to approve, approve with modifications, or disapprove the proposed Project. This Final EIS is not a decision document. After publication of this Final EIS, NEPA requires BOEM to wait a minimum of 30 days before issuing a Record of Decision (ROD) that will state BOEM's decision on the COP. This Final EIS incorporates the draft analyses presented in the previously published Draft EIS.

This Final EIS was prepared consistent with the U.S. Department of the Interior's NEPA regulations (43 Code of Federal Regulations [CFR] Part 46), longstanding federal judicial and regulatory interpretations, and Biden Administration priorities and policies, including Secretary of the Interior's Order Number 3399 requiring bureaus and offices to not apply any of the provisions of the 2020 changes to the Council of Environmental Quality's (CEQ) regulations, published in the *Federal Register* at Volume 85, Issue 137 (July 16, 2020) pp. 43304–43376 (85 Fed. Reg. 137 pp.43304–43376), "in a manner that would change the application or level of NEPA that would have been applied to a proposed action before the 2020 Rule went into effect."

The format and organization of the Final EIS is detailed in Table 1-1.

[1] The developer of the Vineyard Wind 1 Project (Vineyard Wind, LLC) will assign the spare southwestern portion of Lease Area OCS-A 0501 to Park City Wind for the New England Wind Project if that portion of Lease Area OCS-A 0501 and its remaining positions are not developed as part of the Vineyard Wind 1 Project.

Table 1-1: Format and Organization of the Final Environmental Impact Statement

Chapter/Appendix	Description
Chapter 1, Introduction	This chapter describes the background of the proposed Project, its purpose and need, relevant regulatory considerations, and the methodology used to assess impacts throughout the Final EIS.
Chapter 2, Alternatives	This chapter describes the Proposed Action and alternatives including the No Action Alternative. In addition, this chapter identifies the Preferred Alternative.
Chapter 3, Affected Environment and Environmental Consequences	This chapter describes the portions of the environment that could be affected by the proposed Project and analyzes the potential impacts of the proposed Project.
Appendix A, Required Environmental Permits and Consultations	This appendix lists the environmental permits that the proposed Project must obtain, as well as the public, agency, and tribal consultation and coordination that occurred as part of preparing this Final EIS.
Appendix B, Supplemental Information and Additional Figures and Tables	This appendix includes supplemental information and tables and figures that do not appear in Chapters 1 through 3 of the Final EIS.
Appendix C, Project Design Envelope and Maximum-Case Scenario	This appendix includes a detailed description of the PDE.
Appendix D, Geographical Analysis Areas	This appendix includes a description of the geographical analysis areas for each resource evaluated in the Final EIS.
Appendix E, Planned Activities Scenario	This appendix describes the projects included in the planned activities scenario and analyzes the impacts of the proposed Project in combination with projects in that scenario.
Appendix F, Analysis of Incomplete and Unavailable Information and Other Required Analyses	This appendix describes information pertinent to the analysis in the Final EIS that is incomplete or unavailable. It also includes the required analyses of unavoidable adverse impacts of the Proposed Action; irreversible and irretrievable commitment of resources; and the relationship between the short-term use of the environment and the maintenance and enhancement of long-term productivity.
Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor (or Lower) Impacts	this appendix identifies individual IPFs applicable to each resource, along with the analysis of how the proposed Project and projects in the planned activities scenario contribute to the overall analysis of impacts in Chapter 3.
Appendix H, Mitigation and Monitoring	This appendix identifies the mitigation and monitoring measures that the applicant has committed to implement, as well as other measures that may result from permitting decisions for the proposed Project.
Appendix I, Seascape, Landscape, and Visual Impact Assessment	This appendix includes the seascape, landscape, and visual impact assessment prepared for this Final EIS.
Appendix J, Finding of Adverse Effect for the New England Wind Project Construction and Operations Plan	This appendix includes the analysis supporting the determination of whether the proposed Project would have an adverse effect on cultural resources, as required under Section 106 of the NHPA.
Appendix K, References Cited	This appendix includes a list of all references cited in the Final EIS.
Appendix L, Glossary	This appendix includes a glossary of terms used in the Final EIS.
Appendix M, List of Preparers and Reviewers	This appendix includes a list of all preparers and reviewers of the Final EIS.
Appendix N, List of Agencies, Organizations, and Persons to Whom Copies of the Statement Are Sent	This appendix includes the list of agencies, groups, and individuals who received the Final EIS.
Appendix O, Public Comments and Responses on the Draft Environmental Impact Statement	This appendix includes the complete compilation of substantive public and agency comments on the Draft EIS, along with identification of individuals and groups who submitted those comments and responses to those comments.

EIS = Environmental Impact Statement; IPF = impact-producing factor; NHPA = National Historic Preservation Act; PDE = Project design envelope

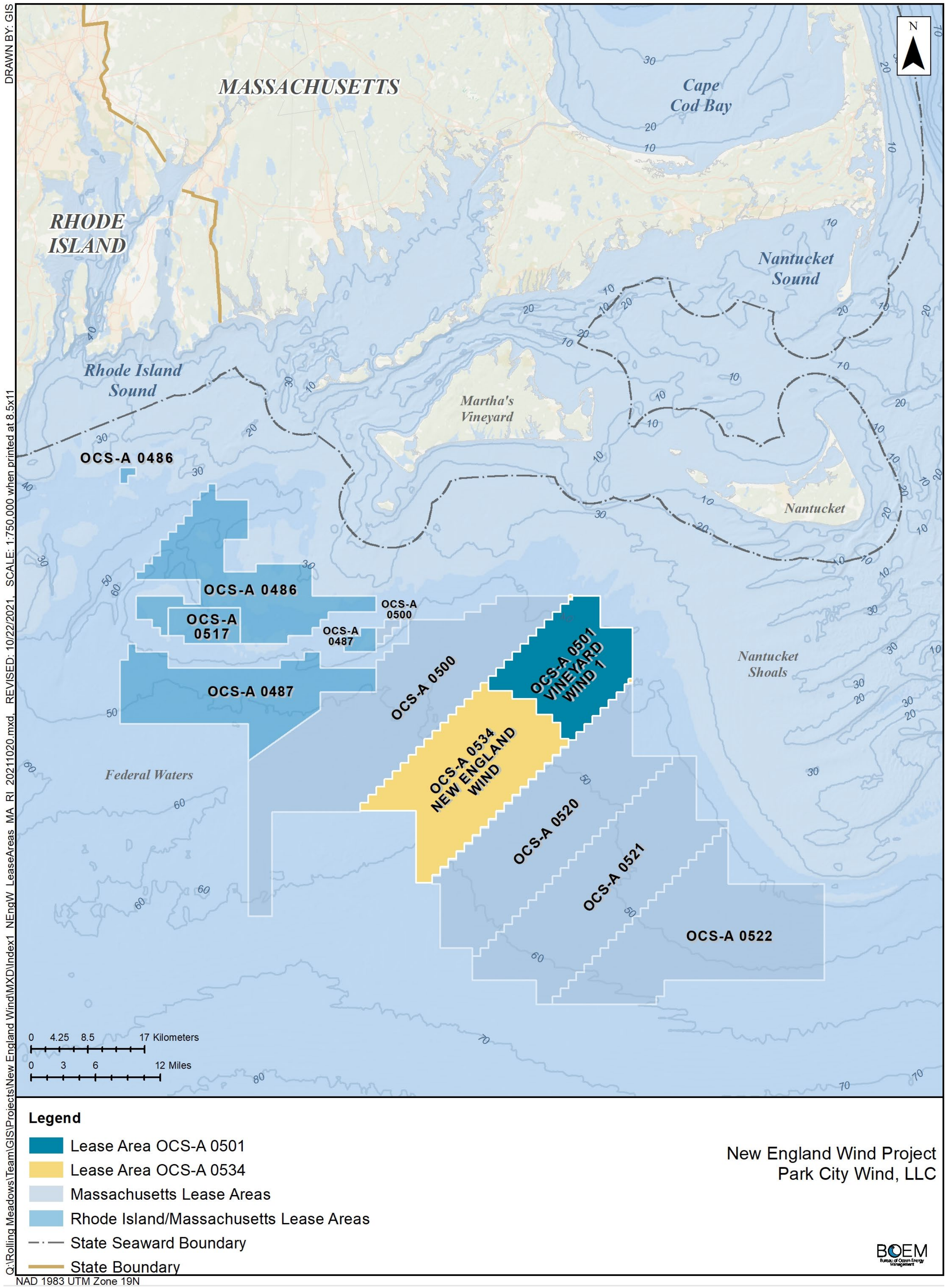


Figure 1.1-1: Proposed Wind Development Area Relative to Rhode Island and Massachusetts Lease Areas

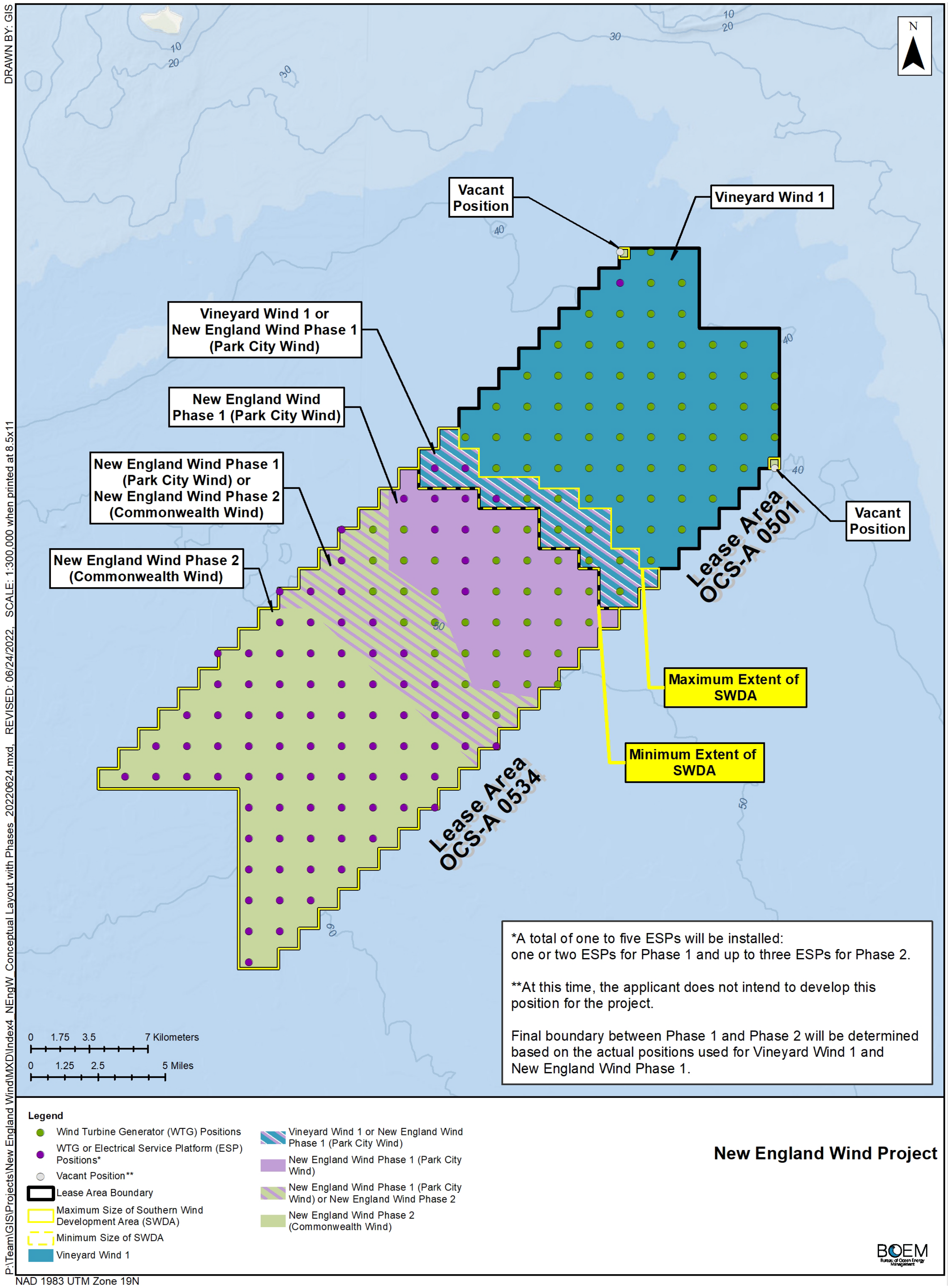


Figure 1.1-2: Proposed Project Overview

1.1 Background

In 2009, the U.S. Department of the Interior announced final regulations for the Outer Continental Shelf (OCS) Renewable Energy Program, which were authorized by the Energy Policy Act of 2005. The Energy Policy Act provisions implemented by BOEM provide a framework for issuing renewable energy leases, easements, and rights-of-way (ROW) for OCS renewable energy activities (Section 1.3). BOEM's renewable energy program occurs in four distinct phases: (1) regional planning and analysis, (2) lease issuance, (3) site assessment, (4) construction and operations, and (5) decommissioning.

In 2009, BOEM established an intergovernmental renewable energy task force to evaluate OCS wind energy offshore the Commonwealth of Massachusetts (Massachusetts). After extensive consultation with the task force, which included elected officials from state, local, and tribal governments, as well as representatives of affected federal agencies, BOEM removed some areas from further consideration for offshore wind leasing to reduce visual impacts, including areas within 12 nautical miles (13.8 miles) of inhabited land. Appendix A describes the detailed steps BOEM then took concerning planning and leasing for the OCS offshore Massachusetts. On April 1, 2015, BOEM held a competitive leasing process as prescribed in 30 CFR § 585.211 and awarded Lease Area OCS-A 0501 to Vineyard Wind 1, LLC.

On December 14, 2021, BOEM approved Vineyard Wind 1, LLC's assignment of 101,590 acres to the applicant, which were designated as Lease Area OCS-A 0534. Vineyard Wind 1, LLC retained, as Lease Area OCS-A 0501, the remaining 65,296 acres (Figure 1.1-1).[2] The applicant has the exclusive right to submit a COP for activities within the area covered by Lease OCS-A 0534. A small portion of the area covered by Lease Area OCS-A 0501 not used for development of the Vineyard Wind 1 Project (Vineyard Wind 1) may also be assigned to the applicant and developed as part of the proposed Project (i.e., the New England Wind Project);[3] however, any development of the area within Lease Area OCS-A 0501 would require an additional (future) lease assignment.

Under the Proposed Action, the proposed Project would be developed in two phases, with a combined maximum of 130 wind turbine generator (WTG) and electrical service platform (ESP) positions, all located within the SWDA. Phase 1, also known as the Park City Wind Project, would deliver at least 804 megawatts (MW) and would be immediately southwest of Vineyard Wind 1. Phase 2, also known as the Commonwealth Wind Project, would deliver at least 1,232 MW and would be constructed southwest of Phase 1 within the remainder of the SWDA. Collectively, the proposed Project would generate at least 2,036 MW and up to 2,600 MW.

The proposed Project's offshore renewable wind energy facilities would be immediately adjacent to Vineyard Wind 1, which would occupy most of the area covered by Lease Area OCS-A 0501. Up to five offshore export cables would transmit electricity generated by the WTGs to onshore transmission systems in the Town of Barnstable and Bristol County, Massachusetts (Avangrid 2022a). The proposed Project

[2] Except for the description of lease area, which now reflects the two different lease areas, the terms, conditions, and stipulations of the two leases, including the lease effective date of April 1, 2015, remain the same.

[3] Lessees may request to assign a portion of their lease to another qualified legal entity (30 CFR § 585.408).

would also include associated onshore operations and maintenance facilities. For analysis purposes, BOEM assumes that the proposed Project would have a 33-year operating period.[4]

1.2 Purpose of and Need for the Proposed Action

In Executive Order (EO) 14008, Tackling the Climate Crisis at Home and Abroad, issued on January 27, 2021, President Biden stated that it is the policy of the United States:

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

Park City Wind has submitted a COP to BOEM proposing the construction, operations, and decommissioning of facilities in the lease area (proposed Project) in accordance with BOEM's COP regulations under 30 CFR §§ 585.626 et seq. Park City Wind's goal for the New England Wind Project is to develop a commercial-scale offshore wind energy project in the lease area, with up to 132 total foundations for 125 to 129 WTGs and 1 to 5 ESPs to be installed in 130 positions. The New England Wind Project would generate at least 2,036 MW and up to 2,600 MW of electricity to meet the combined demand of the states of Connecticut, Massachusetts, and Rhode Island for up to 6,000 MW of electricity from offshore wind.[5] Five offshore electrical transmission cables, including two for Phase 1 (Park City Wind) and three for Phase 2 (Commonwealth Wind), would be installed in an offshore export cable corridor (OECC) through Muskeget Channel (including the Western Muskeget Variant). Landing sites for Phase 1 cables would be in Barnstable County, Massachusetts. Intended landing sites for Phase 2 cables would also be in Barnstable County. Onshore electrical cables, grid interconnection cables, and up to three new or upgraded substations would be installed in Barnstable County, Massachusetts. Under BOEM's phased development regulation (30 CFR § 585.629), Park City Wind proposed the South Coast Variant (SCV) (a contingency export cable route) as a latter phase for potential development for which BOEM conducted an initial analysis under NEPA for only the portion located on the OCS. Before Park City Wind could develop the SCV, additional reviews, consultation and permits would be required. The SCV could include up to three offshore electrical transmission cables for Phase 2 only (in lieu of or in addition to the proposed route through Muskeget Channel) with a cable landing site, onshore transmission cable, grid interconnection, and new or upgraded substations in Bristol County, Massachusetts. The

[4] Vineyard Wind 1, LLC's lease with BOEM (Lease Area OCS-A 0501) and Park City Wind, LLC's lease with BOEM (Lease Area OCS-A 0534) were modified by BOEM on June, 22, 2021, to reflect a 33-year operational term. This Final EIS analyzes a 33-year operating period to ensure use of the maximum-case scenario and associated adequate NEPA coverage.

[5] Park City Wind previously secured multiple power purchase agreements (PPA) that, combined, would deliver up to 2,600 MW of power to the ISO-NE electric grid under agreements with Connecticut and Massachusetts entities, in accordance with the states' respective renewable energy requirements. Due to unforeseen economic factors, both PPAs were terminated in 2023. Park City Wind is actively seeking new offtake agreements for the New England Wind Project. Specifically, Massachusetts, Connecticut, and Rhode Island all issued solicitations for additional offshore wind generated electricity and signed a memorandum of understanding in October 2023 to allow developers to submit multi-state bids and states to collaborate on their procurement decisions. Proposals are due on March 27, 2024, and Park City Wind intends to submit one or more proposals in response to these solicitations.

proposed Project is intended to assist the states of Connecticut,[6] Massachusetts,[7] and Rhode Island[8] to meet their climate and renewable energy / offshore wind goals and to meet the Biden Administration's target of 30 gigawatts (GW) of offshore wind by 2030 (Section 1.2 of the COP [Epsilon 2023]).

Based on BOEM's authority under the Outer Continental Shelf Lands Act (OCSLA) to authorize renewable energy activities on the OCS, EO 14008, the shared goals of the Departments of Interior, Energy, and Commerce to deploy 30 GW of offshore wind in the United States by 2030 while protecting biodiversity and promoting ocean co-use (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 Park City Wind's COP. BOEM will make this determination after weighing the factors in Subsection 8(p)(4) of 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 requires BOEM to make a decision on the lessee's plan to construct and operate a commercial-scale offshore wind energy facility(ies) in the lease area.

In addition, the National Marine Fisheries Service (NMFS) received a request for authorization (in the form of a Letter of Authorization [LOA]) under the Marine Mammal Protection Act (MMPA) to take marine mammals incidental to construction activities related to the proposed Project. NMFS' issuance of an MMPA incidental take authorization would be a major federal action connected to BOEM's action (40 CFR § 1501.9(e)(1)). The purpose of the NMFS action—which is a direct outcome of the applicant's request for authorization to take marine mammals incidental to specified activities associated with the proposed Project (e.g., pile driving)—is to evaluate the applicant's request pursuant to specific requirements of the MMPA and its implementing regulations administered by NMFS, consider impacts of the applicant's activities on relevant resources, and if appropriate, issue the permit or authorization. NMFS needs to render a decision regarding the request for authorization due to NMFS' responsibilities under the MMPA (16 § USC 1371(a)(5)(A)) and its implementing regulations. 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 to be undertaken through authority delegated to the District Engineer by 33 CFR § 325.8, under Section 10 of the Rivers and Harbors Act of 1899 (RHA; 33 USC § 403) and Section 404 of the Clean Water Act (CWA; 33 USC § 1344). In addition, it is anticipated that a Section 408 permission may be required pursuant to Section 14 of the RHA (33 USC § 408) for any proposed alterations that have the potential to alter, occupy, or use any federally authorized civil works projects. USACE considers issuance of permit decisions under these three delegated authorities to be a major federal action connected to BOEM's action (40 CFR § 1501.9(e)(1)). The need for the proposed Project as provided by the applicant in Section 1.2 of the COP (Epsilon 2023) and reviewed by USACE for NEPA purposes is to provide a commercially viable offshore wind energy project within the lease area to address Connecticut's and Massachusetts' need for clean energy. The basic Project purpose, as determined by USACE for

[6] In June 2019, Governor Ned Lamont signed Public Act 19-71, An Act Concerning the Procurement of Energy Derived from Offshore Wind, authorizing the Connecticut Department of Energy and Environmental Protection to procure up to 2,000 MW of offshore wind energy.

[7] On August 11, 2022, Governor Charlie Baker signed Bill H.5060, An Act Driving Clean Energy and Offshore Wind, codifying the goal of procuring 5,600 MW of offshore wind no later than June 30, 2027.

[8] On July 6, 2022, Governor Dan McKee signed Rhode Island Senate Bill 2583, An Act Relating to Public Utilities and Carriers – Affordable Clean Energy Security Act, requiring market-competitive procurement of 600 to 1,000 MW of newly developed offshore wind capacity.

Section 404(b)(1) guidelines evaluation, is offshore wind energy generation. The overall Project purpose for Section 404(b)(1) guidelines evaluation, as determined by USACE, is the construction and operation of a commercial-scale offshore wind energy project, including associated transmission lines, in Lease Area OCS-A 0534 south of Martha's Vineyard, Massachusetts, for renewable energy generation and distribution to the Connecticut and Massachusetts energy grids.

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

1.3 Regulatory Overview

The Energy Policy Act of 2005, Public Law 109-58, amended the OCSLA (43 USC § 1331 et seq.)[9] by adding a new Subsection 8(p) that authorizes the Secretary of the Interior to issue leases, easements, and ROWs in the OCS for activities that "produce or support production, transportation, or transmission of energy from sources other than oil and gas," which include wind energy projects.

The Secretary of the Interior delegated this authority to the former Minerals Management Service (MMS) and later to BOEM. Final regulations implementing the authority for renewable energy leasing under OCSLA (30 CFR Part 585) were promulgated on April 22, 2009 (74 Fed. Reg. 81 [April 29, 2009]). These regulations prescribe BOEM's responsibility for determining whether to approve, approve with modifications, or disapprove COPs (30 CFR § 585.628).

As stated in M-Opinion 37067, "... subsection 8(p)(4) of the OCSLA imposes a general duty on the Secretary to act in a manner providing for the subsection's enumerated goals. The subsection does not require the Secretary to ensure that the goals are achieved to a particular degree, and she retains wide discretion to determine the appropriate balance between two or more goals that conflict or are otherwise in tension" (U.S. Department of the Interior 2021).

Section 2 of commercial Renewable Energy Lease OCS-A 0534 provides the lessee with an exclusive right to submit a COP to BOEM for approval. Section 3 provides that BOEM will decide whether to approve a COP in accordance with applicable regulations in 30 CFR Part 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 OCSLA Subsection 8(p)(4), or for other reasons provided by BOEM under 30 CFR §§ 585.613(e)(2) or 585.628(f). BOEM reserves the right to approve a COP with modifications, and BOEM reserves the right to authorize other uses within the leased area that will not unreasonably interfere with the description of the leased area and lease activities.

BOEM's evaluation of and decision on the COP are also governed by other applicable federal statutes and implementing regulations, such as NEPA and the Endangered Species Act (ESA; 16 USC §§ 1531–1544).

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[9] Public Law Number 109-58, § 119 Stat. 594 (2005)

The analyses in this Final EIS inform BOEM's decision under 30 CFR § 585.628 for the COP that was submitted in July 2020 and later updated with new information in June 2021, October 2021, December 2021, April 2022, May 2022, and June 2022 (Epsilon 2023). BOEM is required to coordinate with federal agencies and state and local governments to ensure that renewable energy development occurs in a safe and environmentally responsible manner. In addition, BOEM's authority to approve activities under the OCSLA only extends to approval of activities on the OCS. Table A.1-1 in Appendix A outlines the federal, state, regional, and local permits and authorizations that are required for the proposed Project and the status of each permit and authorization. Appendix A also provides a description of BOEM's consultation efforts during development of the Final EIS.

1.4 Relevant Existing NEPA and Consulting Documents

BOEM used the following previously prepared NEPA and consulting documents to inform preparation of this Final EIS (Table 1-2); these documents are incorporated by reference where appropriate.

Table 1-2: Relevant Documentation

Document Name	Description
Final Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf (MMS 2007)	MMS developed this Programmatic EIS to support establishment of a program that provides for efficient and orderly development of alternative energy projects on the federal OCS, as well as the alternate use of offshore facilities for other energy- and marine-related activities. The four alternatives considered in the Final Programmatic EIS are (1) the proposed action (i.e., the establishment of the Alternative Energy and Alternate Use Program on the OCS through rulemaking); (2) a case-by-case alternative (i.e., the MMS would consider individual project proposals for alternative energy or alternate use on a case-by-case basis but would not issue formal regulations); (3) a no action alternative (i.e., the MMS would not approve leases, easements, or ROW for any alternative energy facility on the federal OCS or alternate use of existing offshore facilities); and (4) a preferred alternative (i.e., a combination of the proposed action and the case-by-case alternative). The document examined the potential environmental consequences of each of these alternatives and was used to establish initial measures to mitigate environmental consequences.
Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts: Revised Environmental Assessment (BOEM 2013)	BOEM prepared this Environmental Assessment to consider the environmental impacts of issuing renewable energy leases and authorizing site characterization activities needed to develop specific project proposals on those leases in identified wind energy areas on the OCS offshore Rhode Island and Massachusetts. BOEM used this Environmental Assessment to inform decisions to issue leases and subsequently approve site assessment plans on those leases.
Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts: Revised Environmental Assessment (BOEM 2014a)	BOEM prepared this Environmental Assessment to consider the environmental impacts of issuing renewable energy leases and authorizing site characterization activities needed to develop specific project proposals on those leases on the OCS offshore Massachusetts. BOEM used this Environmental Assessment to inform decisions to issue leases in the refined wind energy areas and subsequently approve site assessment plans on those leases.
Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New York: Revised Environmental Assessment (BOEM 2016)	BOEM prepared this Environmental Assessment to consider the environmental impacts of issuing a renewable energy lease and authorizing site characterization activities needed to develop specific project proposals on a lease located on the OCS offshore New York. BOEM used this Environmental Assessment to inform decisions to issue a lease and subsequently approve a site assessment plan on that lease.
National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf (BOEM 2019a)	BOEM prepared this study to identify the relationships between IPFs associated with specific past, present, and reasonably foreseeable future activities on the North Atlantic OCS, which were incorporated into this EIS analysis, as applicable.

Document Name	Description
New England Wind Project Biological Assessment (for the U.S. Fish and Wildlife Service; BOEM 2022a)	BOEM prepared this document pursuant to Section 7 of the ESA to evaluate potential impacts of the Proposed Action on ESA-listed species under the jurisdiction of the U.S. Fish and Wildlife Service.
New England Wind Project Essential Fish Habitat Assessment (for NMFS; BOEM 2023a)	BOEM prepared this document pursuant to the MSA to evaluate the potential impacts of the Proposed Action on EFH and EFH species under the jurisdiction of NMFS.
New England Wind Project Biological Assessment (for NMFS; BOEM 2023b)	BOEM prepared this document pursuant to Section 7 of the ESA to evaluate potential impacts of the Proposed Action on ESA-listed species under the jurisdiction of NMFS.

BOEM = Bureau of Ocean Energy Management; EFH = essential fish habitat; EIS = Environmental Impact Statement; ESA = Endangered Species Act; IPF = impact-producing factor; MMS = Minerals Management Service; MSA = Magnuson-Stevens Fishery Conservation and Management Act; NMFS = National Marine Fisheries Service; OCS = Outer Continental Shelf; ROW = right-of-way

BOEM has elected to incorporate by reference the New England Wind COP prepared by Epsilon Associates, Inc. for New England Wind dated August 9, 2023 (Epsilon 2023). The COP and its supporting documentation provide a description of the proposed Project activity, siting and design development, resources required, site characterization and assessment of potential impacts, and references. The New England Wind COP is located on the BOEM webpage for the New England Wind Project at this link: https://www.boem.gov/renewable-energy/state-activities/new-england-wind-ocs-0534-construction-and-operations-plan.

Additional environmental studies performed in Massachusetts to support decisions concerning offshore wind energy development are available on BOEM's website (https://www.boem.gov/Massachusetts-Environmental-Studies/).

1.5 Methodology for Assessing the Project Design Envelope

The proposed Project is being developed using a Project design envelope (PDE) approach to define and bracket proposed Project characteristics for environmental review and permitting while maintaining a reasonable degree of flexibility to allow the applicant to select and purchase proposed Project components such as WTGs, foundations, submarine cables, and offshore substations.

This Final EIS assesses the impacts of the PDE described in the COP and presented in Appendix C by using the "maximum-case scenario" process. The maximum-case scenario is composed of each design parameter or combination of parameters that would result in the greatest impact for each physical, biological, and socioeconomic resource. This Final EIS evaluates potential impacts of the Proposed Action and each action alternative using the maximum-case scenario to assess the design parameters or combination of parameters for each environmental resource (BOEM 2018a). This Final EIS considers the relationship between aspects of the PDE rather than simply viewing each design parameter independently. Certain resources may have multiple maximum-case scenarios, and the most impacting design parameters may not be the same for all resources. Appendix C explains the PDE approach in more detail and presents a table outlining the design parameters with the highest impact potential by resource for the proposed Project's two phases. Through consultation with its own engineers and outside industry experts, BOEM verified that the maximum-case scenarios analyzed in the Final EIS could reasonably occur.

1.6 Methodology for Assessing Impacts

In 2019, BOEM released a study of impact-producing factors (IPF) from renewable energy projects on the North Atlantic OCS (BOEM 2019a). In addition to the cumulative impacts analysis addressing onshore and offshore non-wind activities, this Final EIS specifically analyzes the cumulative impacts of relevant IPFs from offshore wind by resource. Where possible, BOEM provides a quantitative estimate of these offshore wind impacts. Although these BOEM estimates inform the impact analysis in the Final EIS, it is not possible to precisely predict future conditions.

This Final EIS assesses past, present (ongoing), and reasonably foreseeable future (planned) activities that could occur during the life of the proposed Project. Ongoing and planned activities occurring within the geographic analysis area 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 describes the past and ongoing actions that BOEM has identified as potentially contributing to existing conditions and the planned activities potentially contributing to cumulative impacts when combined with impacts from the alternatives over the specified spatial and temporal scales.

1.6.1 Past and Ongoing Activities and Trends (Existing Conditions)

Each resource-specific environmental consequences section in Chapter 3 of this Final EIS includes a description of existing conditions of the affected environment. That basel1line considers past and present activities in the geographic analysis area, including those related to offshore wind projects with an approved COP (e.g., the Vineyard Wind 1 Project [Vineyard Wind 1] and South Fork Wind) and approved past and ongoing site assessment surveys, as well as other non-wind activities (e.g., Navy military training, existing vessel traffic, climate change). The existing condition of resources as influenced by past and ongoing activities and trends comprises the existing baseline condition for impact analysis. Other factors currently affecting the resource, including climate change, are also acknowledged for that resource and are included in the impact-level conclusion.

1.6.2 Planned Activities

It is reasonable to predict that future activities may occur over time, and that cumulatively, those activities would affect the existing conditions discussed in Section 1.6.1. Cumulative impacts are analyzed and concluded separately in each resource-specific section in Chapter 3 of this Final EIS. The existing condition as influenced by future planned activities evaluated in Appendix E comprises the baseline for cumulative impact analysis. 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. Through analyzing the possible extent of future offshore wind energy development activities on the Atlantic OCS, BOEM generated a table (Appendix E, Table E-1) that represents the status of all OCS projects as of July 12, 2023.

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2 Alternatives

This chapter describes the alternatives considered for the proposed Project, including the Proposed Action, No Action Alternative, and other action alternatives (Table 2.1-1); describes the non-routine activities and low-probability events that could occur during construction and installation (construction), operations and maintenance (operations), and conceptual decommissioning (decommissioning) of the proposed Project; and presents a summary and comparison of impacts among alternatives and resources affected.

Identification of the Preferred Alternative: The CEQ NEPA regulations require the identification of a preferred alternative in the Final EIS. BOEM has selected the combination of Alternative B and Alternative C-1 as the Preferred Alternative, with the intent of limiting the installation of export cables to the Eastern Muskeget route. In doing so, the proposed Project would reduce the total amount of impacts on complex benthic habitat and limit the total number of potential crossings of the proposed Project's offshore export cables with the proposed SouthCoast Wind Project (SouthCoast Wind) export cables to a single crossing south of the Muskeget Channel, where complex benthic habitat is rarer. The Preferred Alternative includes a Western Muskeget Variant Contingency Option, which would allow the use of the Western Muskeget Variant only if the lessee provides adequate written justification to BOEM that its use is necessary for the proposed Project's viability. The Preferred Alternative would also disallow the co-location of ESPs or WTGs resulting in the construction, operations, and eventual decommissioning of up to 130 WTG or ESP positions for 125 to 129 WTGs and 1 to 5 ESPs on the OCS installed within Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501. The Preferred Alternative is identified to let the public know which alternative BOEM, as the lead agency, is leaning toward before an alternative is selected 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.

2.1 Alternatives Analyzed in Detail

BOEM considered a reasonable range of alternatives that emerged during the EIS development process of scoping, interagency coordination, and internal BOEM deliberations. Alternatives were reviewed using BOEM's screening criteria, described in Section 2.2. Alternatives that did not satisfy the screening criteria (i.e., were found to be infeasible or did not meet the purpose and need) were dismissed from detailed analysis in this Final EIS. Alternatives considered but dismissed from detailed analysis and the rationale for their dismissal are described in Section 2.2. The alternatives carried forward for detailed analysis in this Final EIS are summarized in Table 2.1-1 and described in detail in Sections 2.1.1 through 2.1.3. Table 2.1-2 summarizes potential scenarios for Phase 2 export cable installation. The alternatives listed in Table 2.1-1 are not mutually exclusive. BOEM may select elements of multiple listed Final EIS alternatives resulting in a preferred alternative identified in the Final EIS provided that the design parameters are compatible and the preferred alternative still meets the purpose and need.

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

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

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

Table 2.1-1: Alternatives Considered for Analysis

Alternative	Description
Alternative A, No Action Alternative	**<u>Under Alternative A</u>**, BOEM would not approve the COP; the proposed Project construction, operations, and decommissioning would not occur; and no additional permits or authorizations for the proposed Project would be required.[a] Any potential environmental and socioeconomic impacts, including benefits, associated with the proposed Project as described under the Proposed Action would not occur. However, all other past and ongoing impact-producing activities would continue. The current resource condition, trends, and impacts from ongoing activities under Alternative A serve as existing conditions 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 existing conditions even in the absence of the Proposed Action. The continuation of all other existing and reasonably foreseeable future activities described in Appendix E, Planned Activities Scenario, without the Proposed Action serves as the baseline for the evaluation of cumulative impacts.
Alternative B, Proposed Action	**<u>Under Alternative B</u>**, the construction, operations, and decommissioning of a wind energy facility in the SWDA offshore Massachusetts would consist of the components described below: • Up to 132 total foundations for 125 to 129 WTGs and 1 to 5 ESPs would be installed in 130 positions, generating at least 2,036 MW and up to 2,600 MW of electricity to meet existing and potential future offtake demands for New England states. This equates to an approximate minimum nameplate capacity of 16 MW per WTG.[a] • If two ESPs are used for Phase 1, the applicant states that each ESP could occupy one of the 130 positions in the SWDA, or the two ESPs could be co-located at a single position, with each ESP's monopile foundation located within 250 feet of that position (i.e., the monopiles would be separated by up to 500 feet). Similarly, if two or three ESPs are used for Phase 2, each ESP could occupy one of the 130 positions in the SWDA, or two of the ESPs could be co-located at a single position (COP Volume I, Sections 3.2.1.3 and 4.2.1.3; Epsilon 2023). As a result, Phase 1 could include 64 foundations at 63 positions, and Phase 2 could include 89 foundations at 88 positions—a total of 132 foundations at 130 positions.[b, c] Inter-array cables would be installed, linking the individual WTGs to the ESPs and inter-link cables between ESPs. • Five offshore electrical transmission cables, including two for Phase 1 and three for Phase 2, would be installed in an OECC through Muskeget Channel (including the Western Muskeget Variant).[d] Table 2.1-2

<table>
<tr><th>Alternative</th><th>Description</th></tr>
<tr><td></td><td>provides the Phase 2 export cable scenarios. Landing sites for Phase 1 cables would be in Barnstable County, Massachusetts. Intended landing sites for Phase 2 cables would also be in Barnstable County, except if the SCV is implemented (see below).

• Onshore electrical cables, grid interconnection cables, and up to three new or upgraded substations would be installed in Barnstable County, Massachusetts (including, but not limited to, the existing West Barnstable Substation).

• Park City Wind proposed the SCV under BOEM's phased development regulation (30 CFR § 585.629) as a latter phase for potential development for which BOEM conducted an initial analysis under NEPA. The SCV could include up to three offshore electrical transmission cables for Phase 2 only (in lieu of or in addition to the proposed route through Muskeget Channel) with a cable landing site, onshore transmission cable, grid interconnection, and new or upgraded substations in Bristol County, Massachusetts. The SCV is conceptual and a contingency route with limited details included in the COP (Epsilon 2023) for review at this time. Future use of the SCV is subject to the submission of a revised COP, additional reviews under NEPA, OCSLA, and NHPA and subject to additional consultations. Future use of the SCV could also necessitate upgrades to existing substations in Bristol County not currently envisioned by substation operators or ISO-NE.[e]

Development of the proposed Project would occur within the range of design parameters outlined in the COP (Epsilon 2023), subject to applicable mitigation and monitoring measures.</td></tr>
<tr><td>Alternative C, Habitat Impact Minimization Alternative</td><td><u>Under Alternative C</u>, the construction, operations, and decommissioning of a wind energy facility on the OCS offshore Massachusetts would occur within the range of the design parameters outlined in the proposed Project COP (Epsilon 2023), subject to applicable mitigation and monitoring measures. However, this alternative would limit the available scenarios for the Phase 2 export cable routes and configurations to minimize impacts on complex fisheries habitats in Muskeget Channel, compared to Alternative B.[d]

• Alternative C-1: Western Muskeget Variant Avoidance. This alternative would preclude use of the Western Muskeget Variant, limiting available scenarios to those that include only the Eastern Muskeget route and SCV (Scenarios 1, 3, 5, and 6 in Table 2.1-2). Avoiding use of the Western Muskeget Variant would avoid a crossing of a proposed export cable route for the SouthCoast Wind Project within the Western Muskeget Channel and limit the total number of potential crossings of the SouthCoast Wind cable to a single crossing south of Muskeget Channel. This area of the proposed cable crossing south of Muskeget Channel has potentially less biogenic structure than the additional crossing that would occur within the channel if the Western Muskeget Variant route were used. Figure 2.1-1 provides approximate mapping of the proposed Project and SouthCoast Wind export cable routes, including potential areas of cable crossings.

• Alternative C-2: Eastern Muskeget Route Minimization. This alternative would minimize, to the degree practicable, the use of the Eastern Muskeget route and maximize the use of the Western Muskeget Variant and/or the SCV (Scenarios 4, 5, and 6 in Table 2.1-2) for all Phase 2 export cables. Under this alternative, the two Phase 1 cables would be installed in the Eastern Muskeget route, along with a maximum of one Phase 2 cable. This eliminates the option for a total of two to three Phase 2 cables to be installed in the Eastern Muskeget route. This alternative could potentially reduce impacts on productive complex habitats along the Eastern Muskeget route compared to Alternative B. Scenarios 5 and 6 would require significant delays to Phase 2 due to the need to upgrade substation(s) connected to ISO-NE that are not currently planned for upgrade. The applicant states that Scenarios 5 and 6 would require significant delays to Phase 2 due to the need to upgrade substations connected to ISO-NE that are not currently planned for upgrade (Avangrid 2022a).</td></tr>
</table>

Alternative	Description
Preferred Alternative	The Preferred Alternative aligns with the Proposed Action, where it adopts aspects of both Alternative B and Alternative C-1. All other proposed Project components, including construction, operations, and decommissioning, would also align with the alternatives described above, except as described below. The Preferred Alternative would identify the use of the Eastern Muskeget route as the preferred OECC through the Muskeget Channel for both Phase 1 and Phase 2, with the export cables making landfall in the Town of Barnstable, Massachusetts (identical to cable Scenario 1 of Phase 2 under Alternative C-1, Table 2.1-2). If necessary, a contingency option for the use of the Western Muskeget Variant (cable Scenario 2 of Phase 2 under Alternative B, Table 2.1-2) is also provided in the Preferred Alternative to maintain technical and economic viability of the proposed Project. Use of the Western Muskeget Variant Contingency Option would require written justification from the lessee to BOEM that use of the Western Muskeget Variant is necessary to preserve proposed Project viability, as described in Appendix H. As described in the mitigation measure, use of the Western Muskeget Variant Contingency Option would require review and approval from BOEM that it is essential to maintain proposed Project viability. The Preferred Alternative would also disallow the co-location of ESPs or WTGs resulting in 130 WTG or ESP positions, as opposed to 132 positions as described in Alternative B. This would result in the installation of 125 to 129 WTGs and 1 to 5 ESPs within Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501.

BOEM = Bureau of Ocean Energy Management; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; EIS = Environmental Impact Statement; ESP = electrical service platform; MMPA = Marine Mammal Protection Act; MW = megawatt; NEPA = National Environmental Policy Act; NHPA = National Historic Preservation Act; OCS = Outer Continental Shelf; OCSLA = Outer Continental Shelf Lands Act; OECC = offshore export cable corridor; RI/MA Lease Areas = Rhode Island and Massachusetts Lease Area; SCV = South Coast Variant; SWDA = Southern Wind Development Area; WTG = wind turbine generator

[a] Under Alternative A, impacts on marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the applicant.

[a] The applicant has not yet identified the nameplate capacity of the WTG, and the COP has identified the maximum capacity for the proposed Project to be approximately 2,600 MW using up to the maximum 130 positions within the lease area.

[b] The COP seafloor disturbance tables (Appendix III-T; Epsilon 2023), acoustic impacts (Appendix III-M; Epsilon 2023), the Navigation Safety Risk Assessment (COP Appendix III-I; Epsilon 2023), Marine Archaeological Resources Assessment (COP Appendix II-D; Epsilon 2023), and air emissions (COP Appendix III-B; Epsilon 2023) incorporate 132 foundations in 130 WTG/ESP positions (Maria Hartnett, Pers. Comm, November 15, 2022).

[c] BOEM has determined not to approve the co-location of ESPs in the Preferred Alternative due to navigation concerns. The consideration of co-locating ESPs will be maintained in the EIS to ensure consistency with the best available science and modeling used in the analysis.

[d] The applicant states that "With the rapid advancement of WTG technology, it is possible that an additional offshore export cable could be needed for New England Wind. If used, the additional cable would remain within the existing offshore export cable corridor or variants assessed and would not exceed the impacts analyzed for each corridor or variant" (COP Volume I, Section S-1; Epsilon 2023). If an additional cable is proposed, the applicant would be required to file a COP revision per 30 CFR § 585.634, describing the need for this cable and providing the information necessary to complete a sufficient analysis. In response, BOEM would complete additional environmental analysis and relevant consultations required by NEPA, NHPA, and other applicable statutes to inform BOEM's decision to approve, approve with conditions, or disapprove the COP revision.

[e] If the SCV is necessary, the applicant would be required to file a COP revision per 30 CFR § 585.634, describing the need for the SCV and providing the information necessary to complete a sufficient analysis. In response, BOEM would complete additional environmental analysis and relevant consultations required by NEPA, NHPA, and other applicable statutes to inform BOEM's decision to approve, approve with conditions, or disapprove the COP revision.

Table 2.1-2: Export Cable Scenarios

Alternative	Phase	Scenario	Cable Layout (Number of Cables)		
			Eastern Muskeget OECC	Western Muskeget Variant OECC	SCV OECC [a]
Alternative B, Proposed Action	1	NA	2	—	—
	2	1	3	—	—
		2	2	1	—
		3	2	—	1
		4	1	2	—
		5 [b]	1	—	2
		6 [b]	—	—	3
Alternative C-1, Western Muskeget Variant Avoidance	1	NA	2	—	—
	2	1	3	—	—
		3	2	—	1
		5 [b]	1	—	2
		6 [b]	—	—	3
Alternative C-2, Eastern Muskeget Route Minimization	1	NA	2	—	—
	2	4	1	2	—
		5 [b]	1	—	2
		6 [b]	—	—	3
Preferred Alternative	1	NA	2	—	—
	2	1	3	—	—
		2 (Contingency Option)	2	1	—
		3 [a, b]	2	—	1
		5 [a, b]	1	—	2
		6 [a, b]	—	—	3

Source: COP Volume I, Table 4.1-2; Epsilon 2023

BOEM = Bureau of Ocean Energy Management; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; NA = not applicable; NEPA = National Environmental Policy Act; NHPA = National Historic Preservation Act; OECC = offshore export cable corridor; SCV = South Coast Variant

[a] If the SCV is necessary, the applicant would be required to file a COP revision per 30 CFR § 585.634, describing the need for the SCV and providing the information necessary to complete a sufficient analysis. In response, BOEM would complete additional environmental analysis and relevant consultations required by NEPA, NHPA, and other applicable statutes to inform BOEM's decision to approve, approve with conditions, or disapprove the COP revision.

[b] The applicant states that Scenarios 5 and 6 are theoretically possible but unlikely and would require significant delays to Phase 2 due to the need to upgrade substations connected to ISO-NE that are not currently planned for upgrade (Avangrid 2022a).

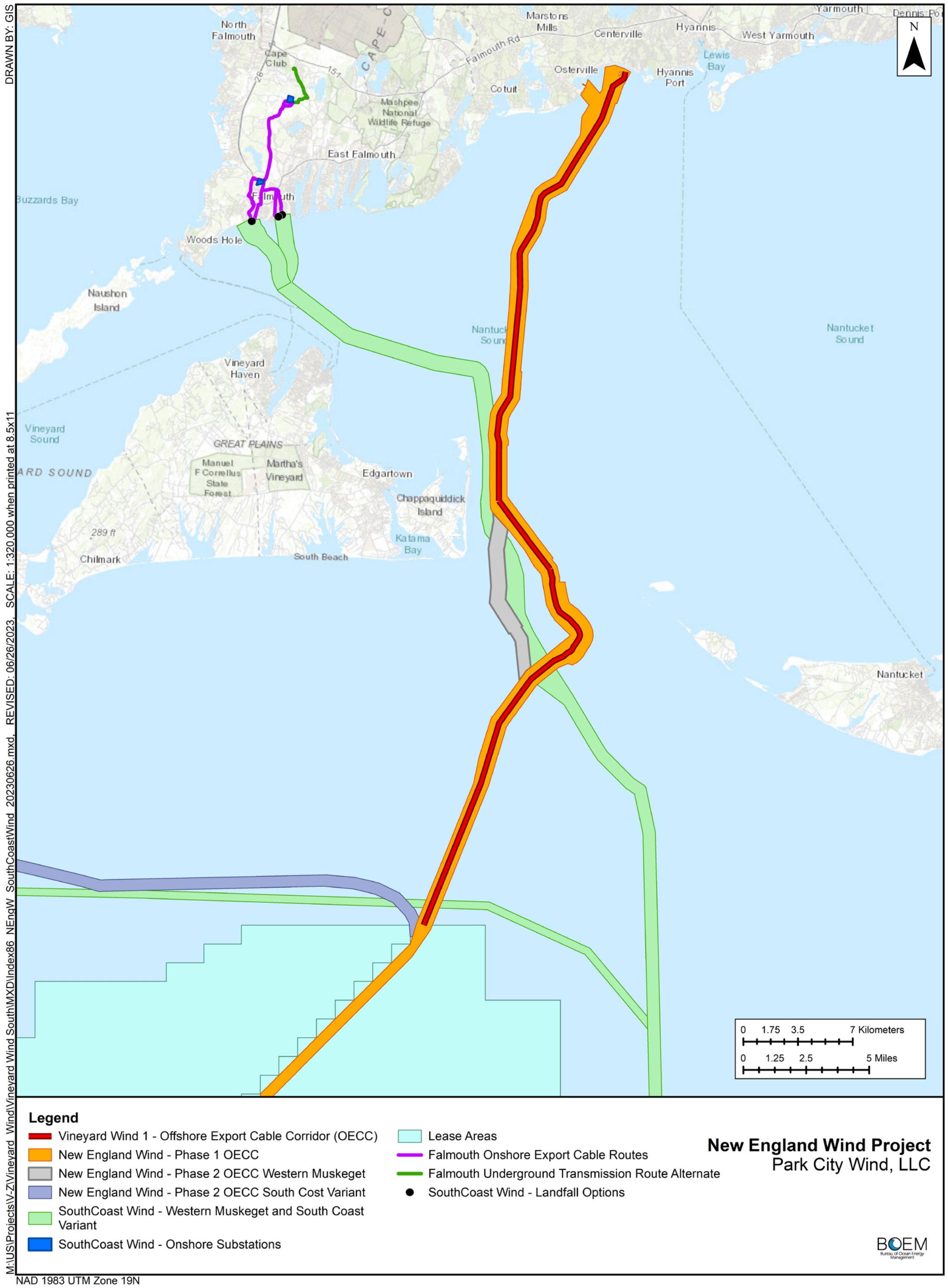


Figure 2.1-1: SouthCoast Wind Project and New England Wind Project Offshore Export Cable Corridor Routes in Muskeget Channel

2.1.1 Alternative A – No Action Alternative

Under Alternative A, BOEM would not approve the COP. Proposed Project construction, operations, and decommissioning would not occur, and no additional permits or authorizations for the proposed Project would be required.[10] Any potential environmental and socioeconomic impacts, including benefits, associated with the proposed Project, as described under Alternative B, would not occur. However, all other past and ongoing impact-producing activities would continue. The current resource condition, trends, and impacts from ongoing activities under Alternative A serve as existing conditions 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 existing conditions even in the absence of Alternative B. The continuation of all other existing and reasonably foreseeable future activities described in Appendix E, Planned Activity Scenario, without Alternative B serves as the baseline for the evaluation of cumulative impacts.

2.1.2 Alternative B – Proposed Action

Under Alternative B, the applicant would be authorized to construct, operate, and decommission a wind energy facility generating at least 2,036 MW, along with associated offshore and onshore cabling, onshore substations, and onshore operations facilities. This proposed Project would be developed in two phases, with a maximum of 130 WTG and ESP positions. Four to five offshore export cables would transmit electricity generated by the WTGs to onshore transmission systems in the Town of Barnstable or in Bristol County, Massachusetts. Figure 1.1-1 provides an overview of the proposed Project.

The proposed Project's WTGs and ESPs would be immediately southwest of Vineyard Wind 1. The proposed Project would occupy all of Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501 (collectively the SWDA). This additional portion could be included if Vineyard Wind 1 does not develop the spare or extra positions included in the area covered by Lease Area OCS-A 0501 and BOEM approves the assignment of those positions to Lease Area OCS-A 0534. Two aliquots (small areas of the ocean surface) adjacent to but outside of Lease Area OCS-A 0501 are within Lease Area OCS-A 0534 but would not contain any proposed Project elements.

The SWDA would occupy 101,590 to 111,939 acres depending on whether any of the Vineyard Wind 1 positions are assigned to the proposed Project. The SWDA is slightly more than 20 miles southwest of Martha's Vineyard, Massachusetts, and approximately 24 miles south of Nantucket, Massachusetts. The WTGs and ESPs in the SWDA would be oriented in an east-to-west, north-to-south grid pattern with 1-nautical-mile (1.9-kilometer, 1.15-mile) × 1-nautical-mile (1.9-kilometer, 1.15-mile) spacing between positions.[11]

The applicant has committed to measures as part of the proposed Project to avoid or minimize impacts on physical, biological, socioeconomic, and cultural resources (COP Volume III, Section 4; Epsilon 2023). These measures are described in Appendix H and are incorporated as part of Alternative B.

[10] Under Alternative A, impacts on marine mammals incidental to construction activities would not occur. Therefore, NMFS would not issue the requested authorization under the MMPA to the applicant.

[11] As discussed in Table 2.1-1 and COP Volume I, Sections 3.2.1.3 and 4.2.1.3 (Epsilon 2023), the PDE allows for the colocation of two ESP foundations into a single position for both Phase 1 and Phase 2. Under this scenario, these foundations would be 0.96-nautical-mile (1.85-kilometers, 1.10-miles) apart.

The applicant would advance the proposed Project within the PDE summarized in Appendix C, Project Design Envelope and Maximum-Case Scenario. Additional details of Alternative B are contained in the COP (Volume I; Epsilon 2023).[12]

2.1.2.1 Monitoring and Surveys Committed to by the Applicant

As part of Alternative B, the applicant has committed to conducting monitoring surveys before, during, and after construction (Table 2.1-3). The applicant is voluntarily conducting pre-construction surveys under existing permits. A description of specific survey activities is provided in the respective resource sections in Chapter 3, Affected Environment and Environmental Consequences. BOEM's review under OCSLA and Section 7 of the ESA and consultations under the ESA and the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as well as reviews under other applicable statutes, including the MMPA and Coastal Zone Management Act, may result in additional measures or changes to these measures.

Table 2.1-3: Monitoring Surveys

Monitoring Survey	Project Stage	Chapter 3 Resource Section
Fisheries monitoring plan	Pre-construction, construction, and operations	Commercial Fisheries and For-Hire Recreational Fishing
Benthic monitoring plan	Pre-construction, construction, and operations	Benthic Resources
Protected species mitigation and monitoring plan: marine mammals, sea turtles, and ESA-listed fish	Pre-construction, construction, and operations	Finfish, Invertebrates, and Essential Fish Habitat; Marine Mammals; Sea Turtles
Avian and bat post-construction monitoring framework	Operations	Bats; Birds

ESA = Endangered Species Act

2.1.2.2 Phase 1 (Park City Wind Project)

Phase 1, also known as the Park City Wind Project, would be developed immediately southwest of Vineyard Wind 1. Phase 1 would have a total generating capacity of up to 804 MW and consist of 41 to 62 WTGs and up to 2 ESPs (Table C-1 in Appendix C, Project Design Envelope and Maximum-Case Scenario).

Phase 1 Construction and Installation

Phase 1 includes the construction of both onshore and offshore facilities. Onshore construction of Phase 1 would likely begin in 2024, and offshore construction would likely begin in 2026. Onshore substation construction would begin in the fourth quarter 2024, and onshore export cable route (OECR) construction would begin in third quarter 2024; construction within the OECC and WTG and ESP would begin in late second quarter 2026; and inter-array cable installation would begin in third quarter 2026. Construction would be complete by fourth quarter 2027 (Stephanie Wilson, pers. comm., June 27, 2023).

[12] The COP can be accessed at https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-south-construction-and-operations-plan.

Onshore Activities and Facilities

Onshore proposed Project elements include the Town of Barnstable Landfall Site, the onshore export cables from the landfall site to the onshore substation, the onshore substation site, and the connection from the proposed substation site to the existing bulk power grid (Figure 2.1-2).

The Phase 1 offshore export cables would make landfall within paved parking areas at either the Craigville Public Beach Landfall Site or the Covell's Beach Landfall Site in the Town of Barnstable. The ocean-to-land transition at either landfall site would employ the horizontal directional drill (HDD) technique, which would avoid or minimize impacts on the beach, intertidal zone, and nearshore areas.

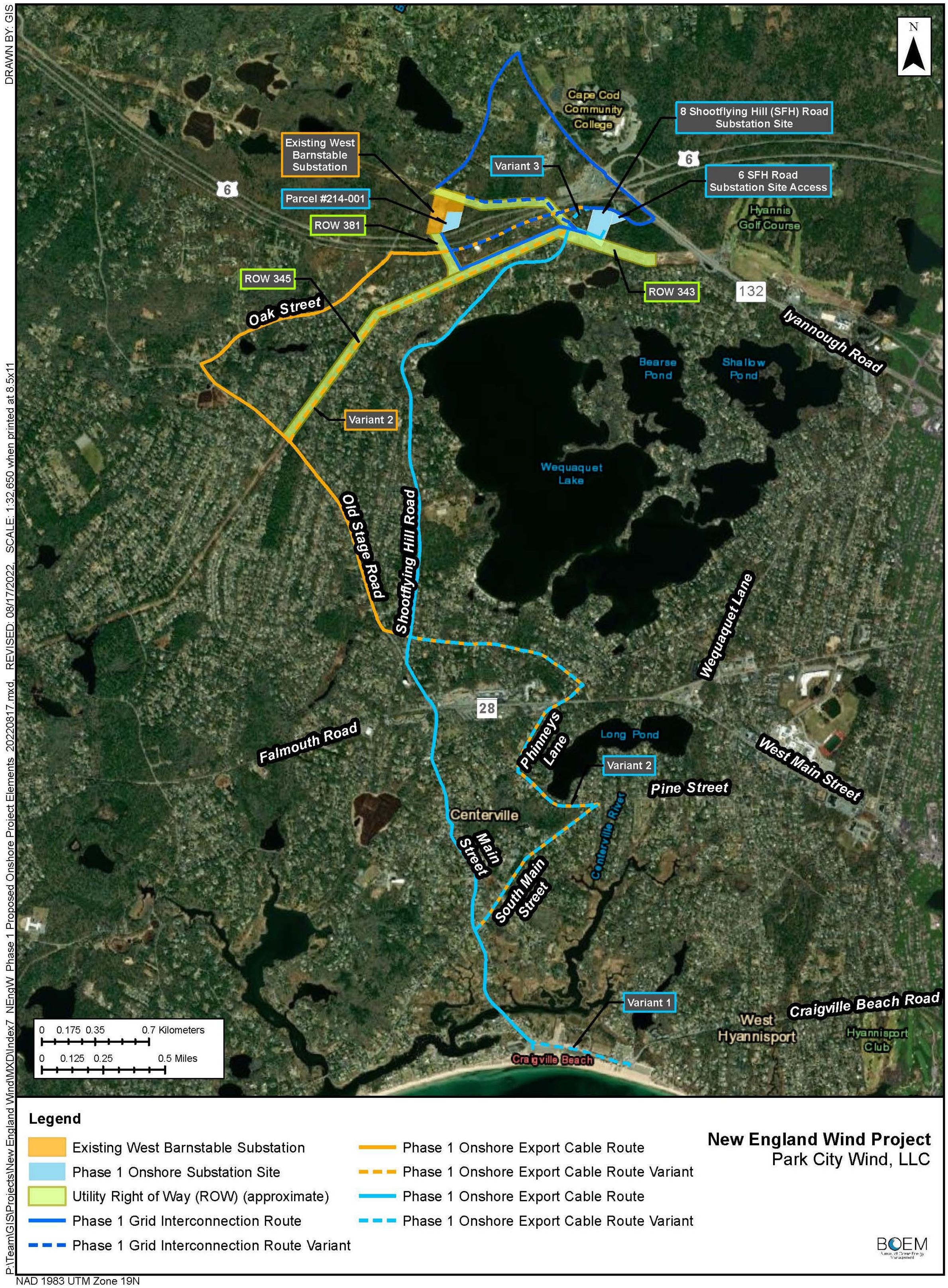
The applicant would construct one or more underground concrete transition vaults, also called splice vaults, at the landfall site. These would be accessible after construction via a manhole. Inside the splice vault(s), the 220 to 275 kilovolt (kV) alternating current (AC) offshore export cables would be connected to the 220 to 275 kV onshore export cables. From the landfall site to the proposed substation site, the Phase 1 OECR would be approximately 6.5 miles long, depending on the cable landfall site and route variant selected. The route options and variants are shown on Figure 2.1-2 (COP Volume I, Section 3.2.2.2; Epsilon 2023). Onshore export cables would be placed in a single concrete duct bank that would primarily be installed via open trenching within public roadway layouts (either beneath the road or within 10 feet of the pavement), although portions of the duct bank could be within existing utility ROWs.

The duct bank could vary in size along its length, although the typical trench for the duct bank would be 8 feet deep, 5.5 feet wide at the bottom, and 11 feet wide at the top. Excavated areas for splice vaults, either at the landfall site or along the OECR, would measure approximately 20 feet wide by 50 feet long. The top of the duct bank would typically have a minimum of 3 feet of cover comprised of properly compacted sand topped by pavement.

Most of the proposed OECR would pass through already developed areas, primarily paved roads, and existing utility ROWs. The OECR would be entirely underground. Duct bank system installation would typically occur outside of the summer peak tourist season, where feasible, to minimize traffic disruption. All work would be performed in accordance with local, state, and federal safety standards, and any applicant-specific requirements. The duct bank could vary in size and orientation along its length and could be installed either as a flat layout (four conduits wide by two conduits deep) or as an upright layout (two conduits wide by four conduits deep).

The Phase 1 onshore export cables would terminate at the proposed substation site on an approximately 6.7-acre commercial property at 8 Shootflying Hill Road. If necessary for engineering or other reasons, some of the onshore substation equipment currently intended for the 8 Shootflying Hill Road site could instead be placed on the 2.8-acre Parcel #214001 immediately southeast of (and adjoining) the West Barnstable Substation. Construction would advance similarly on either site. The applicant has also acquired the 1-acre property at 6 Shootflying Hill Road and would construct an access road on this property to reach the 8 Shootflying Hill Road onshore substation site. Construction of the onshore substation would take approximately 18 to 24 months.

Ground-disturbing activities during onshore substation construction include excavation and grading. The applicant anticipates the entire 8 Shootflying Hill Road site would need to be cleared to accommodate grading and access, as would the entire 6 Shootflying Hill Road parcel. Clearance of Parcel #214-001 would also be necessary if the parcel is used for the proposed Project. The applicant would plant a vegetated screening on the western and northern boundaries of the onshore substation site, providing visual screening for existing residences. The eastern boundary could be used for part of the perimeter access drive, and the abutting land is undeveloped wooded land. The entire site would have a perimeter access fence, and the western edge could have sound attenuation walls, if necessary.



Source: COP Volume I, Section 3.2.2; Epsilon 2023

Figure 2.1-2: Proposed Phase 1 Onshore Elements

Phase 1 would connect into the ISO New England electric grid (the regional electrical grid) via Eversource's existing 345 kV West Barnstable Substation. The proposed Project would install cables along a grid interconnection route, which would run up to 1.8 miles, depending on the route selected (Figure 2.1-2). As with the OECR, the grid interconnection route would be installed within public roadway layouts (either beneath the road or within 10 feet of the pavement) or entirely within existing utility ROWs. The 345 kV grid interconnection cables would be the same type of cable as the onshore export cables and installed in an underground duct bank with the same maximum dimensions as those described for the OECR.

Modifications and an expansion at the West Barnstable Substation would also be required to accommodate Phase 1. ISO New England and Eversource would determine the design and schedule of this work, which could include installation of an additional transformer and associated electrical transmission equipment (COP Volume I, Section 3.2.2; Epsilon 2023). It is anticipated that the West Barnstable Substation expansion could occur between the existing substation and the Oak Street Substation on the northern part of the same parcel.

Offshore Activities and Facilities

Offshore proposed Project components for Phase 1 include WTGs and their foundations, ESPs and their foundations, scour protection for all foundations, inter-array cables that connect the WTGs to the ESPs, the inter-link cables that connect the ESPs, and the export cables to the landfall location (Figures 2.1-3 and 2.1-4). The offshore proposed Project elements, with the exception of the export cables installed within 3 nautical miles (3.5 miles) of the Massachusetts coastline, are within federal waters. A summary of export, inter-link, and inter-array cable distances within federal and state waters is provided in Table 2.1-4. The COP provides a detailed description of proposed construction methods (Volume I, Section 3.3.1; Epsilon 2023).

The applicant would install up to 62 WTGs with maximum nacelle-top heights of 725 feet above mean lower low water (MLLW) and maximum vertical blade tip extension of 1,171 feet MLLW. Figure 2.1-5 provides a schematic drawing of the maximum WTG design parameters. The applicant would mount Phase 1 WTGs on monopile or jacket foundations. A monopile (Figure 2.1-6) is a long steel tube driven up to 180 feet into the seabed. A jacket foundation (Figure 2.1-7) is a latticed steel frame with three or four supporting pin piles driven up to 279 feet into the seabed. Additional schematic drawings and photos of proposed foundation types are included in the COP (Volume I, Section 4.2.1.1; Epsilon 2023).

Each Phase 1 WTG would contain approximately 3,012 gallons of transformer oil, approximately 1,820 gallons of general oil (for hydraulics and gearboxes), and approximately 1,849 gallons of diesel fuel. Use of other chemicals would include coolants/refrigerants, grease, paints, and sulfur hexafluoride (COP Volume I, Table 4.3-7; Epsilon 2023).

Table 2.1-4: Federal and State Jurisdictional Summary of Selected Phase 1 Facilities

Phase 1 Facility	Federal Waters (nautical miles)	State Waters (nautical miles)	Total (nautical miles)
Maximum length of each cable within the OECC	24	21	45
Maximum length of each cable within the SWDA	10	0	10
Maximum inter-link cable length[a]	11	0	11
Maximum inter-array cable length[a]	122	0	122

OECC = offshore export cable corridor; SWDA = Southern Wind Development Area

[a] The offshore export cable length includes a 15 percent allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5 percent allowance for micro-siting within the OECC outside the lease areas.

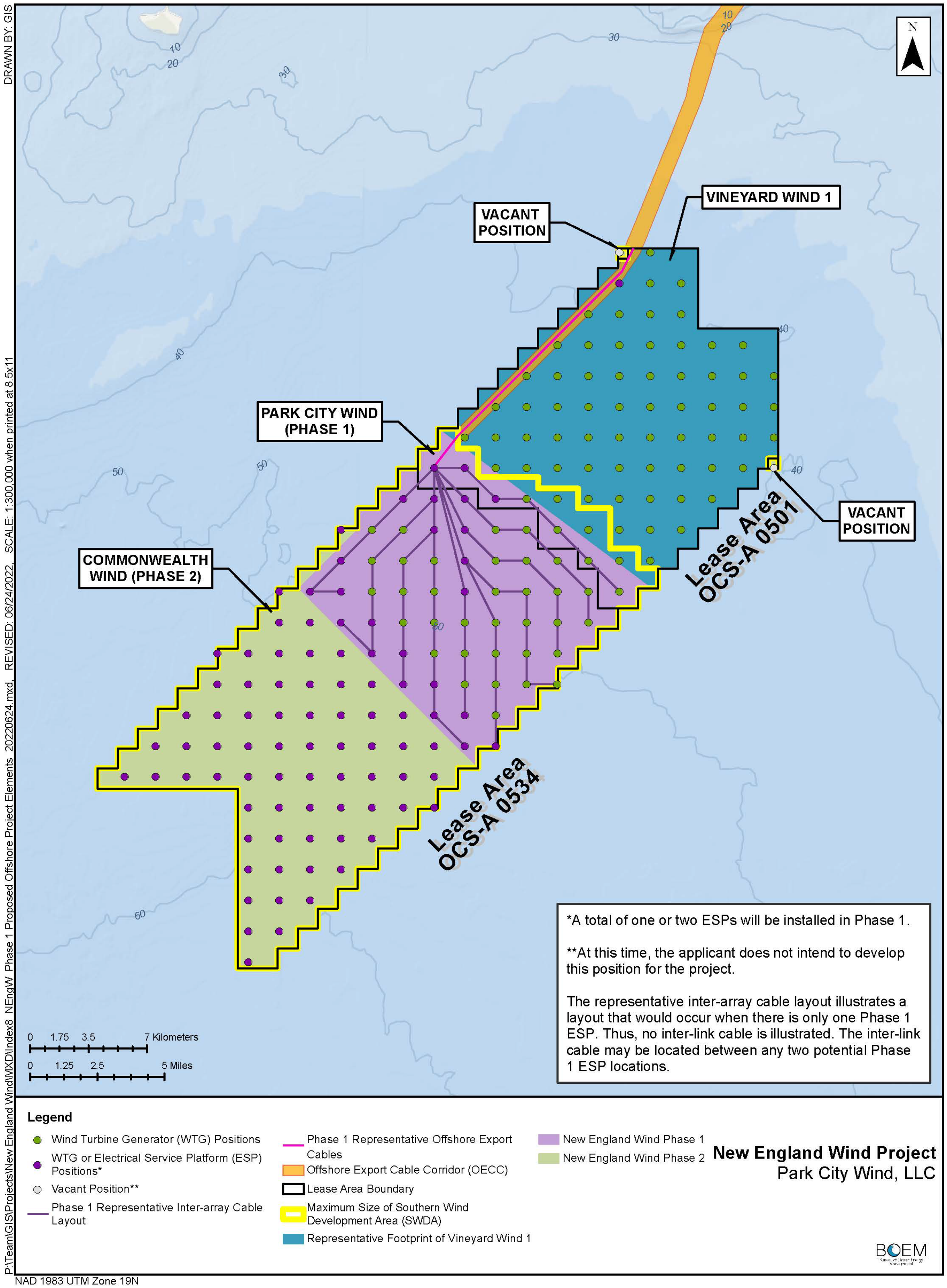


Figure 2.1-3: Proposed Phase 1 Offshore Elements

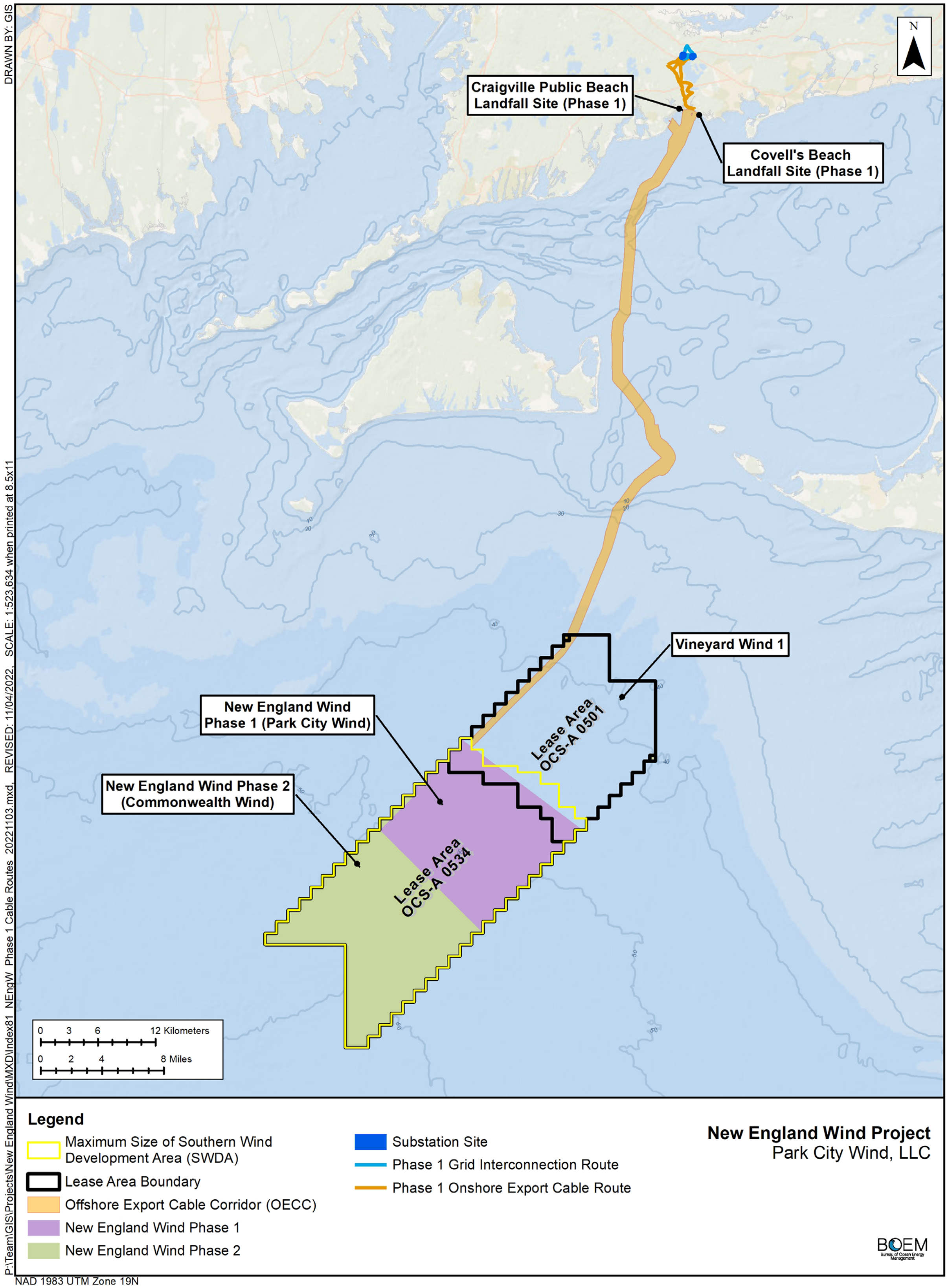
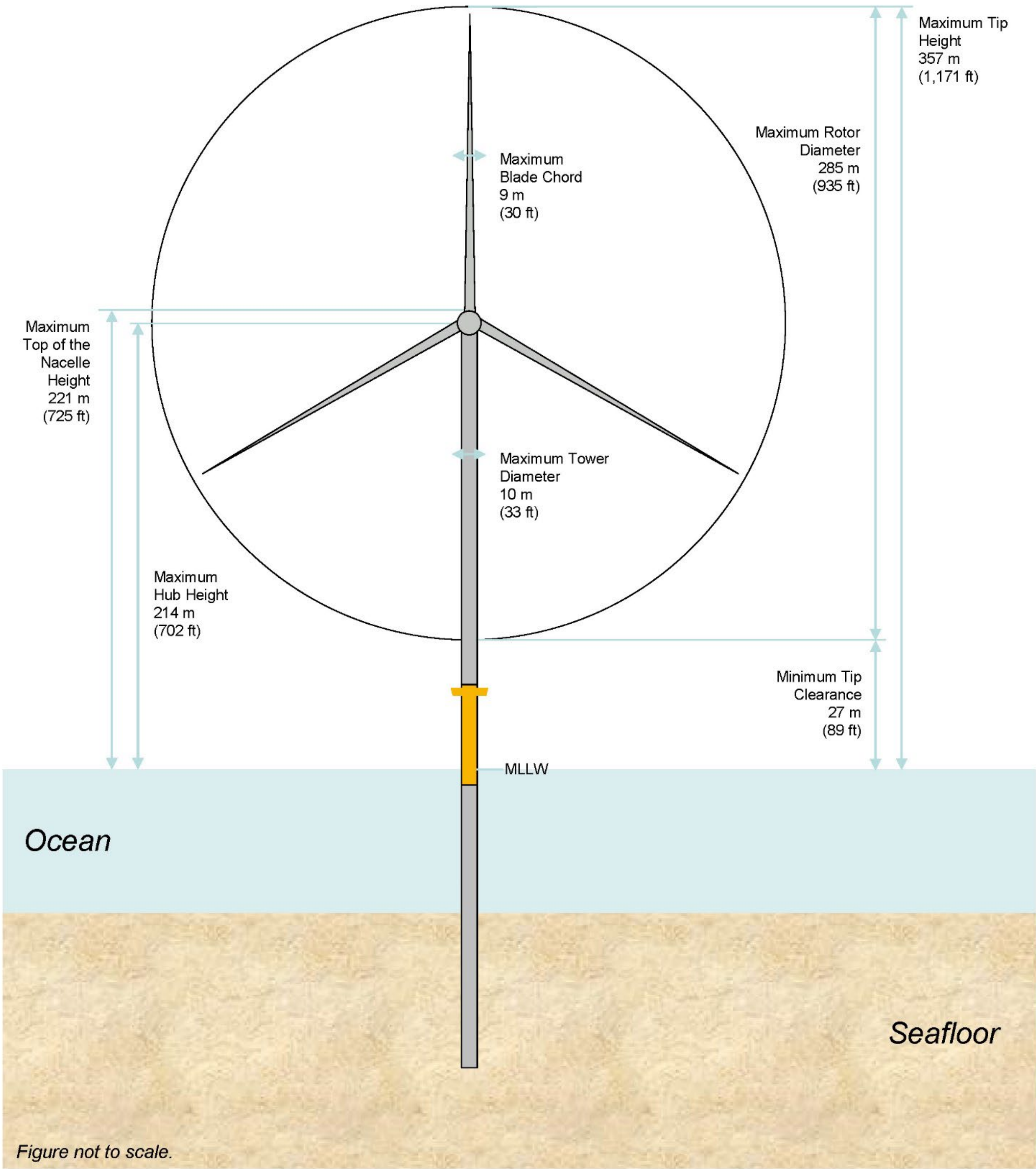
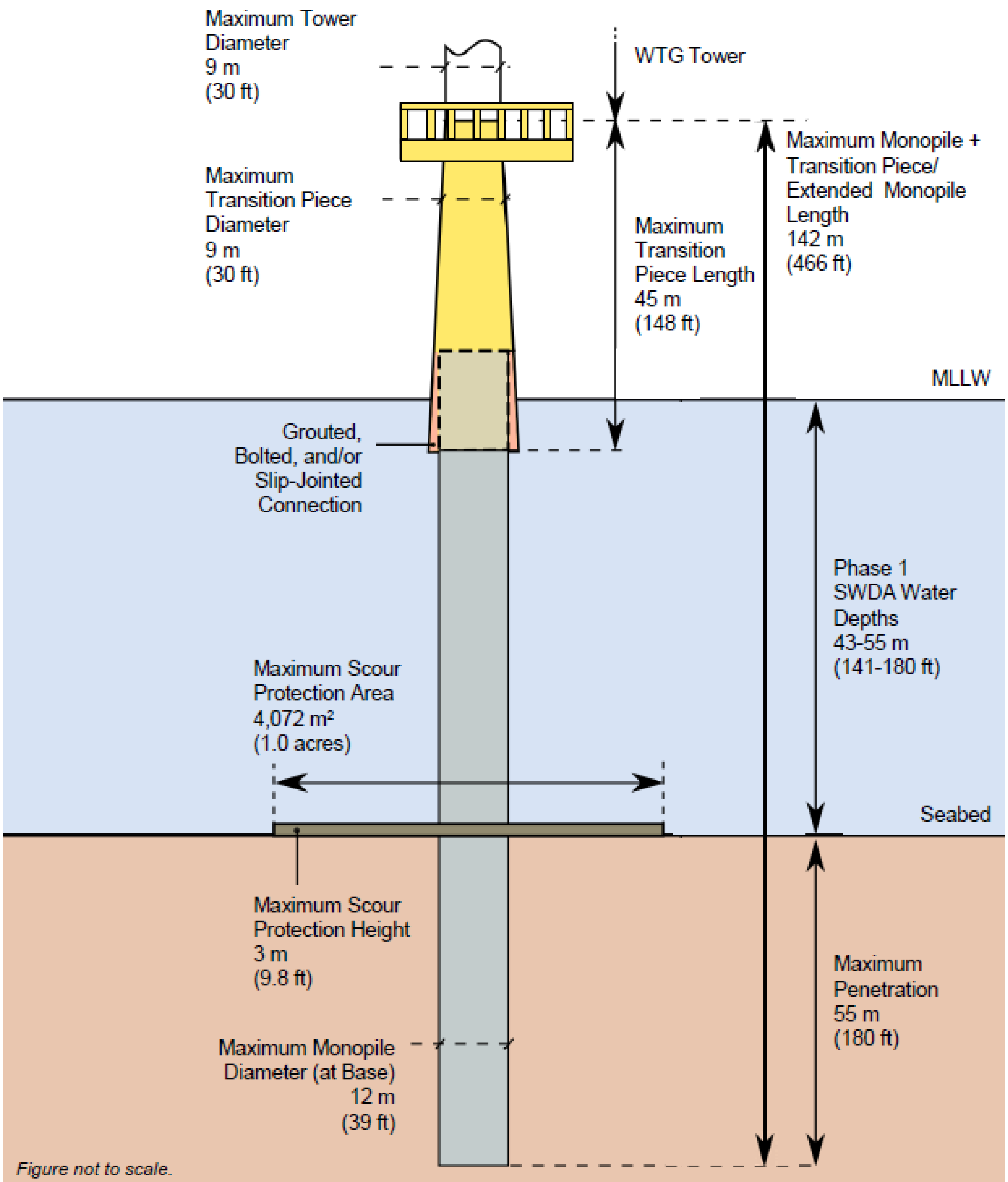


Figure 2.1-4: Proposed Phase 1 Export Cables



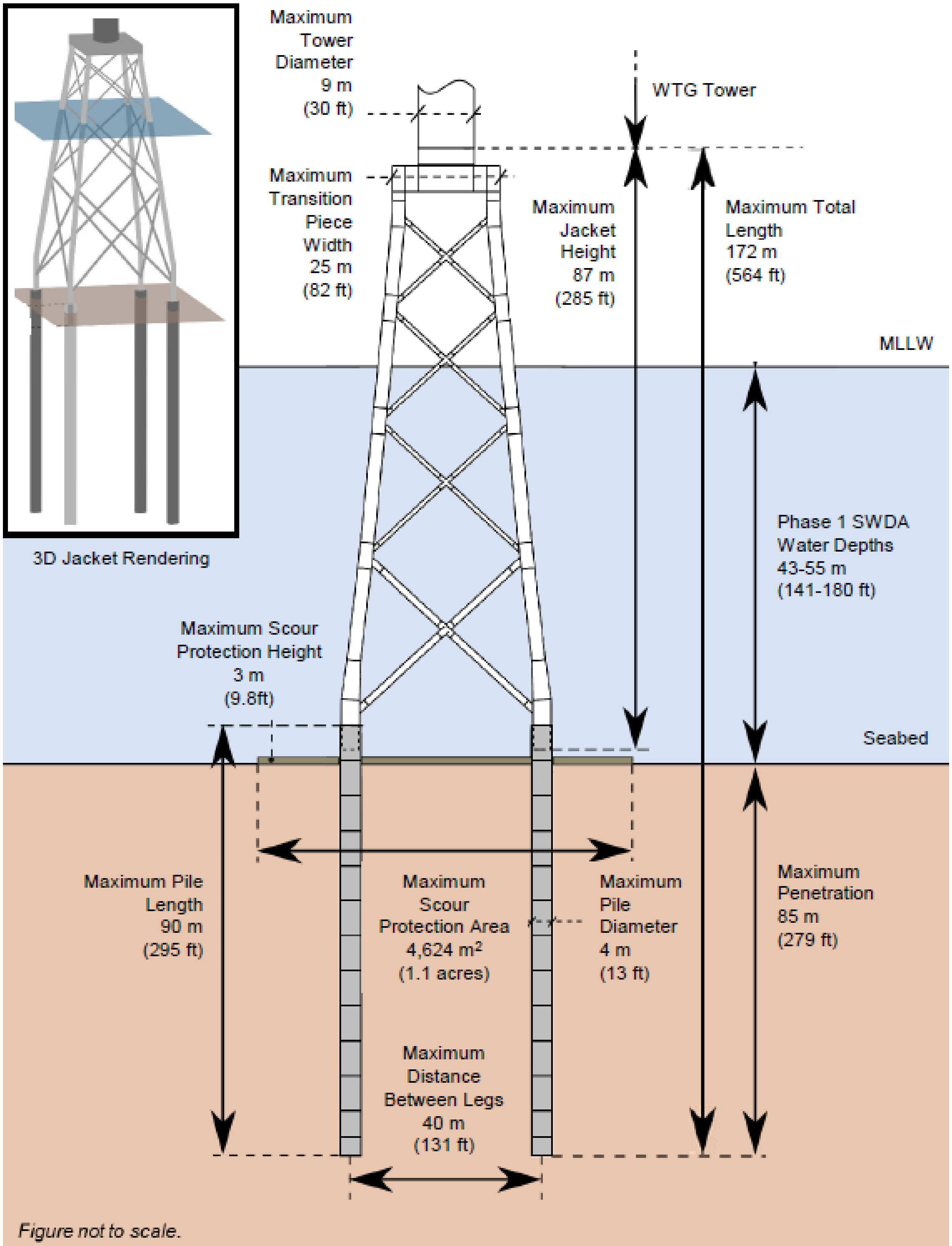
Source: COP Volume I, Section 3.2.1; Epsilon 2023
ft = feet; m = meter; MLLW = mean lower low water

Figure 2.1-5: Phase 1 Maximum-Case Schematic Wind Turbine Generator Design



Source: COP Volume I, Section 3.2.1; Epsilon 2023
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 2.1-6: Phase 1 Monopile Foundation Conceptual Drawing



Source: COP Volume I, Section 3.2.1; Epsilon 2023
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 2.1-7: Phase 1 Jacket Foundation Conceptual Drawing

The applicant would construct up to two ESPs in the SWDA to serve as the interconnection point between the WTGs and the export cables. The ESPs would be located along the northwestern edge of the SWDA and include step-up transformers and other electrical equipment needed to connect the 66 to 132 kV inter-array cables to the 220 to 275 kV offshore export cables. Each inter-array cable would be buried below the seabed and connect a string consisting of multiple WTGs to the ESP. The number and orientation of the inter-array cables would depend on the exact WTG and ESP positions used. If the proposed Project uses more than one ESP, a 66 to 275 kV inter-link cable would be installed to connect the ESPs.

The ESPs could be co-located with WTG positions. In such cases, two foundations would be installed in a single position, separated by approximately 500 feet (COP Volume I, Section 3.2.1.3; Epsilon 2023). As a result, Phase 1 could include 64 foundations at 63 positions, and Alternative B overall would include up to 132 foundations in the 130 positions shown on Figure 2.1-3. Each ESP would contain up to approximately 118,281 gallons of transformer oil, approximately 335 gallons of general oil, and approximately 5,468 gallons of diesel fuel. The COP provides additional details related to proposed chemicals stored in WTGs and ESPs, as well as their anticipated volumes (Volume I, Section 3.3.4.4 and Table 4.3-7; Epsilon 2023).

The WTGs and ESPs would include a nighttime obstruction lighting system that complies with Federal Aviation Administration (FAA) and U.S. Coast Guard (USCG) lighting standards and is consistent with BOEM best practices (BOEM 2021a). The applicant's lighting and marking plan would describe the lighting and marking system as part of the final layout plan, consistent with USCG standards. Such a plan would specify WTG paint colors and the lighting configuration, and BOEM would require the applicant to include justification for any deviations from BOEM's guidelines on lighting and marking. The applicant anticipates using (and BOEM may require, as a condition of COP approval outlined in the ROD) an aircraft detection lighting system (ADLS) that would automatically activate lights when aircraft approach. The WTGs would be painted off-white or light grey (no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey) to reduce daytime visibility against the horizon.

The applicant would submit an application to USCG for a Private Aids to Navigation (PATON) permit for each WTG constructed. Upon receipt and review of this application, which has not yet been filed, USCG would issue the PATON permits. Each WTG would be maintained as a PATON and contain marine navigation lighting and marking in accordance with the USCG's PATON marking guidance for offshore wind facilities in waters of the USCG First District (which includes waters from northern New Jersey to the Maine-Canada border [USCG 2022]). All WTGs and ESPs would also display a uniform system of marine navigation lighting and marking that includes yellow flashing lights on every WTG foundation and alphanumeric identifiers (approximately 10 feet high) on each WTG tower and/or foundation. The lights and alphanumeric identifiers would be visible from all directions. Each WTG's air draft restriction would be indicated on the foundation and/or tower. The proposed Project also includes mariner radio activated sound signals[13] and automatic identification system (AIS) transponders for offshore facilities.

The WTGs and ESP foundations would be installed using jack-up vessels, anchored vessels, or dynamic positioning (DP)[14] vessels along with necessary support vessels and supply vessels, resulting in temporary seafloor disturbance. The potential impacts associated with jack-up or anchored vessels are described in

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

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

Chapter 3. Vessels would be equipped with a crane and a pile-driving hammer. The applicant would begin pile driving by using a “soft start” to help enable some marine life to leave the area before driving intensity increases. ESP foundation installations could require specialized crane vessels. It is possible that monopiles would be transported to the SWDA by floating in the water while pulled by tugs. The COP provides more details about installation (Volume I, Section 3.3.1; Epsilon 2023). Scour protection for foundations would be up to 9.8 feet high, would extend away from the foundation as far as 118 feet, and would consist of rock and stone at least 2.5 inches in diameter. To maximize precision when placing scour protection, the applicant would use the fall pipe method whenever feasible, as discussed in COP Section 3.2.1.5.4 (Volume I; Epsilon 2023).

Two high-voltage AC 220 to 275 kV offshore export cables up to 62.8 miles long (per cable; Table 2.1-4) would be installed within the OECC and SWDA and transmit electricity from the ESPs to a landfall site at either Craigville Public Beach or Covell’s Beach in the Town of Barnstable. One or more fiber optic cables (for communication and other purposes) would also be installed within the OECC. The offshore export cables would be installed at a target burial depth of 5 to 8 feet below the seafloor.

As part of the PDE, several cable installation methods could be used for the inter-array cables, inter-link cables, and offshore export cables. The applicant would typically use post-lay burial techniques for cables, which involve laying cable sections on the seafloor and using a jet plow or jet trenching (or possibly a mechanical plow) to bury the cables. Other burial methods could be more rarely used, although the choice of installation method would depend on seafloor conditions and sediment characteristics (COP Volume I, Section 3.3.1.3; Epsilon 2023). The applicant states that installation method selection would prioritize adequate burial depth achievement while using the “least environmentally impactful [method] that is practicable for each segment of cable installation” (COP Volume I, Section 3.3.1.3.6; Epsilon 2023). If sufficient burial is not achieved on the first installation pass, the applicant would make subsequent attempts, possibly using other installation techniques to achieve sufficient burial. No drilling or blasting would be required.

Prior to cable laying, a pre-lay grapnel run and pre-lay survey would be performed to clear obstructions and inspect the route. Large boulders along the route may need to be relocated, and some dredging may be required prior to cable laying to achieve sufficient burial depth below the stable seafloor. Most of the dredging would occur on large sand waves, which are mobile features (COP Volume II-A, Figure 3.2-3; Epsilon 2023). The applicant anticipates that, where necessary, dredging would occur within a corridor that is 50 feet wide at the bottom and 1.6 feet deep, potentially extending as deep as 17 feet.

For the installation of the two Phase 1 offshore export cables, total dredging could affect a maximum of 52 acres and include up to 176,786 cubic yards of dredged material. This dredge volume includes 66,600 cubic yards of material in federal waters and up to 110,186 cubic yards of material in state waters. The applicant could use several techniques to accomplish the dredging but would primarily rely on either trailing suction hopper dredge (TSHD) or jetting (also known as mass flow excavation).[15] For Phase 1, a TSHD could be used to remove enough of the top of a sand wave (to be deposited into a hopper) to allow subsequent cable installation into the stable seabed using one of the techniques described above. Should a TSHD be used, the TSHD would dredge along the cable alignment until the hopper was filled to an appropriate capacity, at which point the TSHD vessel would sail several hundred feet away and deposit the dredged material within the OECC. If use of a TSHD is required during export cable installation, the applicant may be required to obtain a Marine Protection, Research and Sanctuaries Act

[15] The TSHD is used in sand waves of most sizes, whereas the jetting technique is used in sand waves less than 6.6 feet high. Sand wave dredging could be accomplished entirely by the TSHD or by a combination of jetting and TSHD.

Section 103 permit from USACE to identify specific dumping locations for dredge material and the potential impacts of disposing dredge material in those locations. Under Section 103 of the Marine Protection, Research and Sanctuaries Act, USACE regulates the transportation of dredged material for purposes of dumping it into ocean water. At this time, the potential for use of a TSHD is low, and the applicant is not currently pursuing a Section 103 permit. Should the applicant determine the definitive need for the use of a TSHD during export cable installation, the applicant will coordinate with USACE regarding Section 103 permitting and supplemental NEPA review, as applicable, prior to conducting dredging activities as part of export cable installation.

Jetting uses a pressurized stream of water to push sand to the side. The jetting tool draws in seawater from the sides and jets this water out from a vertical down pipe at a specified pressure and volume. The down pipe is positioned over the cable alignment, enabling the stream of water to fluidize the sands around the cable, allowing the cable to settle into the trench. This process causes the top layer of sand to be side-casted to either side of the trench; jetting removes the top of the sand wave and buries the cable. Typically, several passes are required to lower the cable to the minimum target burial depth. Protection conduits installed at the approach leading to each WTG and ESP foundation protect all offshore export cables and inter-array cables.

If sufficient burial depth is not achieved through the methods described above, additional cable protection measures such as rock placement, gabion rock bags, concrete mattresses, half-shell pipes, or similar techniques could be needed. Rock placement involves laying rocks on top of the cable to provide protection. Concrete mattresses are prefabricated flexible concrete coverings that are laid on top of the cable. In certain cases, the mattresses can be filled with grout or sand (referred to as grout/sandbags); this method is generally applied on smaller-scale applications rather than standard concrete mattresses. Lastly, half-shell pipes or similar products could be used that are made from composite materials or cast iron with suitable corrosion protection. The applicant estimates that approximately 6 percent of the OECC route and 2 percent of inter-array and inter-link and offshore export cable length could require such additional measures (COP Volume I, Section 3.2.1; Epsilon 2023). The potential impacts associated with implementation of the cable protection methods specified above are described in Chapter 3.

Site preparation would include high-resolution geophysical (HRG) surveys and other risk mitigation for potential unexploded ordnance, munitions, and explosives of concern. Avoidance is the preferred approach to ordinance and munitions; however, where avoidance is not possible, proper disposal of the contaminated object would occur with appropriate contractors involved (COP Volume II-A, Section 3.2.6.4; Epsilon 2023). The applicant would use vessels, vehicles, and aircraft during Phase 1 construction, including construction and support vessels to complete tasks in the SWDA and along the OECC. Table 2.1-5 lists the onshore port facilities that could be used for crew transfer, component shipments, storage, preparing components for installation, and potentially some component fabrication and assembly. In addition to the ports listed in Table 2.1-5, some components, materials, and vessels could come from ports in other nations.

The applicant does not propose to direct or implement any potential port improvements specifically to support Phase 1. In selecting the ports to be used for Phase 1 construction and operations, the applicant would consider the suitability of existing ports listed in Table 2.1-5, including upgrades planned or completed by the port owners. Therefore, no port upgrades would occur as a direct result of Phase 1 (COP Volume I, Section 3.2.2.5; Epsilon 2023).

Table 2.1-5: Possible Ports Used during Phase 1 Construction, Operations, and Decommissioning

Geography	Ports
Massachusetts	New Bedford Marine Commerce Terminal, other areas in New Bedford Harbor, Brayton Point Commerce Center, Vineyard Haven, Fall River, Salem
Rhode Island	Port of Davisville, ProvPort, South Quay Terminal
Connecticut	Bridgeport, New London State Pier
New York	Capital Region Ports (Port of Albany, Coeymans, and New York State Offshore Wind Port); Staten Island Ports (Arthur Kill and Homeport Pier); South Brooklyn Marine Terminal; GMD Shipyard; Shoreham; Greenport Harbor (operations only)
New Jersey	Paulsboro
Canada	Halifax, Sheet Harbor, Saint John

ProvPort = Port of Providence

During Phase 1 construction, the applicant anticipates an average of approximately 30 vessels operating during a typical workday in the SWDA and along the OECC. Approximately 60 vessels could be present during the period of maximum construction activity at the start of WTG installation. Many construction vessels would remain in the SWDA or OECC for days or weeks at a time. The proposed Project construction would generate an average of 7 daily round trips from select ports listed in Table 2.1-5, with approximately 15 daily round trips during maximum construction activity. Additionally, construction vessels may make infrequent trips to port for bunkering and provisioning.

The maximum number of vessels at any one time is highly dependent on the proposed Project's final schedule, final design, and the logistics solution used to achieve compliance with the Jones Act (COP Volume I, Section 3.3.1.12.1; Epsilon 2023). Vessel types proposed for the cable installation include vessels capable of DP, anchored vessels, self-propelled vessels, and/or barges. All proposed Project vessels are subject to applicable USCG regulations for ballast water management (33 CFR Part 151 Subpart C, 33 CFR Part 151 Subpart D, and 46 CFR Subpart 162.060). These requirements apply to all U.S. and foreign-flagged commercial vessels equipped with ballast water tanks and operating in U.S. waters. Additional information can be found in the Navigation and Vessel Inspection Circular 01-18, Ballast Water Management for Control of Non-Indigenous Species in Waters of the United States (USCG 2018).

The proposed Project could require vessel anchoring, especially during the cable burial process. Anchoring, if used, would avoid sensitive seafloor habitats to the greatest extent practicable and be completely prohibited in eelgrass beds (Appendix H). Where it is considered impracticable to avoid a sensitive seafloor habitat, mid-line anchor buoys would be used where feasible and considered safe by vessel operators as a potential measure to reduce and minimize potential impacts from anchor line sweep (Appendix H).

Phase 1 Operations and Maintenance

Phase 1 is expected to have an operating period of 30 years. The proposed Project would include a comprehensive maintenance program, including preventative maintenance (e.g., oil changes) based on statutory requirements, original equipment manufacturer (OEM) guidelines, and industry best practices. In addition, the applicant would maintain an oil spill response plan (OSRP), an emergency response plan, and a safety management system, including an environmental management system that would be issued to the vessels and construction firms (COP Volume I, Appendices I-B and I-F; Epsilon 2023). These BOEM- and Bureau of Safety and Environmental Enforcement- (BSEE-) approved plans would be in place prior to construction. The applicant would inspect WTGs, foundations, ESPs, inter-array cables, offshore export cables, landfall locations, onshore export cables, and other proposed Project facilities.

Proposed Project WTGs would be designed to operate without attendance by any operators. Continuous monitoring would be conducted using a supervisory control and data acquisition (SCADA) system from a remote location. Parameters that would be monitored include temperature limits, vibration limits, current limits, voltage, etc. The WTGs would include self-protection systems that would be activated if a WTG operates outside its specifications or the SCADA system fails. These self-protection systems could curtail or halt WTG electricity production or disconnect WTGs from the grid.

The applicant and/or the selected WTG OEM would be responsible for the operation and monitoring of the WTGs 24 hours per day, 7 days per week (24/7). This would be achieved through the applicant's operations facilities and a 24/7 control center owned and operated by shareholder company Avangrid Renewables, LLC.

Onshore Activities and Facilities

For Phase 1, the applicant would establish a long-term service operation vessel (SOV) operations base in Bridgeport, Connecticut, and operate crew transfer vessels (CTV) or the SOV daughter craft out of Vineyard Haven on Martha's Vineyard. Although the applicant plans to locate the Phase 1 operations facilities in Bridgeport and/or Vineyard Haven, other ports listed in Table 2.1-5 could also be used to support operations activities.

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

Offshore Activities and Facilities

Routine maintenance is expected for WTGs, ESPs, and foundations. The applicant expects to conduct annual inspections of foundations, structures, components, and equipment, including, but not limited to, high-voltage equipment, lifting equipment, safety equipment, hook-on points, ladders, boat landing structures, and internal structures (e.g., corrosion measurement, etc.). The applicant would proactively repair or replace deteriorated components identified during these inspections. The applicant would conduct HRG surveys and monitor cable exposure and/or depth of burial. It is expected that the cables will be surveyed within 6 months of commissioning, at years 1 and 2, and every 3 years thereafter.

The applicant would prepare detailed preventative maintenance plans as part of the permitting process to identify specific timetables for other inspections and maintenance activities. This monitoring schedule may be adjusted over time based on results of the ongoing surveys (COP Volume I, Section 3.2.3.3; Epsilon 2023). The applicant would need to use vessels, remote sensing equipment, vehicles, and aircraft during the inspection and maintenance activities described above.

Phase 1 Conceptual Decommissioning

Pursuant to 30 CFR Parts 285 and 585, as well as other BOEM and BSEE requirements, the applicant would be required to remove or decommission all facilities, projects, cables, pipelines, and obstructions and clear the seabed of all obstructions created by the proposed Project. Methods of site clearance have involved trawling, sonar, or remotely operated vehicle (ROV) or diver verifying that the site is clear. Other methods may be used if approved from BSEE/BOEM. In accordance with applicable regulations and a BSEE-approved decommissioning plan, the applicant would have up to 2 years to decommission the proposed Project after the 33-year lease ends, unless the lease is extended, and return the area to pre-construction conditions, as feasible. The applicant would need to obtain separate and subsequent approval, via a decommissioning application from BSEE, to retire any portion of the proposed Project in place. The applicant would submit a decommissioning application prior to any decommissioning activities. BOEM would conduct a NEPA review at that time, which could result in the preparation of a NEPA document. If the COP is approved or approved with modifications, the applicant would have to submit a bond that would be held by the U.S. government to cover the cost of decommissioning the entire facility. Decommissioning may not occur for all proposed Project components. However, for the purposes of the Final EIS, all analyses assume that decommissioning would occur as described in this section.

The applicant would be required to complete decommissioning within 2 years of termination of the lease and either reuse, recycle, or responsibly dispose of all removed materials. The applicant has submitted a decommissioning plan as part of the COP (Volume I, Section 3.3.3.4), and the final plan would outline the applicant's process for managing waste and recycling proposed Project components (Volume I; Epsilon 2023). Although the proposed Project has a designed life span of 33 years, some installations and components could remain fit for continued service after this time. The applicant would need to apply for an extension to operate the proposed Project for more than the 33-year operations term stated in its lease.

The applicant must submit a decommissioning application upon the earliest of the following dates: 2 years before the expiration of the lease; 90 days after completion of the commercial activities on the commercial lease; or 90 days after cancellation, relinquishment, or other termination of the lease (30 CFR § 285.905). Upon completion of the technical and environmental reviews, BOEM can approve, approve with conditions, or disapprove the lessee's decommissioning application. This process includes an opportunity for public comment and consultation with municipal, state, and federal management agencies. Furthermore, pursuant to 30 CFR Parts 285 and 585 and other BOEM requirements, the applicant would be required to remove or decommission all installations and clear the seabed of all obstructions created by the proposed Project. The applicant would need to obtain separate and subsequent approval from BOEM to leave any portion of the proposed Project in place in compliance with all applicable law.

According to the decommissioning plan included in the COP (Volume I, Section 3.3.3.4; Epsilon 2023), the WTG and ESP fluids would be drained into vessels for disposal in onshore facilities before disassembling the structures and bringing them to port. Foundations would be temporarily emptied of sediment, cut 15 feet below the mudline in accordance with BOEM regulations (30 CFR § 285.910(a)), and removed. The portion of foundations buried below 15 feet would remain, and the depression refilled with the temporarily removed sediment. In consideration of mobile gear fisheries (i.e., dredge and bottom trawl gear), the applicant would remove scour protection during decommissioning. Offshore cables could be retired in place or removed, subject to 30 CFR Part 285, Subpart I (COP Volume I, Section 3.3.3.4; Epsilon 2023).

Depending on the needs of the host locations, the applicant may leave onshore facilities in place for future use. Onshore cable removal, if required, would likely proceed using truck-mounted winches and handling equipment. There are no plans to disrupt streets or onshore public utility ROWs by excavating or deconstructing buried facilities. If the COP is approved or approved with modifications, the applicant would be required to submit a bond (or another form of financial assurance) held by the U.S. government to cover the cost of decommissioning the entire facility in the event that the applicant would not otherwise be able to decommission the facility.

2.1.2.3 Phase 2 (Commonwealth Wind Project)

Phase 2, also known as the Commonwealth Wind Project, would be developed immediately southwest of Phase 1 in the portion of Lease Area OCS-A 0534 that is not developed as part of Phase 1. Phase 2 would deliver at least 1,232 MW of power to the ISO New England grid to assist the states of Connecticut and Massachusetts, and the federal government, to meet climate and renewable energy/offshore wind goals.

Phase 2 would consist of up to 88 WTGs and 3 ESPs (Table C-3 in Appendix C). The full buildout and capacity of Phase 2 is largely dependent on market conditions and available WTG technology at the time of procurement. The applicant has identified six potential scenarios, including contingencies, for the Phase 2 OECC (Table 2.1-2). The applicant's preference is to install the Phase 2 OECC adjacent to the Phase 1 OECC. The Phase 2 OECR is proposed to be installed in the same general part of the Town of Barnstable (although following different routes) as the Phase 1 OECR (Figure 2.1-8).

If the applicant is unable to install all Phase 2 export cables in the proposed (Eastern Muskeget) OECC through Muskeget Channel, one or more Phase 2 cables could be installed in the Western Muskeget Variant. If technical, logistical, grid interconnection, or other unforeseen issues prevent all Phase 2 export cables from interconnecting at the West Barnstable Substation, the applicant would develop and use the SCV in place of or in addition to the currently proposed Phase 2 OECC and OECR (Figure 2.1-9 shows the OECCs for the Western Muskeget Variant and SCV). Because the SCV is a contingency, the applicant had not provided information on grid interconnection routes, onshore cable routes, landfall locations, and nearshore cable routes necessary to prepare a sufficient analysis of the SCV at the time of publication of this Final EIS. Therefore, the analysis of the SCV in this Final EIS includes available information but reflects some uncertainty. If the applicant determines that the SCV is necessary, the applicant would be required to file a COP revision per 30 CFR § 585.634, describing the need for the SCV and providing the information necessary to complete a sufficient analysis. In response, BOEM would complete additional environmental analysis and relevant consultations required by NEPA, NHPA, and other applicable statutes (including making the analysis available for public review and comment) to inform BOEM's decision to approve, approve with conditions, or disapprove the COP revision.

Phase 2 Construction and Installation

Phase 2 includes the construction of both onshore and offshore facilities. If Phase 2 proceeds immediately following Phase 1, Phase 2 onshore construction would likely begin in 2025, and offshore construction would begin in late 2026 (Stephanie Wilson, pers. comm., June 27, 2023). In this scenario, each major construction activity would be sequential for the two phases (e.g., Phase 2 foundation installation would follow Phase 1 foundation installation). However, there could be some overlap of Phase 1 and Phase 2 offshore activities (e.g., offshore export cable installation and termination and WTG installation and commissioning). There would be no concurrent/simultaneous pile driving of Phase 1 and Phase 2 foundations. It is expected that Phase 2 would follow a similar order of construction and timing of activities as Phase 1.

Onshore Activities and Facilities

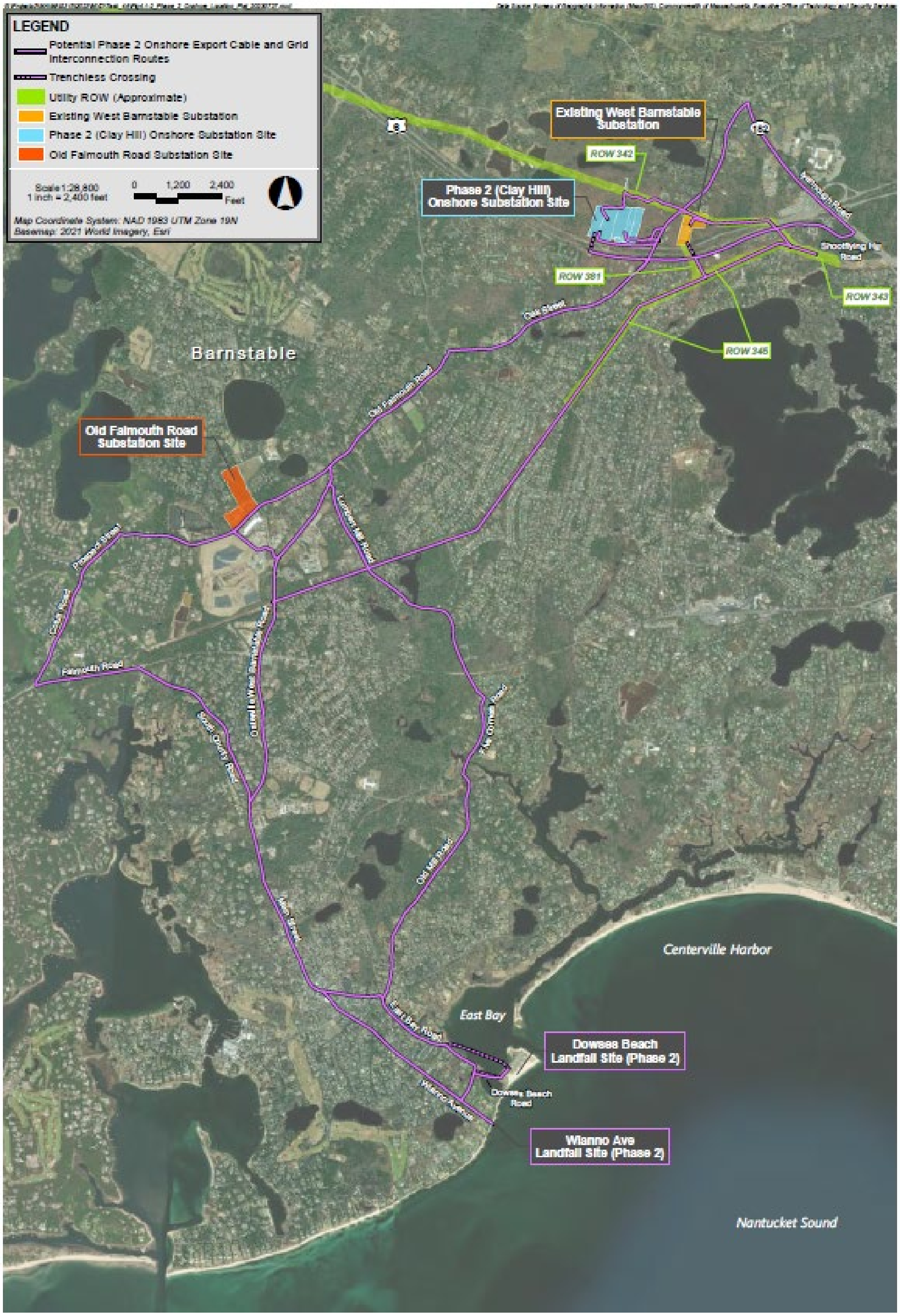
The applicant intends to interconnect the entire Phase 2 electrical output to the electrical grid at the West Barnstable Substation, the same location as used for Phase 1. The final design of Phase 2 (including the number and size of the WTGs and the total power production capacity of Phase 2) would depend on the available capacity at existing onshore grid tie-in points and could require up to two onshore transmission systems. Consistent with the PDE approach, this Final EIS evaluates a Phase 2 configuration with two landfall sites, two OECRs, and two onshore substation sites to transmit power to the grid. The first system would be within the Town of Barnstable, while the second system, if necessary, would include the SCV and constructed in south-central Bristol County, Massachusetts. Figure 2.1-8 shows the location of the potential onshore transmission systems in Barnstable County. The OECR and substation associated with the SCV have not been identified. If use of the SCV is required, BOEM will provide additional information about the SCV OECR and substation as part of a supplemental NEPA analysis once the applicant provides more detailed information. As a result, this chapter does not further discuss the SCV OECR or substation(s).

The Phase 2 offshore export cables would make landfall within paved parking areas at either the Dowses Beach Landfall Site or the Wianno Avenue Landfall Site in the Town of Barnstable (Figure 2.1-8). The ocean-to-land transition at the Dowses Beach Landfall Site would employ the HDD technique, which would avoid or minimize impacts on the beach, intertidal zone, and nearshore areas. The preferred transition method at the Wianno Avenue Landfall Site would also be HDD, although open trenching methods may be used at this site due to challenges associated with topography and other existing conditions (COP Volume I, Section 4.2.2.1; Epsilon 2023).

The applicant would construct one splice vault (described in Section 2.1.2.2) per offshore export cable at the landfall site. These would be accessible after construction via a manhole. Inside the splice vault, the 220 to 345 kV AC offshore export cables would be connected to the 345 kV onshore export cables. From the landfall site, the Phase 2 OECR would be approximately 10.6 miles long, depending on the cable landfall site and route variant selected. The route options and variants are shown on Figure 2.1-8 (COP Volume I, Section 4.2.2.2; Epsilon 2023). Onshore export cables would be installed in duct banks as described for Phase 1 (Section 2.1.2.1). Duct banks would primarily be installed via open trenching within public roadway layouts (either beneath the road or within 10 feet of the pavement), although portions of the duct bank could be within existing utility ROWs. (COP Volume I, Section 4.2.2; Epsilon 2023).

The applicant has identified two potential sites for the proposed Phase 2 substation (Clay Hill Substation and Old Falmouth Road Substation; Figure 2.1-8). The Phase 2 Clay Hill onshore substation site would be located approximately 0.25 mile west of the interconnection location at the existing Eversource West Barnstable Substation. The applicant has site control over eight contiguous privately owned parcels totaling approximately 29 acres. Of the eight parcels, four (parcels 2 through 5) would be developed as part of substation construction. The total area to be disturbed for the substation, including site grading, and stormwater features along with associated access roads, would be approximately 13.6 acres, which includes removal of the existing single-family residential structure. The total area of tree clearing associated with these activities would be approximately 13.3 acres (COP Volume I, Section 4.2.2. Epsilon 2023).

The Old Falmouth Road onshore substation site option consists of four parcels totaling approximately 18.5 acres. The Old Falmouth Road site would be located over 2.5 miles from the West Barnstable Substation. Of the four parcels that comprise the site, only two were available to the applicant through option agreements, and those two would not provide enough space to accommodate the proposed substation. Therefore, the applicant would need to secure additional option agreements to allow for use of the Old Falmouth Road site as the location for the Phase 2 onshore substation.



Source: COP Volume I, Section 4.2.1; Epsilon 2023
ROW = right-of-way

Figure 2.1-8: Proposed Phase 2 Onshore Elements

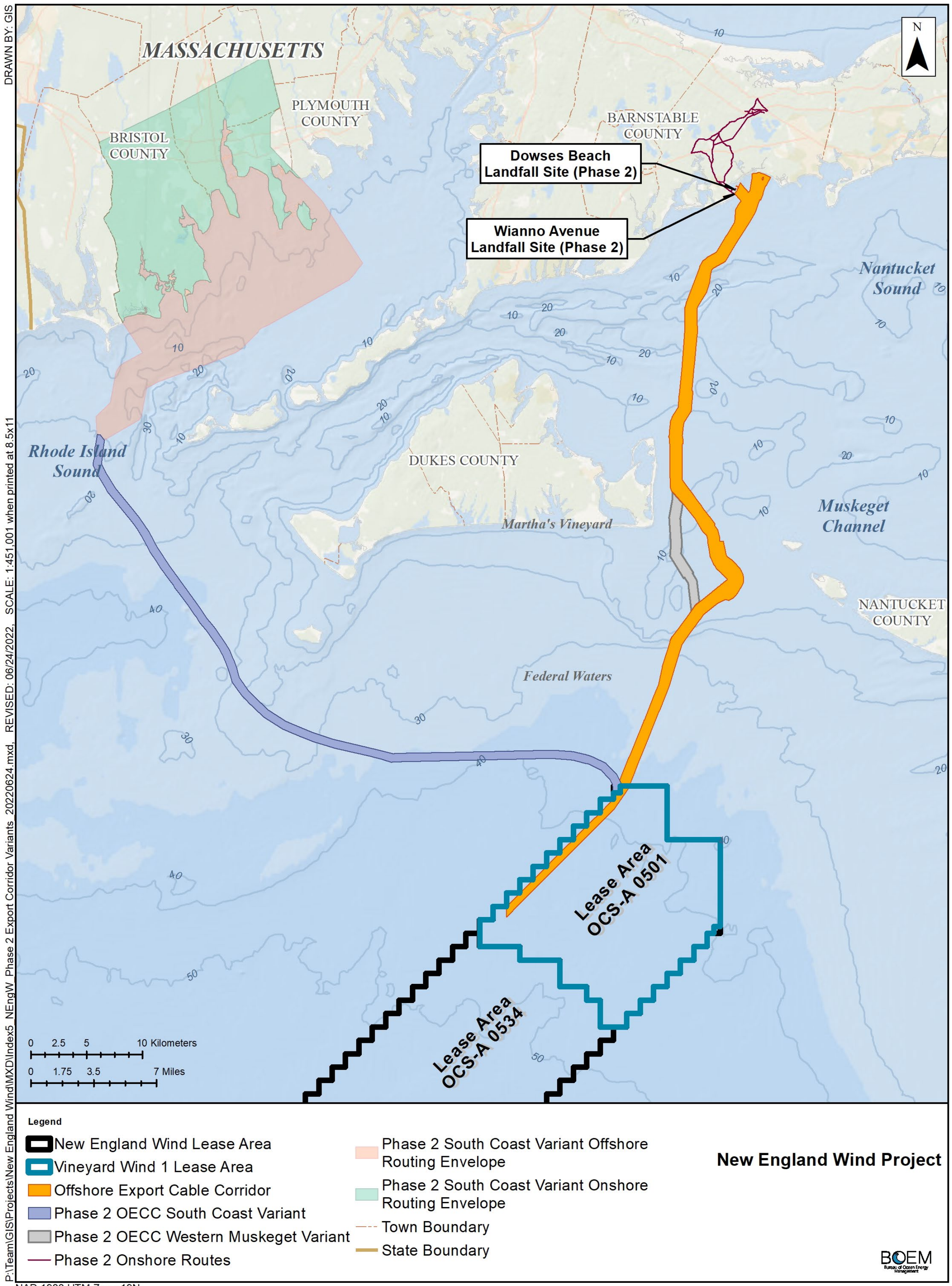


Figure 2.1-9: Proposed Phase 2 Offshore Export Cable Corridor Variants

Offshore Activities and Facilities

Offshore proposed Project components for Phase 2 include similar components as those described for Phase 1 (Figure 2.1-10). The offshore proposed Project elements, with the exception of the export cables installed within 3 nautical miles (3.5 miles) of the Massachusetts coastline, are within federal waters. A summary of export, inter-link, and inter-array cable distances within federal and state waters is provided in Table 2.1-6. The COP provides a detailed description of proposed construction methods (Volume I, Section 4.3.1; Epsilon 2023). The Phase 2 WTGs and ESPs would have the same maximum dimensions as the Phase 1 WTGs and ESPs (Table C-3 in Appendix C) and would be mounted on either monopile, a piled jacket, or suction bucket jacket foundations. Monopiles for Phase 2 WTGs and ESPs would be as described in Section 2.1.2.2 for Phase 1. Phase 2 jacket foundations could be installed either with pin piles (as described for the Phase 1 WTGs and ESPs) or suction buckets. If suction buckets are used, there would be four buckets to penetrate the seafloor bottom up to 49 feet (Figure 2.1-11). A bottom-frame foundation has a triangular spaceframe type structure secured to the seafloor, which could use either pin piles or suction buckets (Figures 2.1-12 and 2.1-13). If pin piles are used, there would be three piles driven up to 279 feet into the seabed and suction buckets to penetrate up to 49 feet into the seabed. Additional schematic drawings and photos of the proposed foundation types are included in the COP (Volume I, Section 4.2.1; Epsilon 2023). The amount of oil and other chemicals in each Phase 2 WTG would be the same as described for the Phase 1 WTGs (Section 2.1.2.2).

The applicant would construct up to three ESPs in the SWDA to serve as the interconnection point between the WTGs and the export cables. If two or three ESPs are used for Phase 2, each ESP could occupy one of the 130 positions in the SWDA, or two of the ESPs could be co-located at a single position (COP Volume I, Section 4.2.1.3; Epsilon 2023). Phase 2 could thus include 89 foundations at 88 positions. [2] The Phase 2 ESPs would be along the northwestern edge of the SWDA and as described for Phase 1 (Section 2.1.2.2). As with Phase 1, a string of multiple WTGs would be connected to each inter-array cable, and the inter-array cables would be connected to the ESP buried below the seabed. The number and orientation of the inter-array cables would depend on the exact WTG and ESP positions used. A 66 to 345 kV inter-link cable would be installed to connect the ESPs together. As described in Section 2.1.2.2, ESPs could be co-located with WTG positions. Overall, Alternative B would include up to 132 foundations in the 130 positions shown on Figure 2.1-3.

All WTGs and ESPs would include the same type of aviation obstruction lighting system and marine navigation components (or would adhere to applicable guidelines at the time of construction) and be painted a similar color as the Phase 1 WTGs and ESPs. As with the Phase 1 structures, the applicant would apply to have each Phase 2 structure registered as a PATON.

Table 2.1-6: Federal and State Jurisdictional Summary of Selected Phase 2 Facilities

Phase 2 Facility	Federal Waters (nautical miles)	State Waters (nautical miles)	Total (nautical miles)
Maximum length of each cable within the OECC[a]	24	20	44
Maximum length of each cable within the OECC using Western Muskeget Variant	24	18	42
Maximum length of each cable within the SWDA[a]	23	0	23
Maximum inter-link cable length	32	0	32
Maximum inter-array cable length	175	0	175

OECC = offshore export cable corridor; SWDA = Southern Wind Development Area
[a] The offshore export cable length includes a 15 percent allowance for micro-siting within Lease Areas OCS-A 0534 and OCS-A 0501 and a 5 percent allowance for micro-siting within the OECC outside the lease areas.

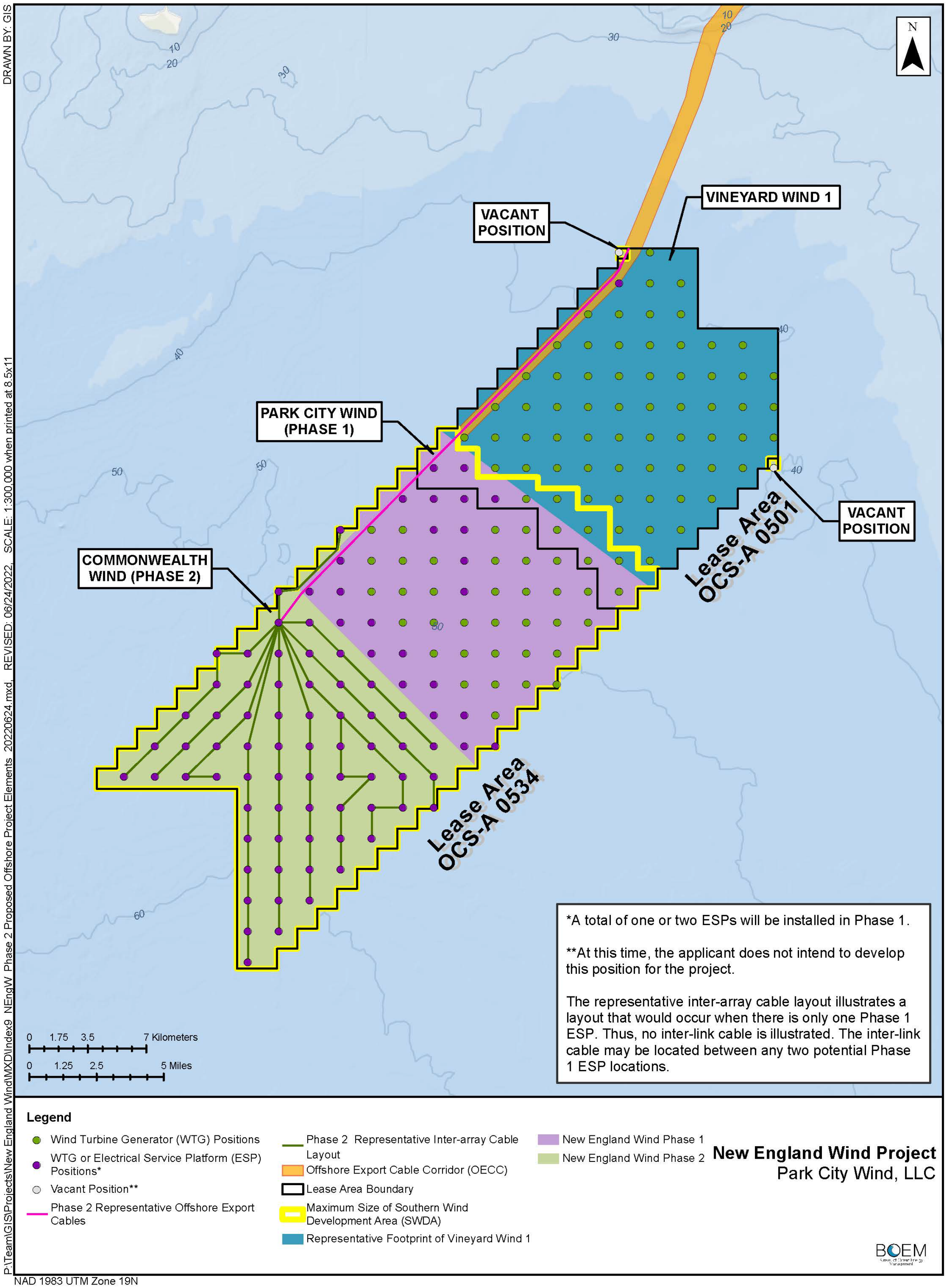
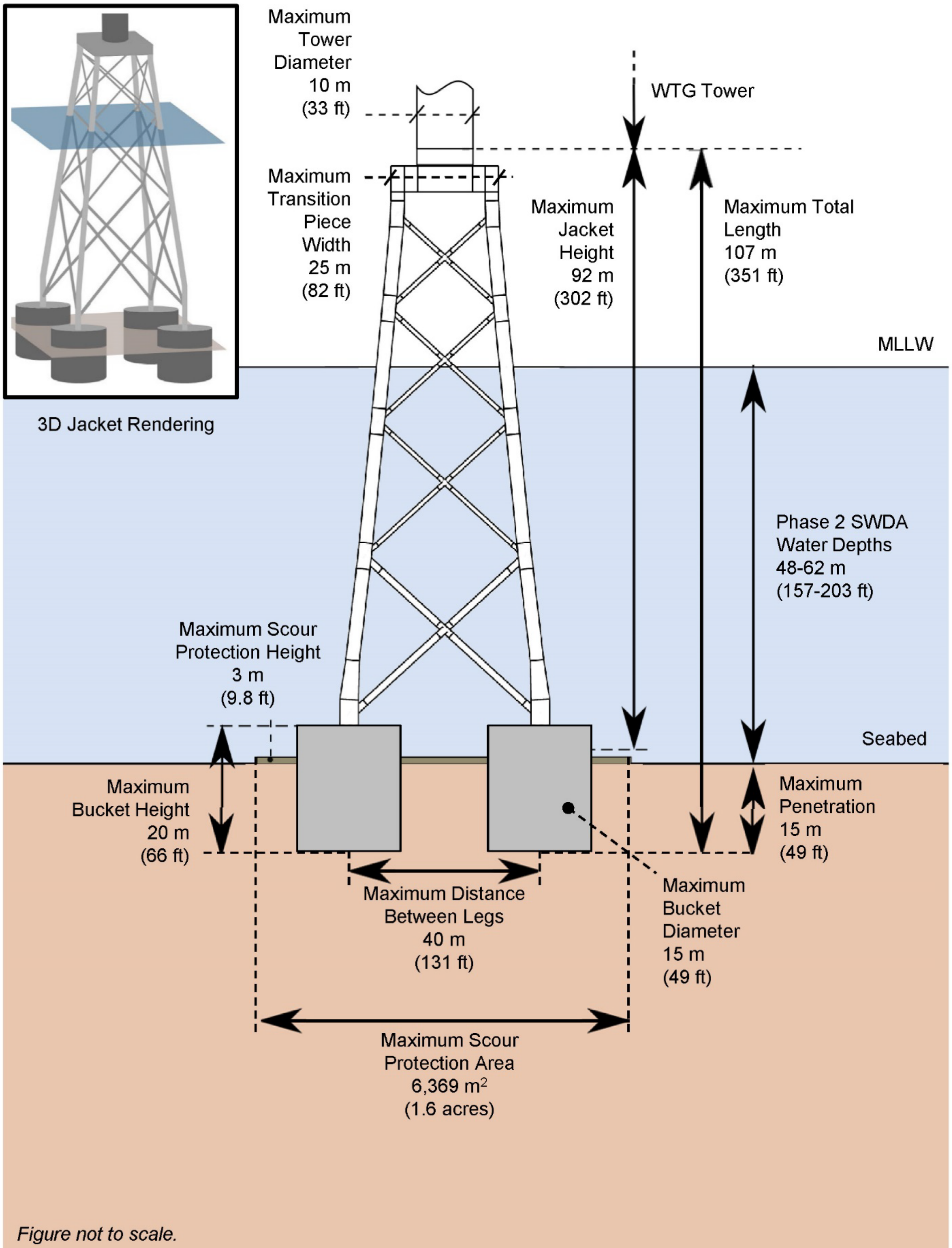
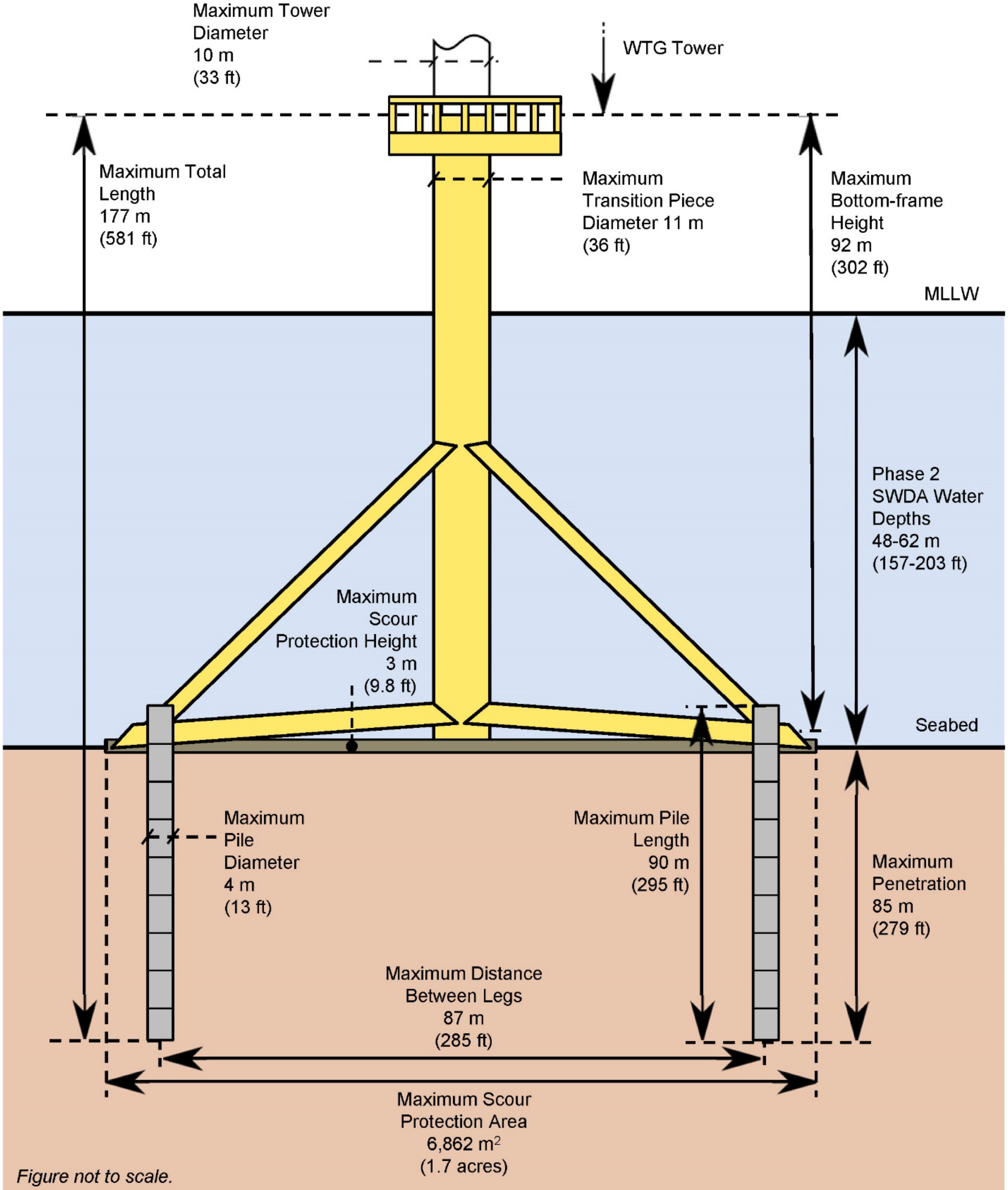


Figure 2.1-10: Proposed Phase 2 Offshore Elements



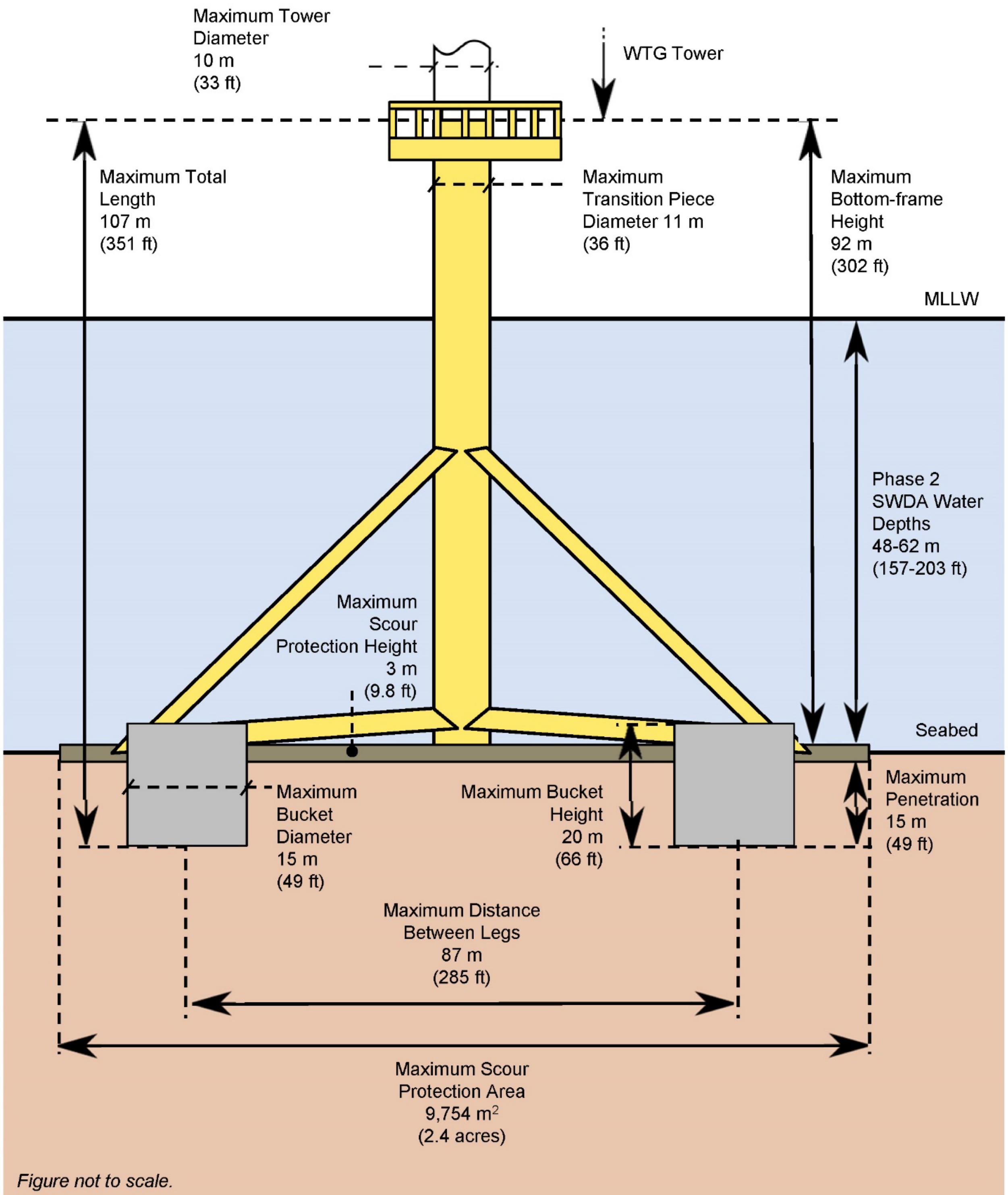
Source: COP Volume I, Section 4.2.1; Epsilon 2023
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 2.1-11: Phase 2 Jacket Foundation with Suction Buckets Conceptual Drawing



Source: COP Volume I, Section 4.2.1; Epsilon 2023
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 2.1-12: Phase 2 Bottom-Frame Foundation with Pin Piles Conceptual Drawing



Source: COP Volume I, Section 4.2.1; Epsilon 2023
ft = feet; m = meter; m^2 = square meter; MLLW = mean lower low water; SWDA = Southern Wind Development Area; WTG = wind turbine generator

Figure 2.1-13: Phase 2 Bottom-Frame Foundation with Suction Buckets Conceptual Drawing

The installation methodology for Phase 2 structures would be as described for Phase 1, including the use of jack-up, anchored, or DP vessels. Scour protection for foundations would be as described for Phase 1 (Section 2.1.2.2). To transmit electricity to shore, the applicant would install three, 220 to 345 kV high-voltage AC offshore export cables. Depending on the exact landfall location selected and the final location of the Phase 2 ESPs, the proposed Phase 2 OECC route would have a maximum total length of up to 221 miles between the Phase 2 ESPs and the landfall site in Barnstable. The proposed Phase 2 OECC, Western Muskeget Variant, and SCV are shown on Figure 2.1-13. One or more fiber optic cables (for communication and other purposes) would also be installed within the OECC.

The Phase 2 offshore export cables would be installed at a target burial depth of 5 to 8 feet below the seafloor. Installation techniques for the Phase 2 offshore export cables would be as described for the Phase 1 cables (Section 2.1.2.2). For the installation of three Phase 2 offshore export cables within the proposed corridor through Muskeget Channel to landfalls in Barnstable, total dredging could impact a maximum of 73 acres and include up to 274,900 cubic yards of dredged material. This dredge volume includes 143,800 cubic yards of material in federal waters and up to 131,100 cubic yards of material in state waters.

If selected, the portion of the SCV within federal waters would be approximately 49 miles long per export cable. Dredging for installation of two export cables in the SCV would affect 3.3 acres and include up to 6,131 cubic yards of dredged material for the federal waters portion of the two export cables (Epsilon 2023). These impacted areas would be in addition to or in place of some or all of the impacts described for the proposed OECC through Muskeget Channel, depending on the number of Phase 2 cables installed in the proposed OECC and SCV OECC. Installation of a third export cable within the SCV would require additional dredging. BOEM will provide additional information about the SCV, including any potential dredging within state waters, as part of a supplemental NEPA analysis once the applicant provides more detailed information, if required. If the SCV is selected, a portion or all of the dredging impacts for the Muskeget Channel routes would not occur.

The applicant would use vessels, vehicles, and aircraft during Phase 2 construction, including both construction and support vessels to complete tasks in the SWDA and along the OECC. The possible ports used for Phase 1 construction, as listed in Table 2.1-5, would also be potentially used for Phase 2 crew transfer, components shipments, storage, preparing components for installation, and potentially some component fabrication and assembly. In addition, some components, materials, and vessels could come from ports in other nations.

The applicant does not propose to direct or implement any potential port improvements specifically to support Phase 2. In selecting the ports to be used for Phase 1 construction and operations, the applicant would consider the suitability of existing ports listed in Table 2.1-5, including upgrades planned or completed by the port owners. Therefore, no port upgrades would occur as a direct result of Phase 2 (COP Volume I, Section 4.2.2.5; Epsilon 2023).

During Phase 2 construction, the applicant anticipates an average of approximately 30 vessels operating during a typical workday in the SWDA and along the OECC. Approximately 60 vessels could be present during the period of maximum construction activity at the start of WTG installation. The applicant has noted that many construction vessels would remain in the SWDA or OECC for days or weeks at a time. The proposed Project construction would generate an average of 8 daily round trips from select ports listed in Table 2.1-5, with approximately 15 daily round trips during maximum construction activity. Additionally, construction vessels may make infrequent trips to port for bunkering and provisioning.

As with Phase 1, the maximum number of vessels involved in the proposed Project at any one time is highly dependent on the proposed Project's final schedule, final design, and the logistics solution used to achieve compliance with the Jones Act (COP Volume I, Section 4.3.1.12.1; Epsilon 2023). Vessel types proposed for Phase 2 would be similar to and subject to the same regulations as those described for Phase 1 in Section 2.1.2.2. Depending on the proposed Project's final schedule, some vessel trips could serve both Phase 1 and Phase 2 construction activities.

The proposed Project could require anchoring of vessels, especially during the cable burial process. Anchoring, if used, would avoid sensitive seafloor habitats to the greatest extent practicable and be completely prohibited in eelgrass beds (Appendix H). Where it is considered impracticable to avoid a sensitive seafloor habitat, mid-line anchor buoys would be used, where feasible and considered safe by vessel operators, as a potential measure to reduce and minimize potential impacts from anchor line sweep (Appendix H).

Phase 2 Operations and Maintenance

Phase 2 is expected to have an operating period of 30 years and be subject to the comprehensive maintenance program and management plans identified in Section 2.1.2.2 (COP Appendices I-B and I-F; Epsilon 2023). As with Phase 1, Phase 2 WTGs would be designed to operate without attendance by any operators, and continuous monitoring would be conducted using a SCADA system from a remote location. The Phase 2 WTGs would also include self-protection systems (as described for Phase 1 WTGs in Section 2.1.2.2) that would be activated if a WTG operates outside its specifications or if the SCADA system fails.

The applicant and/or the selected WTG OEM would be responsible for the 24/7 operation and monitoring of the WTGs. This is expected to be achieved through the applicant's operations facilities and a 24/7 control center owned and operated by shareholder company Avangrid Renewables, LLC.

Onshore Activities and Facilities

For Phase 2, the applicant would establish a long-term SOV operations base in Bridgeport, Connecticut, and would operate CTVs or the SOV daughter craft out of Vineyard Haven on Martha's Vineyard. Although the applicant plans to locate the Phase 2 operations facilities in Bridgeport and/or Vineyard Haven, other ports listed in Table 2.1-5 could also be used to support operations activities. The Phase 2 operations facilities would not necessarily be the same location as the Phase 1 operations facilities.

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

Offshore Activities and Facilities

As with Phase 1, the applicant would need to use vessels, remote sensing equipment, vehicles, and aircraft during Phase 2 inspection and maintenance activities. The maintenance and inspection timeframes for Phase 2 would be similar to those described for Phase 1 (Section 2.1.2.2).

Phase 2 Conceptual Decommissioning

The decommissioning process for Phase 2 would be the same as described for Phase 1 of Alternative B (Section 2.1.2.2).

2.1.3 Alternative C – Habitat Impact Minimization Alternative

Under Alternative C, construction, operations, and decommissioning of the proposed Project's WTGs and ESPs would occur within the range of design parameters outlined in the COP, subject to applicable mitigation and monitoring measures (Appendix H). Compared to Alternative B, this alternative would minimize impacts on complex fisheries habitats—areas of seafloor that are stable, exhibit vertical relief, and/or provide rare habitat compared to the broad sand flats that characterize much of the Atlantic OCS. Complex habitats include gravel or pebble-cobble beds, sand waves, biogenic structures (e.g., burrows, depressions, sessile soft-bodied invertebrates), shell aggregates, boulders, hard-bottom patches, and cobble beds, among other features (COP Volume II-A, Section 5.2; Epsilon 2023). To minimize impacts on complex fisheries habitats, BOEM would limit the potential Phase 2 OECC construction scenarios described in Table 2.1-2 through the implementation of one of the sub-alternatives described below. With the exception of the route through Muskeget Channel, as described below, the remainder of the OECC route is identical to the route described under Alternative B.

Table 2.1-7 provides a summary of the cable routes considered under Alternatives B and C and their potential impacts of concern to USACE under Section 404 of the CWA. USACE's Section 404(b)(1) guidelines can be found at 40 CFR Part 230 and apply to the review of proposed discharges of dredged or fill material into waters of the United States regulated under Section 404 of the CWA. In tidal waters, the shoreward limit of Section 404 jurisdiction is the high tide line, whereas the seaward limit is 3 nautical miles (3.5 miles) from the baseline of the territorial seas. In non-tidal waters, the Section 404 jurisdictional limit is the ordinary high water mark of a waterbody. The guidelines also address impacts on special aquatic sites identified in 40 CFR Part 230 Subpart E. Special aquatic sites are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. Special aquatic sites include wetlands, sanctuaries and refuges, vegetated shallows (such as eelgrass), mud flats, coral reefs, and riffle and pool complexes.

Except as provided under Section 404(b)(2), no discharge of dredged or fill material should be permitted if there is a practicable alternative to the proposed discharge that would have fewer adverse impacts on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. Where the activity associated with a discharge proposed for a special aquatic site (as defined in 40 CFR Part 230 Subpart E) does not require access or proximity to or siting within the special aquatic site in question to fulfill its basic purpose (i.e., is not water dependent), practicable alternatives that do not involve special aquatic sites are presumed to be available, unless clearly demonstrated otherwise. In addition, where a discharge is proposed for a special aquatic site, all practicable alternatives to the proposed discharge that do not involve a discharge into a special aquatic site are presumed to have fewer adverse impacts on the aquatic ecosystem, unless clearly demonstrated otherwise. For the proposed Project, USACE has determined that the basic Project purpose is offshore wind energy generation. The following information on alternatives was provided to USACE by the applicant and will be analyzed by USACE according to the appropriate criteria in the guidelines to determine whether the applicant's proposed discharge complies with the guidelines.

2.1.3.1 Alternative C-1 – Western Muskeget Variant Avoidance

This alternative would preclude the use of the Western Muskeget Variant, limiting available scenarios to those that include only the Eastern Muskeget route and SCV, as shown on Figure 2.1-7. Scenarios 1, 3, 5, and 6 in Table 2.1-2 would be considered under Alternative C-1. Avoiding use of the Western Muskeget Variant would avoid a crossing of a proposed OECC route for the SouthCoast Wind (Lease Area OCS-A 0521) within the Western Muskeget Channel. Cable crossings typically require portions of one of the cable systems (either from SouthCoast Wind or the proposed Project) to be laid on the seafloor and covered with protective structures, such as half-shell pipes in lieu of burial. If the crossing occurs in complex habitat areas, the added protective structures could damage or destroy complex habitat features.

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Table 2.1-7: Summary of Cable Route Scenarios within State Waters

Factors	No Action Alternative	Phase 1, Covell's Beach A[a]	Phase 1, Covell's Beach B[b]	Phase 1, Craigville Beach A[a]	Phase 1, Craigville Beach B[b]	Phase 2, Dowses Beach (Cable Scenario 1)[c]	Phase 2, Dowses Beach (Cable Scenario 2)[d]	Phase 2, Dowses Beach (Cable Scenario 4)[e]	Phase 2, Wianno Avenue (Cable Scenario 1)[c]	Phase 2, Wianno Avenue (Cable Scenario 2)[d]	Phase 2, Wianno Avenue (Cable Scenario 4)
Length of each cable (nautical miles)	0.0	21	21	21	21	20	Cables 1 and 2: 20 Cable 3: 18	Cable 1: 20 Cables 2 and 3: 18	20	Cable 1 and 2: 20 Cable 3: 18	Cable 1: 20 Cables 2 and 3: 18
Amount of fill material (acres)[f]	0.0	21.5	21.5	21.5	21.5	29.4	32.5	35.6	29.4	32.5	35.6
Wetland impacts (square feet)	0	0	90[g]	0	90[g]	0	0	0	0	0	0
Other special aquatic site impacts[h]	0	0	0	0	0	0	0	0	0	0	0
Factors for consideration	Does not meet purpose and need	HDD feasible for landfall, engineering and construction constraints	HDD feasible for landfall, engineering and construction constraints	HDD feasible for landfall	HDD feasible for landfall, wetland impacts	HDD feasible for landfall	HDD feasible for landfall	HDD feasible for landfall	Open trenching anticipated for landfall, eelgrass presence adjacent to potential trench area	Open trenching anticipated for landfall, eelgrass presence adjacent to potential trench area	Open trenching anticipated for landfall, eelgrass presence adjacent to potential trench area

HDD = horizontal directional drill; NA = not applicable; OECC = offshore export cable corridor; SCV = South Coast Variant
[a] Scenario A is microtunneling (HDD) the export cable under the Centerville River.
[b] Scenario B is the export cable crossing the Centerville River via a utility bridge.
[c] Additional cable scenarios, as defined in Table 2.1-2, would use the SCV, and additional analysis would be required if the applicant chooses to move forward with the SCV.
[d] For Alternative C-1, if final design and engineering determines that technical issues would preclude installation of the third export cable within the Eastern Muskeget OECC, the Western Muskeget Variant Contingency Option (Cable Scenario 2) may be required to maintain the technical and economic viability of the proposed Project.
[e] Cable Scenario 4 represents Alternative C-2.
[f] Fill is limited to secondary cable protection and HDD redeposition, if necessary. Cable installation method is such that displaced material is incidental fallback; therefore, cable installation not subject to Section 404 review.
[g] This includes 48 square feet of temporary impacts 42 square feet of permanent impacts (COP Volume III, Section 6.1.2.1; Epsilon 2023).
[h] Other special aquatic sites include sanctuaries and refuges, vegetated shallows (like eelgrass), mudflats, coral reefs, and riffle and pool complexes.

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By avoiding a cable crossing within the Muskeget Channel, Alternative C-1 would limit the total number of potential crossings of the SouthCoast Wind cable to a single crossing south of Muskeget Channel, where complex fisheries habitat is rarer. Under Alternative C-1, dredging for Phase 2 cable installation would have the same impacts as described under Alternative B.

2.1.3.2 Alternative C-2 – Eastern Muskeget Route Minimization

This alternative would minimize, to the degree practicable, the use of the Eastern Muskeget route and maximize the use of the Western Muskeget Variant and/or the SCV (Scenarios 4, 5, and 6 in Table 2.1-2) for all Phase 2 export cables. Under this alternative, the two Phase 1 cables would be installed in the Eastern Muskeget route, along with a maximum of one Phase 2 cable. This eliminates the option for a total of two to three Phase 2 cables to be installed in the Eastern Muskeget route. This alternative could potentially reduce impacts on productive complex habitats along the Eastern Muskeget route compared to Alternative B. Scenarios 5 and 6 would require significant delays to Phase 2 due to the need to upgrade substation(s) connected to ISO-NE that are not currently planned for upgrade. Under Alternative C-2, dredging for Phase 2 cable installation could impact up to 73 acres and could include up to 274,800 cubic yards of dredged material (compared to 67 acres and 235,400 cubic yards for Alternative B and Alternative C-1).

2.1.4 Preferred Alternative

The Preferred Alternative would adopt aspects of Alternative B and Alternative C-1 with the intent of limiting the installation of export cables to the Eastern Muskeget route. In doing so, the proposed Project would reduce the total amount of impacts on complex benthic habitat and limit the total number of potential crossings of the proposed Project's offshore export cables with the proposed SouthCoast Wind export cables to a single crossing south of the Muskeget Channel, where complex benthic habitat is rarer. The Preferred Alternative includes a Western Muskeget Variant Contingency Option, which would allow the use of the Western Muskeget Variant only if the lessee provided adequate written justification to BOEM that its use is necessary for the proposed Project's viability. Although preliminary designs indicate that all three Phase 2 cables could be installed within the Eastern Muskeget route, if final design and engineering determines there are technical issues with installing the third Phase 2 cable in the Eastern Muskeget route, the economic and technical viability of the proposed Project could be jeopardized, as the proposed Project would not be able to proceed without the availability of the Western Muskeget Variant. The Preferred Alternative cable alignment would be identical to Alternative C-1 if the Western Muskeget Variant Contingency Option were not exercised (Scenario 1 for Phase 2 cables; Tables 2.1-2 and 2.1-7). If the Western Muskeget Variant Contingency Option is exercised, the Preferred Alternative would be identical to Alternative B (Scenario 2 for Phase 2 cables; Tables 2.1-2 and 2.1-7). The Preferred Alternative would also disallow the co-location of ESPs or WTGs resulting in the construction, operations, and decommissioning of up to 130 WTG or ESP positions for 125 to 129 WTGs and 1 to 5 ESPs on the OCS installed within Lease Area OCS-A 0534 and potentially a portion of Lease Area OCS-A 0501.

2.2 Alternatives Considered but Not Analyzed in Detail

Under NEPA, a reasonable range of alternatives framed by the purpose and need must be developed for analysis for any major federal action. The alternatives should be "reasonable," which the Department of the Interior has defined as those that are "technically and economically practical or feasible and meet the purpose and need of the Proposed Action" (43 CFR § 46.420(b)) (the terms "practical" and "feasible" are not intended to be synonymous [73 Fed. Reg. 61331, October 15, 2008]). 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.

BOEM considered alternatives to the Proposed Action that were identified through coordination with cooperating and participating agencies, as well as public comments received during the public scoping period for the EIS. BOEM then evaluated the alternatives for consistency with NEPA and dismissed from further consideration alternatives that did not meet the purpose and need, did not meet the screening criteria (summarized below), or both:

- It does not respond to BOEM's purpose and need.
  - It results in activities that are prohibited under the lease (e.g., requires locating part, or all, of the wind energy facility outside of the lease area, or constructing and operating a facility for another form of energy).
  - It is inconsistent with the federal and state policy goals below:
    - The U.S. policy under the OCSLA to make OCS energy resources available for expeditious and orderly development, subject to environmental safeguards;
    - EO 14008, Tackling the Climate Crisis at Home and Abroad, issued on January 27, 2021;
    - The shared goal of the Departments of the Interior, Energy, and Commerce to deploy 30 GW of offshore wind in the United States by 2030 while protecting biodiversity and promoting ocean co-use; and
    - The goals of affected states, including state laws that establish renewable energy goals and mandates, where applicable.
  - It is inconsistent with existing law, regulation, or policy; a state or federal agency would be prohibited from permitting activities required by the alternative.
- It does not meet the primary goals of the applicant, such as:
  - It proposes relocating a majority of the project outside of the area proposed by the applicant.
  - It results in the development of a project that would not allow the developer to satisfy contractual offtake obligations.
- There is no scientific evidence that the alternative would avoid or substantially lessen one or more significant socioeconomic or environmental impacts of the project.
- It is technically infeasible or impractical, meaning implementation of the alternative is unlikely given past and current practice, technology, or site conditions as determined by BOEM's technical experts.
- It is economically infeasible or impractical, meaning implementation of the alternative is unlikely due to unreasonable costs as determined by BOEM's technical and economic experts.
- It is environmentally infeasible, meaning implementation of the alternative would not be allowed by another agency from which a permit or approval is required, or implementation results in an obvious and substantial increase in impacts on the human environment that outweighs potential benefits.
- The implementation of the alternative is remote or speculative, or it is too conceptual in that it lacks sufficient detail to meaningfully analyze impacts, or there is insufficient available information to determine whether the alternative is technically feasible.
- It has a substantially similar design to another alternative that is being analyzed in detail.
- It would have a substantially similar impact as an alternative that is analyzed in detail.

Table 2.2-1 lists the alternatives considered but not analyzed in detail and the rationale for their dismissal. These alternatives are presented with a brief discussion of the reasons for their elimination as prescribed in CEQ regulations at 40 CFR § 1502.14(a) and U.S. Department of the Interior regulations at 43 CFR § 46.420(b)–(c).

Table 2.2-1: Alternatives Considered but Not Analyzed in Detail

Alternative	Rationale for Dismissal
1. Alternative that uses a shared OECC	BOEM cannot dictate that a lessee uses a shared cable corridor that does not already exist (30 CFR § 585.200(b)). BOEM has no way of determining if the use of a future shared cable corridor would be a technically and economically practical and feasible alternative for the proposed Project. Therefore, BOEM cannot require the applicant to use a non-existent shared cable corridor for the proposed Project. Furthermore, the proposed Project's export cables would connect to the power grid via different points of interconnection than other offshore wind projects located near Rhode Island, Connecticut, and Massachusetts (e.g., SouthCoast Wind). Developing a shared export cable corridor would not likely be technically or economically practicable because each other offshore wind project has distinct interconnection points to the electric power grid. Notably, the proposed Project's preferred OECC is already collocated with the permitted Vineyard Wind 1 OECC. Under Alternative B, the two Phase 2 cable route variants (Western Muskeget Variant and SCV) would only be used if the preferred export cable route is found to be infeasible. Moreover, if the Western Muskeget Variant is used, the cable route would still be mostly collocated with the permitted Vineyard Wind 1 export cable corridor. Consequently, the proposed Project already includes potential collocated cable routes to the maximum extent possible.
2. Alternative that installs three to five export cables in the Western Muskeget Variant	Installing three to five cables in the Western Muskeget Variant is economically and technically infeasible and impractical. The technical constraints include that the Western Muskeget Variant is deeper, up to about 148 feet MLLW, compared to the proposed (Eastern Muskeget) OECC route, up to about 82 feet MLLW. Steep slopes within the Eastern Muskeget route are associated with the edge of bedforms, which can be cleared through using a vertical injector. In contrast, steep slopes (slopes greater than 20 degrees) within the Western Muskeget Variant are associated with the edge of the Muskeget Channel, which is a significantly more technically challenging and dynamic environment for cable burial (COP Volume II-A, Figure 3.2-3b; Epsilon 2023). The steepest parts of the Muskeget Channel cross most of the surveyed Western Muskeget Variant, so routing even up to two cables around these steep slopes would be significantly technically challenging and risky due to limited available space for cable routing around future identified hazards such as large boulders or unexploded ordnance (Avangrid 2022a). Any potential future cable repairs along this route would also face similar risks. In addition, the channel acts to funnel currents, which leads to high scour potential and high cable installation risk along the deepest parts of the channel, which bisect the Western Muskeget Variant (Avangrid 2022a). Moreover, the Muskeget Channel thalweg (path tracing the lowest points through the channel) has been known to migrate (COP Volume II-A, Figure 3.2-5a; Epsilon 2023). Along the Western Muskeget Variant, the "channel's thalweg shifted over 197 feet to the east between 2010 and 2018 resulting in an elevation decrease of up to 30 feet at the 2018 channel thalweg location." Seabed erosion or deposition of up to 30 feet in an 8-year timeframe leads to significant risk of cable exposure or cable overheating during the lifespan of the proposed Project (COP Volume II-A; Epsilon 2023). Seabed erosion or deposition can lead to significant risk of cable exposure or cable overheating during the lifespan of the proposed Project. The Eastern Muskeget route does not exhibit channel and bedform migration or sediment mobility on the scale observed within the Western Muskeget Variant. Taken together, these challenges demonstrate that installing up to five cables in the Western Muskeget Variant is economically and technically infeasible and impractical. In its comments during the scoping period for the New England Wind EIS, NMFS reiterated that it "support[s] consolidating impacts to one corridor…done through a full evaluation" (NMFS 2021a). Both the Eastern Muskeget route and Western Muskeget Variant were reviewed in the Vineyard Wind 1 Final EIS and remained in the approved Vineyard Wind 1 COP. After COP approval, Vineyard Wind, LLC (the applicant for the Vineyard Wind 1 Project) selected the Eastern Muskeget route for that project's OECC. Based on this input, and similar past input, the applicant for the proposed Project identified a preferred OECC that included the Vineyard Wind 1 Eastern Muskeget OECC, widened along its entire western boundary and eastern boundary within

Alternative	Rationale for Dismissal
	Muskeget Channel. These widenings allow for micro-siting and collocation of the proposed Project's export cables (particularly for Phase 1 but potentially for both phases) with export cables for Vineyard Wind 1. As a result, the applicant only proposes to use the Western Muskeget Variant for up to two cables as a contingency if collocating all proposed Project cables in the Eastern Muskeget route is found to be technically infeasible.
3. Alternative that places the Phase 1 export cables within either the SCV or the Western Muskeget Variant	Installing the Phase 1 cables in the SCV is not technically or economically feasible or practicable, consistent with BOEM's screening criteria because: • The interconnection point for the Phase 1 is fixed at the West Barnstable Substation through the ISO-NE transmission interconnection process. It is not technically or commercially feasible to land a cable on the south coast of Massachusetts (i.e., not on Cape Cod) and connect it to the West Barnstable Substation (Avangrid 2022a); and • Any interconnection to the south coast of Massachusetts (i.e., not on Cape Cod) is currently limited to 400 MW, which is half the capacity of Phase 1. Placing the two Phase 1 cables (with 800 MW of total capacity) in the SCV would delay transmission interconnection process for the proposed Project by years, due to the need to upgrade substations connected to the ISO-NE grid that are not currently planned for upgrade (Avangrid 2022a). This would jeopardize the proposed Project's ability to secure future PPAs through the Massachusetts, Connecticut, and Rhode Island solicitations for up to 6,000 MW of electricity from offshore wind. Similar to the reasoning for dismissing Alternative #2, placing the Phase 1 export cables within either the Western Muskeget Variant or SCV would be technically and economically infeasible and impracticable. While the applicant's cable scenarios (Table 2.1-2) include the installation of up to two Phase 2 export cables within the Western Muskeget Variant to provide maximum flexibility, the applicant believes it would be challenging to route even one cable within the Western Muskeget Variant for the technical reasons previously described (Avangrid 2022a). As a result, the Western Muskeget Variant is only proposed as a contingency for Phase 2. In addition, the applicant already has contractual agreements supporting cable installation that are specific to the Eastern Muskeget route for Phase 1 (Avangrid 2022a). Consequently, this alternative would require amendments or new contracts, which would be an additional cost to the applicant. The technical feasibility of using the Eastern Muskeget route for the two Phase 1 cables is significantly more certain than the technical feasibility of placing the two Phase 1 cables in the Western Muskeget Variant. Moreover, in this scenario, assuming the installation of two Phase 1 export cables in the Western Muskeget Variant (the maximum technically feasible capacity of that route), at least one export cable from Phase 2 would still need to use the Eastern Muskeget route to enable Phase 2 to achieve landfall in Barnstable County as currently proposed in the COP (Epsilon 2023). Landfall in Barnstable County for at least one Phase 2 export cable is necessary for the technical and economic feasibility for the proposed Project because the Barnstable County Landfall Site has the necessary capacity for over 400 MW of offtake, while the potential SCV points of interconnection only have a maximum offtake capacity of 400 MW (Avangrid 2022a). As a result, placing the Phase 1 cables in the Western Muskeget Variant would only reduce the number of export cables (by one) being installed in the Eastern Muskeget route and would neither eliminate use of the Eastern Muskeget route, nor eliminate a season of construction. Finally, the applicant has entered into a Host Community Agreement with the Town of Barnstable for its cable landings at Craigville Beach, onshore cable routes, and substation site under which the applicant will contribute $16 million as a host community fee. The applicant is nearing the end of the review by the Massachusetts Energy Facilities Siting Board of the cable route and interconnection to the West Barnstable Substation, and all state permit applications have been filed. The two Phase 1 cables are also currently designed to be located east of the Phase 2 cables. Moving the Phase 1 cables to a different landing site (i.e., through use of the SCV) would potentially create a new cable crossing scenario, which is generally something the applicant, BOEM, and cooperating agencies avoid, where practicable, because of the potential additional technical complexity and environmental impacts associated with crossings.

Alternative	Rationale for Dismissal
4. Alternative that includes wider structure-free corridors throughout the RI/MA Lease Areas, including the SWDA	The Responsible Offshore Development Alliance requested a 4-nautical mile-wide (4.6-mile-wide) corridor through the RI/MA Lease Areas, while New York State Department of State requested a 2- or 3-nautical-mile (2.3- or 3.4-mile) corridor (BOEM 2022b). However, developers and applicants for projects in the RI/MA Lease Areas have agreed to develop (and have designed) all projects based on a uniform, orthogonal, 1- × 1-nautical-mile (1.15-mile) grid. USCG's May 2020 Final Massachusetts and Rhode Island Port Access Route Study recommended the same grid to maximize safety and navigation consistency (USCG 2020) and stated that 1- × 1-nautical-mile (1.15-mile) spacing provides ample maneuvering space for typical fishing vessels expected in the proposed Project area. BOEM's navigation subject matter expert considered proposed transit lane alternatives proposed by the New York Department of State and the Responsible Offshore Development Alliance and found that transit lanes would cause funneling of vessel traffic and create choke points and intersections, leading to denser traffic with no associated vessel transit or navigational safety benefit. Furthermore, BOEM determined that the presence of these lanes would likely create a conflicting use scenario, regardless of corridor width and layout. Therefore, BOEM did not identify any other alternatives to the proposed lanes proposed by the commenters that would meet the navigational needs identified by the commenters. Finally, transit corridors analyzed as alternatives in the Vineyard Wind 1 and South Fork EISs were not found to measurably increase navigation safety and were ultimately not selected.
5. Alternative that combines the most impactful components for each option included in the PDE	When BOEM conducts an environmental review of an applicant's COP, BOEM considers the maximum-case scenario, which identifies the most impactful parameters or technically feasible combination of parameters defined within the PDE for each resource area. For example, the maximum-case scenario for visual impacts includes the tallest WTGs for each proposed Project phase, whereas the maximum-case scenario for benthic resources involves the largest number of foundations and the smallest (lowest capacity) WTGs. Because BOEM already considers the maximum-case scenario as part of its review of Alternative B, the analysis of a maximum-case alternative and Alternative B would reach the same impact conclusion. This alternative was not carried forward for separate analysis because it is already analyzed in detail as Alternative B.
6. Alternative that considers suction bucket jacket and bottom-frame foundations for Phase 1	As described in Section 2.1.2, the applicant would install Phase 1 WTGs and ESPs on monopiles or jacket foundations with pin piles. The applicant would install Phase 2 WTGs and ESPs on monopiles, jacket, or bottom-frame foundations and could use either pin piles or suction buckets for jacket and bottom-frame foundations, which are not available for Phase 1. The COP describes the technical justifications for selecting or not selecting various foundation measures (Volume I, Section 3.2.3.3 for Phase 1 and Section 4.2.3.3 for Phase 2; Epsilon 2023). The applicant determined that the Phase 2 foundation types suggested by commenters were not suitable for Phase 1 due to local site conditions, as well as technical and supply chain considerations (COP Volume I, Section 3.2.3.3.3; Epsilon 2023). The suggested alternative would, therefore, be technically and economically infeasible and impractical.
7. Alternative that includes "Project modifications," as well as emerging technologies and methodologies	This alternative is vague, speculative, and does not address a specific significant impact or concern or provide sufficient detail to meaningfully analyze impacts; therefore, this alternative was not carried forward for separate analysis.
8. Alternative that requires use of the largest available WTGs to minimize the number of foundations constructed to meet the proposed Project capacity, minimize impacts on marine habitats and resources, and reduce navigation and other space-use concerns	The original commenter (RI-CRMC 2021) requested an alternative using larger WTGs to avoid sensitive habitat and reduce overall impacts. While the comment specifies 12 MW or 13.6 MW capacity WTGs, these WTG sizes would be insufficient to generate the 2,600 MW from the 130 WTG positions as described in Chapter 1, Introduction. Therefore, in response to this comment, BOEM considered two scenarios that would allow development of the minimum number of positions necessary to meet the purpose and need as discussed in Chapter 1 (at least 804 MW for Phase 1 and at least 1,232 MW for Phase 2 for a total of 2,036 MW): • A scenario assuming WTGs with a minimum nameplate capacity of 16 MW and only one dedicated ESP position (some ESP equipment would be mounted on WTG platforms) would eliminate 18 WTG positions.

Alternative	Rationale for Dismissal
	• A scenario assuming a minimum nameplate capacity of 20 MW and no dedicated ESP positions (all ESP equipment would be mounted on WTG platforms) would eliminate 28 WTG positions. Upon close examination, BOEM eliminated this alternative from detailed analysis under the screening criteria because (1) the alternative is not economically feasible or practicable; and (2) there is no scientific evidence that the alternative would avoid or substantially lessen one or more significant environmental impacts of the proposed Project. Each of these issues are discussed in more detail below. (1) This alternative is not economically feasible or practicable. For the proposed Project, selection of WTG design cannot be deferred until the ROD has been issued under the current market conditions. Waiting until the ROD is issued to select a turbine capacity would delay final proposed Project design and engineering by at least 9 months and put the commercial viability of the proposed Project at significant risk by restricting the applicant's negotiating capacity and eliminating competitive bids by turbine suppliers due to the long lead time (years) needed to manufacture WTGs, design and manufacture foundations, and procure construction and installation services. (2) There is no scientific evidence that the alternative would avoid or substantially lessen one or more significant environmental impacts of the proposed Project. No specific sensitive habitats have been identified, and no specific areas were recommended by commenters for a potential "no surface occupancy" area to exclude WTG positions due to the need for navigation accommodations or other uses (other than those items addressed by the other alternatives in the Final EIS). Some commenters broadly suggested that Atlantic cod (*Gadus morhua*) and/or NARW (*Eubalaena glacialis*) could benefit from a smaller proposed Project footprint. However, "SMAST bottom trawl surveys conducted between spring 2019 and winter 2022 caught only 23 individual Atlantic cod in the lease area for an average of 0.23 cod per tow" (Avangrid 2022a). A review of data from the New England Fishery Management Council shows low to no abundance of cod in and around the lease area (Avangrid 2022a). Based on available habitat data and recent benthic surveys, the lease area is wholly dominated by soft-bottom habitat: unconsolidated substrate dominated by sand and silt-sized particles (Avangrid 2022a). While rough bottom habitat, or complex habitat, is not a requirement for Atlantic cod spawning, smooth sand, rocks, or gravel are considered preferred spawning habitat for adults, thus suggesting the lease area does not provide ideal spawning habitat (Avangrid 2022a; Fahay et al. 1999). Further, most Atlantic cod spawning occurs inshore (Fahay et al. 1999). In the event cod spawn in the RI/MA Lease Areas, the applicant has proposed pile-driving restrictions from January 1st to April 30th to protect NARW (Appendix H), which would also confer benefits to Atlantic cod that spawn in southern New England waters between November and April (NMFS 2021a). Noise mitigation systems would also be implemented to reduce potential sound exposure in the environment (Section 2.1.2 and Appendix H). It is likely that impacts from proposed Project activities could temporarily disturb aggregated Atlantic cod if any occur in the lease area during construction. However, the fish exhibit strong site fidelity when they are reproductively active. Because impulsive acoustic impacts (e.g., pile driving) would be of limited duration, and the duration and areal extent of other bottom-disturbing activities (e.g., site preparation and cable installation) at any location would be limited, permanent dispersion of aggregated Atlantic cod is unlikely to occur (BOEM 2021b). Lastly, scientists studying the Block Island Wind Farm have found that catch of structure-oriented species, such as black sea bass (*Centropristis striata*) and Atlantic cod, increased at Block Island Wind Farm following turbine installation (Wilber et al. 2022). Regarding NARWs, the densities in the proposed Project area are low from May to December, when construction activities would take place (Section 3.7, Marine Mammals). The applicant would employ numerous mitigation and monitoring measures anticipated to be required by the Letter of Authorization issued by NMFS and as reasonable and prudent measures from the ESA consultation. Likely mitigation and monitoring measures for NARW and other species listed in Appendix H include, but are not limited to, seasonal pile-driving restriction cited above, sound attenuation technology, soft starts, protective clearance and shut-down zones, use of PSOs, passive acoustic monitoring, and vessel strike avoidance measures. As applicable, the same measures would be employed during proposed Project operations. Furthermore, no basis related to NARW has been given for excluding any specific portion of the proposed Project from offshore wind development. While installing fewer total WTGs would lessen some potential impacts in a generic sense, no rationale was provided by commenters regarding how many WTGs would need to be

Alternative	Rationale for Dismissal
	eliminated to substantially reduce any significant impacts, nor were any specific positions identified for potential elimination. Without this type of information, it is not possible for BOEM to develop and analyze a reasonable alternative.
9. Alternative that includes routing the SCV OECC between Martha's Vineyard and Nomans Island to reduce impacts on seafloor resources	The proposed route of the SCV OECC reflects coordination with tribal representatives to specifically avoid impacts on submerged ancient landforms within the Vineyard Sound and Moshup's Bridge TCP, including the area between Martha's Vineyard and Nomans Island. The suggested alternative would require routing through the TCP. Whereas impacts on benthic or biological species along the currently proposed route can potentially be avoided or mitigated, impacts on submerged landforms that contribute to the TCP cannot be mitigated.
10. Alternative that collocates the SCV OECC with the SouthCoast Wind OECC within and approaching Buzzards Bay	See the discussion for Alternative #1 in this table. At this time, the factors considered for Alternative #1 and this alternative outweigh any potential future decrease in collective seabed disturbance that may result from having multiple projects sharing one cable corridor. In addition, sufficient information to develop an alternative to the SCV that is technically feasible was not available at the time of this Final EIS. If the applicant determines that use of the SCV is necessary in a future COP revision pursuant to 30 CFR § 585.634, alternatives to the SCV would be considered in a supplemental NEPA analysis.
11. Alternative that eliminates the SCV as an option for Phase 2	The SCV would connect to a potential second grid interconnection point in Bristol County, Massachusetts (COP Volume I, Section 4.1.3.3; Epsilon 2023) to provide the commercial flexibility required should technical, logistical, grid interconnection, or other unforeseen issues arise that preclude one or more Phase 2 export cables from interconnecting in Barnstable, Massachusetts. Precluding the use of the SCV could render the proposed Project infeasible by removing the potentially necessary OECC and grid interconnection point for Phase 2. If the SCV becomes necessary, the applicant would be required to file a COP revision pursuant to 30 CFR § 585.634, and alternatives to the SCV would be considered in a supplemental NEPA analysis.
12. Alternative that approves only Phase 1 or Phase 2	BOEM considered a No Action Alternative that would only approve either Phase 1 or Phase 2 of the proposed Project and determined this alternative was not economically feasible for the following reasons: • The applicant is seeking offtake agreements through open solicitations from the states of Massachusetts, Rhode Island and Connecticut, with bids due January 31, 2024. The applicant's bid(s) will incorporate certain economic assumptions, including a lease-wide permitting approach for applicant financing in order to be economically viable. This approach includes starting construction of part of Phase 2 immediately following Phase 1, allowing for continuous construction and installation across both phases (COP Volume I, Section 4.1.1.3; Epsilon 2023). • Efficiencies and economies of scale associated with joint development of Phase 1 and Phase 2, including finalized contracts, would not be realized if a permitting decision were only made for either phase. This includes single competitive contracts being awarded to entities that can demonstrate their ability to reduce costs of, and associated with, several major proposed Project components, including cables, WTGs, foundations, and scour protection. Several services related to the proposed Project are also synergized across both phases, including design contractors, permitting consultants, marine warranty surveyor contracts, and offshore logistics for CTVs and SOVs. • Separating the environmental review process for Phase 1 and Phase 2 would increase uncertainty with respect to proposed Project costs, timelines, and regulatory processes and conditions, thereby increasing risk. This risk could translate to higher financing costs or inability to obtain financing with respect to commercial transactions (financing by third parties other than the applicant).

BOEM = Bureau of Ocean Energy Management; CFR = Code of Federal Regulations; COP = Construction and Operations Plan; CTV = crew transfer vessel; EIS = Environmental Impact Statement; ESA = Endangered Species Act; ESP = electrical service platform; MLLW = mean lower low water; MW = megawatt; NARW = North Atlantic right whale; NEPA = National Environmental Policy Act; NMFS = National Marine Fisheries Service; OECC = offshore export cable corridor; PDE = Project design envelope; PPA = power purchase agreement; PSO = protected species observer; RI/MA Lease Areas = Rhode Island and Massachusetts Lease Areas; ROD = Record of Decision; SCV = South Coast Variant; SMAST = University of Massachusetts Dartmouth's School for Marine Science and Technology; SOV = service operation vessel; SWDA = Southern Wind Development Area; TCP = traditional cultural property; USCG = U.S. Coast Guard; WTG = wind turbine generator

[a] Park City Wind previously secured multiple PPAs that, combined, would deliver up to 2,600 MW of power to the ISO-NE electric grid under agreements with Connecticut and Massachusetts entities, in accordance with the states' respective renewable energy requirements. Due to unforeseen economic factors, both PPAs were terminated in 2023. Park City Wind is actively seeking new offtake agreements for the New England Wind Project. Specifically, Massachusetts, Connecticut, and Rhode Island all issued solicitations for additional offshore wind generated electricity and signed a memorandum of understanding in October 2023 to allow developers to submit multi-state bids and states to collaborate on their procurement decisions. Proposals are due on January 31, 2024, and Park City Wind intends to submit one or more proposals in response to these solicitations.

2.3 Non-Routine Activities and Low-Probability Events

Non-routine activities and low-probability events could occur during construction, operations, or decommissioning of the proposed Project. Examples include corrective maintenance activities; collisions between vessels or allisions (a vessel striking a stationary object), between vessels and WTGs or ESPs, or vessels and marine life; cable displacement or damage by anchors or fishing gear; chemical spills or releases; severe weather and other natural events; and/or terrorist attacks. These activities or events are difficult to predict with certainty. This section provides a brief assessment of these potential events or activities.

- *Corrective maintenance activities:* These activities could be required as a result of low-probability events or of unanticipated equipment wear or malfunctions.
- *Collisions and allisions:* These could result in spills (described below), human injuries or fatalities, or wildlife injuries or fatalities (addressed in Chapter 3 and Appendix A, Required Environmental Permits and Consultations). Collisions and allisions are anticipated to be unlikely because the proposed Project would:
  - Implement USCG requirement for lighting on vessels;
  - Exclude high vessel traffic areas from the Rhode Island and Massachusetts Lease Areas (RI/MA Lease Areas);
  - Implement NOAA vessel strike guidance, as practicable;
  - Apply proposed spacing between WTGs and other facility components;
  - Implement lighting and marking, as required by USCG and BOEM; and
  - Include proposed Project components on nautical charts.
- *Cable displacement or damage by vessel anchors or fishing gear:* This could result in safety concerns for vessels and economic damages for vessel operators and could require corrective action by the applicant. However, such incidents are unlikely to occur because the proposed Project would be indicated on navigational charts, and the cable would be buried at least 5 feet deep or protected with hard armor.
- *Chemical spills or releases:* For offshore activities, these include inadvertent releases from refueling vessels, spills from routine maintenance activities, collisions and allisions (as described above), and any significant spills resulting from a catastrophic event. The applicant would comply with USCG and BSEE regulations relating to prevention and control of oil spills. In addition, spill impacts would be minimized by adhering to the OSRP included in COP Appendix I-F (Epsilon 2023). Additional information related to potential spills can be found in the navigational safety risk assessment (NSRA) (COP Appendix III-I; Epsilon 2023). Onshore, releases could potentially occur from construction equipment and/or HDD activities. Additionally, a spill prevention, control, and countermeasure plan would be prepared in accordance with applicable requirements and outline spill prevention plans and measures to contain and clean up spills that could occur.

- *Severe weather and natural events:* Historical severe weather trends in the proposed Project area are described in Section B.1 of Appendix B, Supplemental Information and Additional Figures and Tables. The applicant designed the proposed Project components to withstand severe weather events (COP Volume III, Section 8.2; Epsilon 2023). The engineering specifications of the WTGs and their ability to sufficiently withstand weather events is independently evaluated by a certified verification agent when reviewing the Facility Design Report and Fabrication and Installation Report according to international standards, which include withstanding hurricane-level events. One of these standards calls for the structure to be able to withstand a 50-year return interval event. An additional standard also includes withstanding 3-second gusts of a 500-year return interval event, which would correspond to Category 5 hurricane windspeeds. If severe weather caused a spill or release, implementation of the OSRP and spill prevention, control, and countermeasure plan would help reduce potential impacts. Severe flooding or coastal erosion could require repairs, with impacts associated with repairs being similar to those outlined in Chapter 3 during construction activities. While highly unlikely, WTG structural failure (i.e., loss of a blade or tower collapse) would result in temporary hazards to navigation for all vessels, similar to the construction impacts described in Chapter 3.
- *Terrorist attacks:* BOEM considers these unlikely, but impacts could vary depending on the magnitude and extent of any attacks. The actual impacts of this type of activity would be the same as the outcomes listed above. Therefore, terrorist attacks are not analyzed further.

2.4 Summary and Comparison of Impacts by Alternatives

Table 2.4-1 summarizes and compares the impacts under each action alternative and includes each action alternative alone, including the Preferred Alternative, the impacts of other planned activities (specifically other planned offshore wind projects) without Alternative B (e.g., Alternative A), and the cumulative impacts of each action alternative in combination with other planned activities. Each resource section in Chapter 3 provides definitions for **negligible**, **minor**, **moderate**, and **major** impacts (both adverse and beneficial, where appropriate). Resources with overall adverse impact ratings no greater than **minor** are analyzed in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor (or Lower) Impacts, while other resources are analyzed in Chapter 3. All impact levels are assumed to be adverse unless specified as beneficial. Where impacts are presented as ranges for each resource in Chapter 3 and Appendix G, the table color represents the most conservative adverse impact level. Although the detailed description of potential impacts could vary across action alternatives, as described in Chapter 3 and Appendix G, many of the differences in potential impacts across alternatives do not warrant differences in impact ratings based on the definitions used.

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

Table 2.4-1: Summary and Comparison of Impacts Among Alternatives

Resources	**Alternative A[a,b]**	**Alternative B[b]**	**Alternative C[b]**	**Preferred Alternative**
Benthic Resources: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Benthic Resources: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Coastal Habitats and Fauna: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Coastal Habitats and Fauna: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Finfish, Invertebrates, and Essential Fish Habitat: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Finfish, Invertebrates, and Essential Fish Habitat: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Marine Mammals: *Alternative Impacts (Without Planned and Ongoing Activities)*[c]	**No impact**	**Minor** for NARW (*Eubalaena glacialis*), **Moderate** for all other mysticetes (except NARW), harbor porpoise (*Phocoena phocoena*), and pinnipeds, and **Minor** for all other odontocetes (except harbor porpoise)	**Minor** for NARW, **Moderate** for all other mysticetes (except NARW), harbor porpoise, and pinnipeds, and **Minor** for all other odontocetes (except harbor porpoise)	**Minor** for NARW, **Moderate** for all other mysticetes (except NARW), harbor porpoise, and pinnipeds, and **Minor** for all other odontocetes (except harbor porpoise)
Marine Mammals: *Alternative Impacts (With Ongoing Activities)*	**Major** for NARW, **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**

Resources	Alternative A[a,b]	Alternative B[b]	Alternative C[b]	Preferred Alternative
Marine Mammals: *Cumulative Impacts (With Planned and Ongoing Activities)*	**Major** for NARW, **Moderate** on all other mysticetes (except NARW), odontocetes, and pinnipeds,	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds	**Major** for NARW, and **Moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Sea Turtles: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Sea Turtles: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Commercial Fisheries and For-Hire Recreational Fishing: *Alternative Impacts*	**Major**	**Major**	**Major**	**Major**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Commercial Fisheries and For-Hire Recreational Fishing: *Cumulative Impacts*	**Major**	**Major**	**Major**	**Major**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Cultural Resources: *Alternative Impacts*	**Major**	**Major**	**Major**	**Major**
Cultural Resources: *Cumulative Impacts*	**Major**	**Major**	**Major**	**Major**
Demographics, Employment, and Economics: *Alternative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Demographics, Employment, and Economics: *Cumulative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Environmental Justice: *Alternative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Environmental Justice: *Cumulative Impacts*	**Minor**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Navigation and Vessel Traffic: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Resources	Alternative A[a,b]	Alternative B[b]	Alternative C[b]	Preferred Alternative
Navigation and Vessel Traffic: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Other Uses: *Alternative Impacts*	**Negligible** for national security and military use, aviation and air traffic, cables and pipelines, radar systems, and marine minerals; **Major** for scientific research and surveys	**Negligible** for cables and pipelines and marine minerals; **Minor** for aviation and air traffic; **Moderate** for national security and military use and radar systems; and **Major** for scientific research and surveys	**Negligible** for cables and pipelines and marine minerals; **Minor** for aviation and air traffic; **Moderate** for national security and military use and radar systems; and **Major** for scientific research and surveys	**Negligible** for cables and pipelines and marine minerals; **Minor** for aviation and air traffic; **Moderate** for national security and military use and radar systems; and **Major** for scientific research and surveys
Other Uses: *Cumulative Impacts*	**Negligible** for aviation and air traffic and marine minerals; **Minor** for cables and pipelines; **moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys	**Negligible** for marine minerals; **Minor** for aviation and air traffic and cables and pipelines; **Moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys	**Negligible** for marine minerals; **Minor** for aviation and air traffic and cables and pipelines; **Moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys	**Negligible** for marine minerals; **Minor** for aviation and air traffic and cables and pipelines; **Moderate** for radar systems; and **Major** for national security and military use and scientific research and surveys
Recreation and Tourism: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Recreation and Tourism: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Minor Beneficial	**Minor Beneficial**	**Minor Beneficial**	**Minor Beneficial**
Scenic and Visual Resources: *Alternative Impacts*	**Major**	**Major**	**Major**	**Major**
Scenic and Visual Resources: *Cumulative Impacts*	**Major**	**Major**	**Major**	**Major**
Air Quality: *Alternative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Air Quality: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
	Moderate Beneficial	**Moderate Beneficial**	**Moderate Beneficial**	**Moderate Beneficial**
Water Quality: *Alternative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**

Resources	Alternative A[a,b]	Alternative B[b]	Alternative C[b]	Preferred Alternative
Water Quality: *Cumulative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Bats: *Alternative Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Bats: *Cumulative Impacts*	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Birds: *Alternative Impacts*	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**
Birds: *Cumulative Impacts*	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**	**Moderate** **Moderate Beneficial**
Terrestrial Habitats and Fauna: *Alternative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Terrestrial Habitats and Fauna: *Cumulative Impacts*	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Non-Tidal Waters and Wetlands: *Alternative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Non-Tidal Waters and Wetlands: *Cumulative Impacts*	**Minor**	**Minor**	**Minor**	**Minor**
Land Use and Coastal Infrastructure: *Alternative Impacts*	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**
Land Use and Coastal Infrastructure: *Cumulative Impacts*	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**	**Minor** **Minor Beneficial**

COP = Construction and Operations Plan; NARW = North Atlantic right whale; SAR = search and rescue; USCG = U.S. Coast Guard
Impact rating colors are as follows: orange = **major**; yellow = **moderate**; blue = **minor**; white = **negligible**; green = **beneficial** (to any degree). All impact levels are assumed to be adverse unless otherwise specified as beneficial. Where impacts are presented as multiple levels, the color representing the most adverse level of impact has been applied. The details of particular impacts and explanations for ranges of impact levels are found in each resource section.
[a] Planned activities without proposed Project impacts includes the impacts evaluated in Alternative A.
[b] Cumulative impacts include the given alternative in combination with all other ongoing and planned activities.
[c] Consideration of Alternatives A, B, and C without the ongoing and planned activities provides the incremental impact of each alternative without existing conditions (i.e., ongoing) or cumulative impacts from planned activities. Under Alternative A (i.e., the No Action Alternative) without the consideration of planned activities, the COP would not be approved, and the proposed Project would not be developed; this alternative would, therefore, have no incremental impact on marine mammals.

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3 Affected Environment and Environmental Consequences

This chapter analyzes the impacts of the Proposed Action and alternatives by establishing existing conditions of affected resources, predicting the direct and indirect impacts,[16] and then evaluating those impacts when added to existing conditions and considered in the context of the reasonably foreseeable impacts of future planned activities. This chapter, thus, addresses the affected environment (i.e., existing conditions) for each resource area and the potential environmental consequences to (i.e., impacts on) those resources from implementation of the alternatives described in Chapter 2, Alternatives. In addition, this chapter addresses the impact of the alternatives when combined with other past, present, or planned activities (i.e., cumulative impacts) using the methodology and assumptions outlined in Chapter 1, Introduction, and Appendix E, Planned Activities Scenario. The geographic analysis area for each resource is described and depicted in the beginning of each resource section, and Appendix E describes other ongoing and planned activities within the geographic analysis area for each resource. These actions may be occurring on the same time scale as the proposed Project or could occur later in time but are still reasonably foreseeable.

In accordance with the CEQ regulations implementing NEPA (40 CFR § 1502.21), BOEM identified information that was incomplete or unavailable for the evaluation of reasonably foreseeable impacts. The identification and assessment of incomplete or unavailable information is presented in Appendix F, Analysis of Incomplete or Unavailable Information and Other Required Analyses.

For each resource, the Final EIS first analyzes the No Action Alternative to predict the impacts of existing conditions (as described in Section 1.6.1). The Final EIS then assesses the cumulative impacts on existing conditions as future planned activities—other than the Proposed Action—occur (as described in Section 1.6.2). Separate impact conclusions are drawn based on these separate analyses. This Final EIS also conducts separate analyses to evaluate the impacts of the Proposed Action and action alternatives when added to existing conditions of resources (as described in Section 1.6.1) and evaluates cumulative impacts by analyzing the incremental impacts of the action alternatives when added to both existing conditions and the impacts of future planned activities (as described in Section 1.6.2).

[16] Direct and indirect effects are defined in CEQ's NEPA implementing regulations (40 CFR § 1508.1(g)):

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

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3.1 Impact-Producing Factors

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

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

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

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

Table 3.1-1: Primary Impact-Producing Factors Addressed in This Analysis

IPF	Sources and/or Activities	Description
Accidental releases	• Mobile sources (e.g., vessels) • Installation, operation, and maintenance of onshore or offshore stationary sources (e.g., renewable energy structures, transmission lines, cables)	Refers to unanticipated release or spills into receiving waters of a fluid or other substance, such as fuel, hazardous materials, suspended sediment, invasive species, trash, or debris. Accidental releases are distinct from routine discharges, which typically consist of authorized operational effluents controlled through treatment and monitoring systems and permit limitations.
Air emissions	• Internal combustion engines (such as generators) aboard stationary sources or structures • Internal combustion engines within mobile sources such as vessels, vehicles, or aircraft	Refers to the release of gaseous or particulate pollutants into the atmosphere. Releases can occur onshore and offshore.
Anchoring and gear utilization	• Anchoring of vessels • Resource monitoring surveys • Attachment of a structure to the sea bottom by use of an anchor, mooring, or gravity-based weighted structure (i.e., bottom-founded structure)	Refers to an activity or action that attaches objects to the seafloor. Gear utilization refers to resource monitoring surveys and entanglement and bycatch from gear utilization during fisheries and benthic monitoring surveys.
Cable emplacement and maintenance	• Dredging or trenching • Cable placement • Seabed profile alterations • Sediment deposition and burial • Mattress and rock placement	Refers to an activity or action associated with installing new offshore submarine cables on the seafloor, commonly associated with offshore wind energy.
Climate change	• Emissions of GHGs	Refers to the impacts of climate change, such as warming and sea level rise and increased storm severity or frequency. Ocean acidification refers to the impacts associated with the decreasing pH of seawater from rising levels of atmospheric CO_2.
Discharges/intakes	• Vessels • Structures • Onshore point and non-point sources • Dredged material ocean disposal • Installation, operation, and maintenance of submarine transmission lines, cables, and infrastructure	Generally refers to routine permitted operational effluent discharges to receiving waters. There can be numerous types of vessel and structure discharges, such as bilge water, ballast water, deck drainage, gray water, fire suppression system test water, chain locker water, exhaust gas scrubber effluent, condensate, and seawater cooling system effluent, among others. These discharges are generally restricted to uncontaminated or properly treated effluents that may have best management practice or numeric pollutant concentration limitations as required through USEPA National Pollutant Discharge Elimination System permits or USCG regulations. The discharge of dredged material refers to the deposition of sediment at approved offshore disposal sites.

IPF	Sources and/or Activities	Description
EMF	• Substations • Power transmission cables • Inter-array cables • Electricity generation	Power generation facilities and cables produce electric fields (proportional to the voltage) and magnetic fields (proportional to flow of electric current) around the power cables and generators. Three major factors determine levels of the magnetic and induced electric fields from offshore wind energy projects: 1) the amount of electrical current being generated or carried by the cable, 2) the design of the generator or cable, and 3) the distance of organisms from the generator or cable.
Land disturbance	• Onshore construction • Onshore land use changes • Erosion and sedimentation • Vegetation clearance	Refers to land disturbances related to any onshore construction activities.
Lighting	• Vessels or offshore structures above or under water • Onshore infrastructure	Refers to lighting associated with offshore wind development and activities that use offshore vessels and may produce light above the water onshore and offshore, as well as underwater.
Noise	• Aircraft • Vessels • Turbines • G&G surveys • Operations and maintenance • Onshore and offshore construction and installation • Pile driving • Dredging and trenching • UXOs	Refers to noise from various sources and commonly associated with construction activities, G&G surveys, and vessel traffic. May be impulsive (e.g., pile driving) or broad spectrum and continuous (e.g., from proposed Project-associated marine transportation vessels). May also be noise generated from turbines themselves or interactions of the turbines with wind and waves.
Port utilization	• Expansion and construction • Maintenance • Use • Revitalization	Refers to an activity or action associated with port activity, upgrades, or maintenance that occurs only as a result of the proposed Project. Includes activities related to port expansion and construction from increased economic activity and maintenance dredging or dredging to deepen channels for larger vessels.

IPF	Sources and/or Activities	Description
Presence of structures	• Onshore and offshore structures including towers and transmission cable infrastructure	Refers to an activity or action associated with onshore or offshore structures other than construction-related impacts, including the following: • Space-use conflicts • Fish aggregation and/or dispersion • Bird attraction and/or displacement • Marine mammal attraction and/or displacement • Sea turtle attraction and/or displacement • Scour protection • Allisions • Entanglement and/or gear ingestion • Gear loss and/or damage • Fishing effort displacement • Habitat alteration (creation or destruction) • Behavioral disruption (migration or breeding) • Navigation hazard • Seabed alterations • Turbine strikes (birds, bats) • Viewshed (physical, light) • Microclimate and circulation effects (above and below water)
Traffic	• Aircraft • Vessels • Vehicles	Refers to marine and onshore vessel and vehicle congestion, including vessel strikes of sea turtles and marine mammals, collisions, and allisions.

CO_2 = carbon dioxide; EMF = electromagnetic field; G&G = geophysical and geotechnical; GHG = greenhouse gas; IPF = impact-producing factor; USCG = U.S. Coast Guard; USEPA = U.S. Environmental Protection Agency; UXO = unexploded ordnance

3.2 Mitigation Identified for Analysis in the Environmental Impact Statement

During the development of this Final EIS and in coordination with cooperating agencies, BOEM considered additional potential mitigation and monitoring measures, in addition to those committed to by the applicant, that could further avoid, minimize, or mitigate impacts on the physical, biological, socioeconomic, and cultural resources assessed in this document. Mitigation and monitoring measures required through completed consultations with respect to environmental statutes such as Section 7 of the ESA are listed in Table H-1 of Appendix H, Mitigation and Monitoring, and incorporated in the Preferred Alternative. Potential additional measures are described in Table H-2 in Appendix H and analyzed in the relevant resource sections in this chapter. In addition, other mitigation and monitoring measures may be required through consultations, authorizations, and permits with respect to several environmental statutes, such as the MMPA, Section 7 of the ESA, or the MSA.[17] If any mitigation measures are analyzed in the impact analyses and those measures influence the impact determinations, those measures are included in the Preferred Alternative. Those additional measures presented in Appendix H may not be within BOEM's statutory and regulatory authority; however, other jurisdictional governmental agencies may require them. Mitigation and monitoring measures for completed consultations, authorizations, and permits are analyzed in each respective resource section in Chapter 3 of the Final EIS. BOEM may choose to incorporate one or more additional measures in the ROD and adopt those measures as conditions of COP approval. As previously discussed, all applicant-committed mitigation and monitoring measures are part of the Proposed Action (see Chapter 2 for details).

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

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3.3 Definition of Impact Levels

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

With regard to temporal extent, the Final EIS assumes that potential construction impacts diminish once construction ends; however, ongoing operations activities could result in additional impacts for the 33-year operational life of the proposed Project. Additionally, the applicant would have up to an additional 2 years to complete decommissioning activities. Therefore, the Final EIS considers the timeframe beginning with construction and ending when the proposed Project's decommissioning is complete, unless otherwise noted. As stated in Chapter 2, Alternatives, the proposed Project would have a 33-year operating period.

The Final EIS uses the following duration terms:

- Temporary impacts: This includes impacts 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 impact would end.
- Short-term impacts: This includes impacts that extend beyond construction, potentially lasting for several months but not for several years or longer. An example would be clearing of roadside landscaping during construction; the area would be revegetated when construction is complete, and once revegetation is successful, this impact would end.
- Long-term impacts: This includes impacts that last for a long period of time, potentially exceeding the life of the proposed Project (e.g., decades or longer). An example would be the loss of habitat where a WTG or ESP foundation has been installed.
- Permanent impacts: This includes impacts that extend beyond the life of the proposed Project. An example would be the conversion of land to support new onshore facilities or the placement of scour protection that is not removed as part of decommissioning.

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3.4 Benthic Resources

3.4.1 Description of the Affected Environment

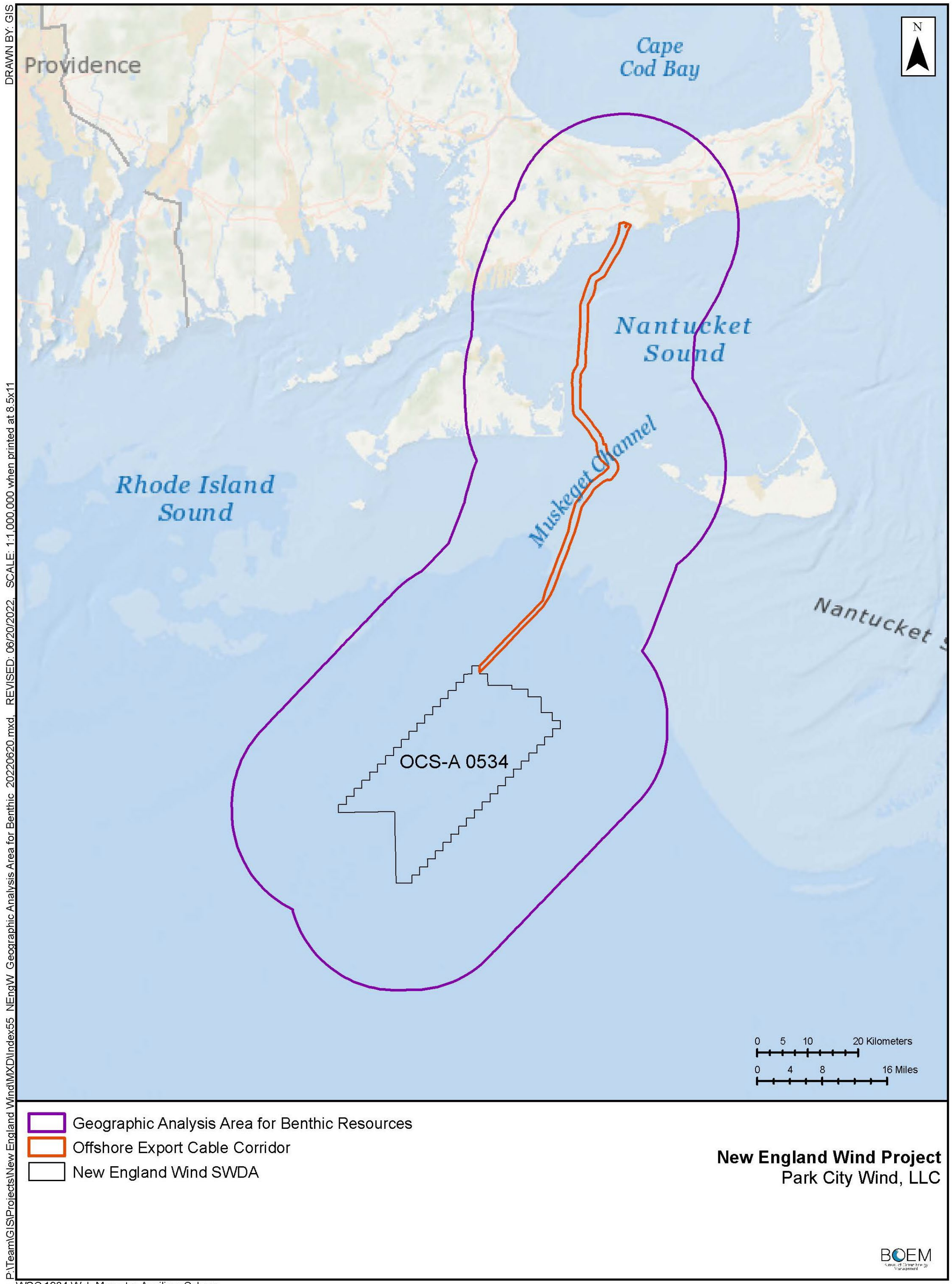
This section discusses existing benthic resources in the geographic analysis area, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.4-1. This includes a 10-mile radius around the SWDA and the OECC. These buffers account for benthic invertebrate larval transport due to regional oceanographic conditions. Although sediment transport beyond 10 miles is possible, sediment transport related to proposed Project activities would likely be limited to a smaller spatial scale than 10 miles (COP Volume III, Appendix III-A; Epsilon 2023). Some species have ranges that extend beyond the geographic analysis area at certain life stages, such as larval invertebrates (Zhang et al. 2016; Incze and Naimie 2020); however, this analysis focuses on impacts within the geographic analysis area.

Benthic resources include the seafloor surface, the substrate, and the associated communities of bottom-dwelling organisms that live there. Benthic habitats include soft-bottom (e.g., mud and sand) and hard-bottom (e.g., gravel, cobble, boulder, and bedrock) habitats, as well as biogenic habitats (e.g., eelgrass, mussel beds, and worm tubes) created by structure-forming species. Benthic habitat in the geographic analysis area is estimated to cover 1,164,963 acres, of which approximately 80 percent is sand, 15 percent is gravel/cobble/boulder, and 5 percent is mud/silt (The Nature Conservancy 2014). Benthic faunal resources in the geographic analysis area include polychaetes, crustaceans (particularly amphipods), mollusks (gastropods and bivalves), echinoderms (sand dollars, brittle stars, and sea cucumbers), and various other groups (sea squirts and burrowing anemones) (Guida et al. 2017). The spatial and temporal variation in benthic prey organisms can affect the growth, survival, and population dynamics of fishes and other higher trophic level organisms.

3.4.1.1 Habitat

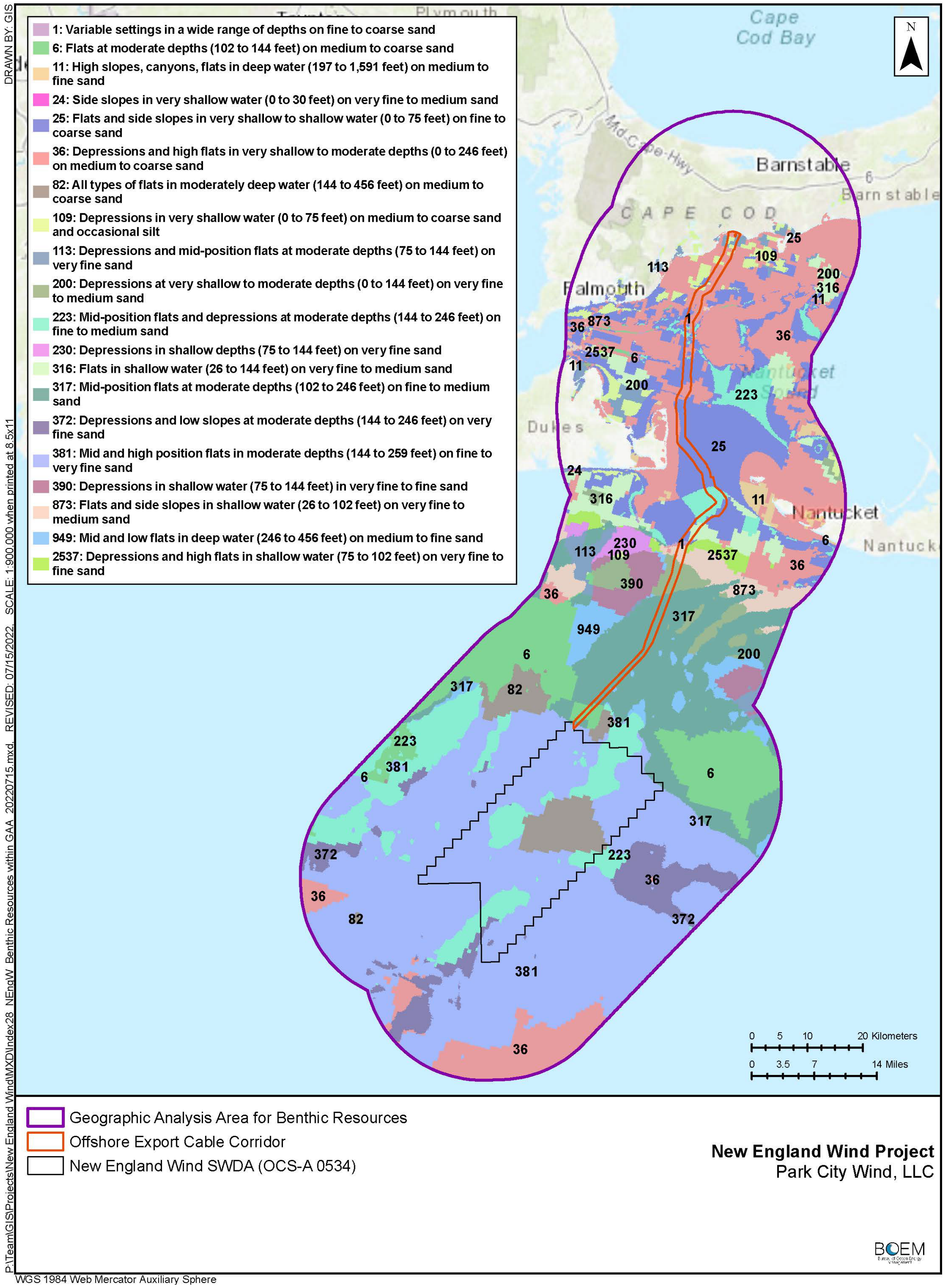
Regional oceanography is influenced by subsurface currents and dominated by seasonal water stratification. Guida et al. (2017) noted that the shelf-wide seasonal temperature pattern of warming surface waters from the spring through fall and the cold current flow of water southward from the Gulf of Maine create a cold pool. This resulting water stratification drives the distribution of benthic and demersal species across New England. The OECC and SWDA are located along the approximate northern boundary of the cold pool.

The seafloor in the OECC and SWDA is predominantly composed of unconsolidated sediments ranging from silt and fine-grained sands to gravel. The SWDA is comprised entirely of fine unconsolidated substrate with predominantly sand and silt-sized material (COP Volume III, Section 6.5.1.1; Epsilon 2023). Local hydrodynamic conditions largely determine sediment types, with finer materials in low-current areas and coarser materials in high-current areas. Coarser materials on the seafloor include gravel, cobble, and boulders, which are typically mixed with a matrix of finer sediments and usually found among discontinuous patches of sand (BOEM 2021b). This patchy distribution of coarse material (representative of coarse glacial till or end moraine deposits) is most common in high current areas, such as in the Muskeget Channel region (Figure 3.4-2) and northwest of Horseshoe Shoal in the North Channel (COP Volume II, Table 2.1-1 Volume II; Epsilon 2023). The applicant did not identify any hard-bottom habitat in the SWDA. Hard-bottom habitat has been documented within the OECC where it has significant coverage through Muskeget Channel's shallow water passage (COP Volume II, Section 5.2.1; Epsilon 2023). A sparse to moderate distribution of living eelgrass was identified in one area of the OECC along the south shore of Cape Cod (COP Volume II, Section 5.2.2; Epsilon 2023). Benthic faunal communities in the OECC and SWDA are typical for the region and vary according to habitat type along gradients in depth, hydrodynamic conditions, and substrate composition.



SWDA = Southern Wind Development Area

Figure 3.4-1: Geographic Analysis Area for Benthic Resources



Source: Mid-Atlantic Regional Council of the Ocean 2023
SWDA = Southern Wind Development Area
Note: Water depths listed in the legend may not encompass the full depth range for each benthic habitat.

Figure 3.4-2: Benthic Resources within the Geographic Analysis Area

Seafloor conditions within the SWDA are generally homogenous and dominated by sand and silt-sized sediments. These homogenous conditions were identified by multibeam echo sounding and side scan sonar imaging techniques that have been ground-truthed via benthic grab samples, underwater video, borings, and cone penetration tests, and further verified via historic grab sample and still photo data (Guida et al. 2017; Stokesbury 2013, 2014). Large, broad, well-defined areas of rippled bedforms and ripple scour depressions are located on the surface of the bathymetric highs, oriented northeast-to-southwest in the southeastern portion of the SWDA. Smaller groupings of ripple scour depressions are found in the northern and western portion of the SWDA, which provide the only relief as compared to the relatively flat seafloor that gradually slopes offshore. These features within the SWDA provide less than 3.2-foot relief, far smaller than sand waves in some other parts of the Atlantic Ocean that can stretch for hundreds of feet. Much of the OECC exhibits unconsolidated sediment soft-bottom habitat with low complexity; approximately 67 percent of video transects found mostly flat sand/mud, sand waves, and biogenic structures, while 27 percent found pebble-cobble bottom and 24 percent found shell aggregate bottom (BOEM 2021b). Sections of the OECC in the vicinity of Muskeget Channel contain special, sensitive, or unique resources habitat that consists of "hard/complex bottom," a category that includes biogenic structures, hard-bottom, and complex seafloor (i.e., sand waves), as defined in the *2021 Massachusetts Ocean Management Plan* (Massachusetts Office of Coastal Zone Management 2021).

The applicant conducted surveys of epifauna and infauna along the OECC using underwater video transects and sediment grab samples, respectively. The majority of the video transect samples recorded bottom habitats with low complexity, mostly comprised of flat sand/mud, sand waves, and biogenic structure (COP Section 5.1.1, Volume II; Epsilon 2023). Areas of shell aggregate, specifically common Atlantic slipper shell (*Crepidula fornicata*) reefs, were observed along the OECC in the northern Nantucket Sound. Several locations within Muskeget Channel contained coarse deposits and hard-bottom habitats consisting of pebble-cobble dominated substrate with sulfur sponge (*Cliona celata*) communities. The Phase 1 OECC would make landfall at Craigville Public Beach or Covell's Beach in Barnstable. A sparse to moderate distribution of eelgrass exists in and around the Spindle Rock boulder pile near the landfall site (COP Volume I, Section 3.2.1; Epsilon 2023). Surveys have revealed isolated human-made objects to be avoided in the OECC and one debris pile/possible shipwreck in the OECC, approximately 6.8 miles southwest of Covell's Beach. The Phase 2 OECC would make landfall at Dowses Beach or Wianno Avenue in Barnstable. During the course of underwater video surveys, a patch of eelgrass was identified, approximately 1,400 feet southwest of the Phase 2 OECC.

3.4.1.2 Biota

The benthic communities in the SWDA are representative of the communities within New England waters in depths from approximately 141 to 203 feet, which includes amphipods and other crustaceans, American lobster (*Homarus americanus*), crabs, gastropods, polychaetes, bivalves, sand dollars, burrowing anemones, brittle stars, sea squirts, tunicates, and sea cucumbers (BOEM 2014a; Provincetown Center for Coastal Studies 2005). These organisms are important food sources for many commercially important fish species. Benthic communities are present in the patches of sand ripples and small mega-ripples within the SWDA (COP Volume II, Section 2; Epsilon 2023); however, within these variable mobile sand environments, fauna is often quite sparse (Jennings et al. 2013).

Drop-down video surveys of benthic epifauna from 2010 to 2013 indicated that the common sand dollar (*Echinarachnius parma*) was the most abundant species within the RI/MA Lease Areas, with this species occurring in approximately 70 percent of a total of 216 samples (SMAST 2016a). Sample results collected during the School for Marine Science and Technology surveys indicated hydrozoans and bryozoans were present in approximately 19 percent of the samples, while hermit crabs, euphausiids, sea stars, and anemones, combined, were present in 13 percent of samples (SMAST 2016a). The SWDA was sampled in 2016, 2018, 2019, and 2020 by the applicant with the single grab sample from 2016 containing a high abundance (62 percent) of polychaete worms, which, together with nematode worms and annelid worms, accounted for 83 percent of all individuals identified (COP Volume II, Section 5.1.3; Epsilon 2023). Analysis of the 16 grab samples from 2018 showed 90 percent of the total abundance was made up of annelid worms and arthropods, which also accounted for 65 percent of all unique taxa. Other phyla captured in these samples included Cnidaria, Echinodermata, Mollusca, Nematoda, Nemertea, Phoronida, and Sipuncula. Grab samples from the 2019 survey contained Arthropoda (66 percent) and Annelida (28 percent) with the highest abundance of the phyla, representing 94 percent of all organisms, with 51 percent of all organisms being identified as amphipods from the family Ampeliscidae (COP Volume II, Section 5.1.3; Epsilon 2023). Analysis of the 39 grab samples from 2020 contained Arthoropoda (43 percent), Annelida (32 percent), and Mollusca (14 percent), representing 89 percent of all organisms, with 30 percent of all organisms identified as amphipods from the family Ampeliscidae.

Bedforms ranging in size from ripples up to sand waves have been identified locally along the OECC; larger bedforms are found in waters with fast-flowing tidal currents. Benthic fauna tend to be most dense in the trough between sand waves where organic matter accumulates, while mobile species such as amphipods are prevalent on the slope of the sand wave (COP Volume III, Section 6.5.1.2; Epsilon 2023). Previous studies of the species composition within sand waves have found that species present tend to be robust filter feeders (e.g., bivalves) as opposed to more delicate deposit feeders (e.g., feather duster worms and sea cucumbers), which tend to be found within flatter sedimentary bedforms (COP Volume III, Section 6.5.1.2; Epsilon 2023). Results from the 2017 towed video survey of the OECC showed that the Nantucket Sound area was dominated by amphipods, slipper limpets, whelks, sponges, polychaetes, and spider crabs. Communities within the Eastern Muskeget Channel were more varied, with sulfur sponge (*Cliona celata*), red beard sponge (*Microciona* sp.), and blue mussels (*Mytilus edulis*) making up most of the observed epifauna. South of the Muskeget Channel, flat sand, mud, and biogenic structures were inhabited by mostly sand dollars and some burrowing anemones (COP Volume III, Section 6.5.1; Epsilon 2023). The dominant infaunal organisms along the OECC include nematodes, amphipods, polychaete worms, nut clams, and snails (e.g., slipper limpets, pyram shells, and dove snails) (COP Volume II, Section 5.1.1; Epsilon 2023).

The conditions of benthic resources can be affected by many external factors, which could impact the habitat, abundance, diversity, community composition, and percent cover of benthic fauna and flora. Benthic resources in the geographic analysis area are subject to pressure from ongoing and future actions, such as climate change, commercial fishing using bottom-tending gear (e.g., dredges, bottom trawls, traps/pots), and sediment dredging, and the impacts on benthic resources will continue regardless of offshore wind energy development. There are limited data on trends related to impacts from non-Project-related activities within the SWDA and OECC, although larger trends within coastal New England likely apply to the entire geographic analysis area for benthic resources. Historical data for Centerville Harbor show a slow decline in eelgrass bed habitat since 1951 (MassDEP 2011). Similarly, New England horseshoe crab (*Limulus polyphemus*) stocks are in decline (ASMFC 2013). Although not considered benthic habitat, beaches may be used for spawning by benthic species such as horseshoe crab, and shoreline development could affect access to spawning areas, although such activities are prohibited from impacting the spawning beaches themselves (MA DMF 2016a, 2018). See Section 3.6, Finfish, Invertebrates, and Essential Fish Habitat, for additional information.

Ongoing commercial and recreational regulations for finfish and shellfish implemented and enforced by the regulatory authorities, individual local municipalities, and NOAA affect benthic resources by modifying the nature, distribution, and intensity of fishing-related impacts, including those that disturb the seafloor (e.g., trawling, dredge fishing) (Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing). Disturbance of benthic invertebrate communities by commercial fishing activities can affect community structure and diversity and limit recovery (BOEM 2019a), although this impact is less significant in sandy areas that are strongly influenced by tidal currents and waves (Nilsson and Rosenberg

2003; Sciberras et al. 2016). However, bottom trawling is noted as one of the most prominent sources of physical disturbance to soft-sediment benthic communities and habitats (Moyrs et al. 2021), while dredging of soft-bottom substrates for navigation results in localized short-term impacts on benthic resources that would recover relatively quickly from the disturbance (BOEM 2019a).

3.4.2 Environmental Consequences

Definitions of impact levels for benthic resources are described in Table 3.4-1.

Table 3.4-1: Impact Level Definitions for Benthic Resources

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

3.4.2.1 Impacts of Alternative A – No Action Alternative on Benthic Resources

When analyzing the impacts of Alternative A on benthic resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for benthic resources (Table G.1-1 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for benthic resources described in Section 3.4.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities that could affect benthic resources within the geographic analysis area are climate change, commercial fishing using bottom-tending gear, and sediment dredging (as briefly described in Section 3.4.1), and the impacts on benthic resources will continue regardless of offshore wind energy development. The rate and extent of these activities vary and are uncertain, but their impacts on benthic resources would likely be detectable through changes in various metrics including habitat structure and faunal abundance, diversity, and composition.

While the proposed Project would not be built under Alternative A, BOEM expects ongoing activities, future non-offshore wind activities, and future offshore wind activities to continue to affect benthic resources, although the exact impacts would not be the same due to temporal and geographical differences.

Ongoing non-offshore wind activities that have the potential to shift the existing conditions of the benthic resources within the geographic analysis area include mining of marine minerals, renewable energy projects other than offshore wind (e.g., wave and tidal), offshore dredged material disposal, military activities, marine transport, and telecommunications cables. It is uncertain whether or to what extent any of these activities would be conducted within the geographic analysis area, but all have the potential for impacting benthic habitat physical features (e.g., topography) and community composition by virtue of various associated IPFs as described in Appendix G.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind activities would affect benthic resources through the following primary IPFs.

Accidental releases: Construction of future offshore wind projects would contribute to an increased risk for hazardous materials spills, the release of trash, and marine debris. There would also be an increase in the risk of the release of invasive species and their associated impacts. Best management practices (BMP) for waste management and mitigation of marine debris would be required and would reduce this risk. Marine debris awareness and elimination measures and other mitigation measures are covered in more detail in Table H-2 in Appendix H, Mitigation and Monitoring. Similar mitigation measures, such as those detailed in Appendix H, would be followed by each planned offshore wind project.

Accidental releases may increase as a result of future offshore wind activities. The risk of accidental releases would increase during all phases of offshore wind development but primarily during construction. Impacts vary in duration based on the material and volume released. Diesel fuel and gasoline tend to float at the water surface and biodegrade/weather more rapidly relative to heavy fuel oil (bunker fuel), which sinks. Anderson et al. 2012 provided oil spill occurrent rates applicable to offshore oil exploration and development activity along the OCS. In 2016, ABS Consulting Inc. provided an updated report, which compared the calculated ratio of occurrence of spills greater than 1,000 barrels (42,000 gallons) to the volume of crude oil handled. Similar calculations occurred for spills greater than 10,000 barrels (420,000 gallons). Updated results were 0.22 spills per billion barrels for spills greater than 1,000 barrels and remained steady at 0.06 spills per billion barrels for spills greater than 10,000 barrels (ABS Consulting Inc. 2016). Vessel spill rates continue to decline, likely due to regulatory changes requiring double hulls. Diesel spills from OCS activities (e.g., from associated vessels or maintenance activities) are relatively rare and small with the median size for spills less than or equal to 1 barrel (42 gallons) to be 0.024 barrels (approximately 1 gallon) (Anderson et al. 2012). In most cases, the corresponding impacts on benthic resources within the geographic analysis area are unlikely to be detectable unless there is a catastrophic spill from ongoing activities (e.g., an accident involving a tanker ship). A large spill is very unlikely, given the typical fuel storage capacities of offshore wind project vessels and facilities (COP Volume II, Appendix A, Section A.8.2; Epsilon 2023).

The risk of a release from a WTG or ESP would be low. Recent modeling within the RI/MA Lease Areas demonstrated that a release of 128,000 gallons is likely to occur no more often than once per 1,000 years, and a release of 2,000 gallons or less is likely to occur every 5 to 20 years (Bejarano et al. 2013). The likelihood of a spill occurring from multiple WTGs and ESPs at the same time is very low and, therefore, the potential impacts from a spill larger than 2,000 gallons are largely discountable.

Invasive species can be released accidentally, especially during ballast water and bilge water discharges from marine vessels. Increasing vessel traffic related to the offshore wind industry would increase the risk of accidental releases of invasive species, primarily during construction. The likelihood of invasive species becoming established as a result of offshore wind activities would be very low, however, range expansion from species already present is a likely scenario, as observed at Block Island Wind Farm. *Didemnum vexillum*, a nonnative tunicate already widespread in the region, was found on the turbines post construction (Hutchison et al. 2020a). The ecological impact of invasives could be strongly adverse, widespread, and permanent if not controlled. However, all offshore wind activities will require compliance with the International Convention for the Prevention of Pollution from Ships and other vessel standards to reduce the occurrence of accidental releases. The increase in this risk related to the offshore wind industry would be small in comparison to the risk from ongoing activities within the region (e.g., trans-oceanic shipping).

Accidental releases of trash and debris from vessels may occur primarily during construction but also during operations and decommissioning. BOEM assumes all vessels would comply with laws and regulations to minimize accidental releases. Heavier, non-buoyant solid waste would sink and could accumulate on the seafloor, where it may eventually be colonized by epibiota. Seafloor debris may leach chemicals and potentially cause localized changes in benthic communities. There is no indication that the anticipated volumes and extents of accidental releases of solid waste within the geographic analysis area would have detectable impacts on benthic resources.

The overall impacts of accidental releases on benthic resources are likely to be localized and short term, resulting in undetectable changes to benthic communities. As such, accidental releases from future offshore wind development would not be expected to appreciably contribute to overall impacts on benthic resources.

Anchoring and gear utilization: Ongoing and planned offshore wind activities are likely to include monitoring surveys in the offshore wind lease areas. These could include video, multibeam bathymetry, and grab samples, as well as other methods of sampling the biota in the area. The presence of monitoring gear could affect benthic resources through seafloor disturbance; however, it is expected that monitoring plans would have sufficient mitigation procedures in place to reduce potential impacts. Impacts from gear utilization from other offshore wind activities on benthic resources are likely to occur at short-term, regular intervals over the lifetime of the projects and have no perceptible consequences to individuals or populations. The future offshore wind scenario would lead to increased vessel anchoring during survey activities and construction, operations, and decommissioning stages. In addition, anchoring/mooring of meteorological (met) towers or buoys could increase. Benthic disturbance would occur from the contact of the anchor to the seabed and anchor drag, as well as anchor rigging (chains, cables, ropes). Anchoring activities disturb local sediments and benthic communities during emplacement. BOEM estimates that 1,031 acres of seabed could be impacted by deployed anchors associated with Alternative A. All impacts from anchoring would be localized, sediment disturbance would be minimal, and benthic resource recovery from impacts (including mortality) would occur in the short term from a population perspective. Degradation of sensitive habitats, such as eelgrass beds and hard-bottom habitats, if it occurs, could be long term to permanent. Habitat complexity and the surface topography of the habitat play a pivotal role in sheltering various fish species. For example, plaice prefer a particular grain size composition of the sediments they bury into, while roundfishes survive best in habitats with structural complexity (Kaiser et al. 2002). Bottom-tending gear greatly reduces the habitat complexity and topography, disrupts and removes the fauna, and may lead to changes in the fish assemblages (Kaiser et al. 2002; Tamsett et al. 2010). A 2006 meta-analysis study on over 100 fishing impact studies consistently showed that scallop dredges, used across a wide range of habitats, had the most severe ecological impacts (Kaiser et al. 2006; Collie et al. 2005).

Impacts from anchoring would affect a relatively limited extent of the geographic analysis area and would be discontinuous in nature. Greater impacts on benthic resources would occur if impacts on sensitive habitats are not avoided.

Cable emplacement and maintenance: Emplacement of offshore submarine cables would cause short-term disturbance of seafloor habitats and injury and mortality of benthic resources in the immediate vicinity of the cable emplacement activities. The cable routes for future projects have not been fully determined at this time. Cable emplacement for other future offshore wind projects within the geographic analysis area would occur over from 2023 through 2030 and beyond and would disturb up to 5,898 acres, approximately 5 percent of available habitat in the geographic analysis area. Moreover, most disturbance would be expected to occur in sand bottom habitat (The Nature Conservancy 2014). Increased localized turbidity would occur during cable emplacement activities. Seafloor disturbance for other future offshore wind projects may affect benthic resources. Assuming future projects use installation procedures similar to those proposed in the proposed Project COP (Volume III, Section 2.2.1; Epsilon 2023), the duration and extent of impacts would be limited and short term, and soft-bottom benthic assemblages would recover from the disturbance. If routes intersect eelgrass or hard-bottom habitats, impacts may be long term to permanent.

Some types of cable installation equipment use water withdrawals, which can entrain planktonic larvae of benthic fauna (e.g., larval polychaetes, mollusks, and crustaceans) with an assumed 100 percent mortality of entrained individuals (COP Volume III, Section 6.5.2.1; Epsilon 2023). Vulnerability to entrainment would depend on the alignment of spawning times for individual species with pelagic eggs and larvae and the cable-laying activities. Due to the surface-oriented intake of such methods, water withdrawal could also entrain pelagic eggs and larvae but would not directly affect resources on the seafloor. However, the rate of egg and larval survival to adulthood for many species is very low (MMS 2009). Due to the limited volume of water withdrawn (up to 1,200 million gallons), BOEM does not expect population-level impacts on any benthic species due to entrainment.

When cable emplacement and maintenance causes resuspension of sediments, increased turbidity could affect filter-feeding fauna such as bivalves. Most of the geographic analysis area for benthic resources is soft-bottom habitat comprised predominantly of sand that would settle out of the water column quickly, making increased turbidity brief. The impact of turbidity on benthic fauna depends on both the concentration of suspended sediment and the duration of exposure. For example, mollusk eggs do not experience sub-lethal impacts until an exposure of 200 milligrams per liter for 12 hours; for other life stages, 24 hours of exposure is the minimum threshold for sub-lethal impacts (Wilber and Clarke 2001). Modeling for the proposed Project predicted that suspended sediment should usually settle well before 12 hours have elapsed—typically between 1 to 6 hours (COP Volume III, Appendix III-A; Epsilon 2023). Applying this finding to other offshore wind projects, relatively little impact from increased turbidity (separate from the impact of sediment deposition) is expected. Under Alternative A, the extent of sediment transport would be limited and spatially discontinuous due to cable emplacement and maintenance.

If the sediment disturbed by construction activities contains elevated levels of toxic contaminants, sediment disturbances could affect water quality and the physiology of benthic organisms. Consistent with the findings for Vineyard Wind 1, contaminated sediments are not anticipated to be a problem in the geographic analysis area for benthic resources. Sediment core samples from within the nearby Lewis Bay found sediment contaminant levels were below levels of concern (MMS 2009).

All impacts included in this IPF would be localized. Turbidity would be present during construction for 1 to 6 hours at a time, and the possible mortality of benthic resources would be recovered in the short term (COP Volume III, Appendix III-A; Epsilon 2023). Any necessary dredging prior to cable installation could also contribute additional impacts. Similar to other physical disturbance (e.g., anchoring), greater impacts on benthic resources would occur if cable emplacement does not avoid sensitive habitats.

Dredging and/or mechanical trenching used during cable installation can cause localized short-term impacts, including habitat alteration, injury, and mortality, on benthic resources through seabed profile alterations, as well as impacts through the sediment deposition and burial IPF. The level of impact from seabed profile alterations would depend on the time of year that such alterations occur, particularly in nearshore locations, and especially if they overlap with times and places of high benthic organism abundance. Locations, amounts, and timing of dredging for future offshore wind projects are not known at this time. The need for dredging depends on local seafloor conditions, assuming the area of such impacts is proportional to the length of cable installed. Dredging typically occurs only in soft-bottoms habitats, which are abundant in the geographic analysis area and quick to recover from disturbance, although full recovery of the benthic faunal assemblage may require several years (Boyd et al. 2005). Mechanical trenching, used in more resistant sediments (e.g., gravel, cobble), causes seabed profile alterations during use, although the seabed is typically restored to its original profile after utility line installation in the trench. Therefore, seabed profile alterations, while locally intense, would have little impact on benthic resources in the geographic analysis area.

Cable emplacement and maintenance activities (including dredging) in or near the geographic analysis area during construction or maintenance of future offshore wind projects could cause sediment suspension for 1 to 6 hours at a time, after which the sediment is deposited on the seafloor (COP Appendix III-A; Epsilon 2023). Sediment deposition can have adverse impacts on benthic resources, including smothering. Benthic organisms' tolerance to being covered by sediment (sedimentation) varies among species. The sensitivity threshold for sediment deposition in demersal eggs (such as fish or squid eggs) is greater than 0.04 inch (1 millimeter) (Berry et al. 2011); the sensitivity threshold for shellfish varies by species but can be generalized as deposition greater than 0.79 inch (20 millimeters) (Colden and Lipcius 2015; Essink 1999; Hendrick et al. 2016). Smit et al. (2008) evaluated the significance of depositional thickness on impacts on benthic communities. Estimates from that study indicated median (50 percent) and low (5 percent) impact levels of 54 millimeters and 6.3 millimeters (2.1 and 0.2 inches) of sediment deposition, respectively. That is, 54 millimeters is the thickness estimated to affect 50 percent of the benthos in the study, and 6.3 millimeters affected 5 percent of the studied benthos.

The level of impact from sediment deposition and burial could depend on the time of year that it occurs, especially if it overlaps with times and places of high benthic organism abundance. Cables for other future offshore wind projects in the geographic analysis area would be emplaced between 2023 and 2030 and beyond (Appendix E). Locations, amounts, and timing of dredging for future offshore wind projects are not known at this time. Assuming the area of such impacts is proportional to the length of cable installed, increased sediment deposition may occur during multiple years. The area with a greater sediment deposition from simultaneous or sequential activities would be limited, as most of the impacted areas would only have relatively light sediment deposition (less than 0.04 inch [1 millimeter]) and would recover naturally in the short term. If any dredged material disposal during construction occurs in the geographic analysis area, the activity would cause localized, temporary turbidity increases and sediment deposition or burial of benthic organisms at the immediate disposal site. The impacts of sediment deposition and burial on benthic resources within the geographic analysis area would be greater if sensitive habitats are not avoided.

Climate change: Benthic resources may be affected by climate change, including ocean acidification and warming, sea level rise, and altered habitat/ecology. Ocean acidification caused by atmospheric carbon dioxide (CO_2) may contribute to reduced growth or the decline of benthic resources with a calcareous structural component (Hoegh-Guldberg and Bruno 2010; PMEL 2020). Examination of 20 years (1990 to 2010) of occurrence and abundance data of soft-bottom benthic invertebrates along the Atlantic coast of the United States showed range shifts, most notably to the north, in response to rising water temperatures, resulting in changes to benthic community structure and function (Hale et al. 2017). Warming of ocean waters is expected to influence the distribution and migration of benthic resources and may influence the frequencies of various diseases (Brothers et al. 2016; Hoegh-Guldberg and Bruno 2010). Temperatures are predicted to continue to rise in the region, so these trends associated with warmer seawater is likely to continue, leading to changes in the distributions of some benthic species (Powell et al. 2020). Impacts on benthic resources through this IPF would be practically the same in the expanded planned activities scenario as they would be with only ongoing activities. See Section G.2.1, Air Quality, for details on the expected contribution of offshore wind development to climate change. Climate change is having notable and measurable impacts on regional benthic resources.

Discharges/intakes: Alternative A would increase the potential for discharges from vessels during construction, operations, and decommissioning. Offshore permitted discharges would include uncontaminated bilge water and treated liquid wastes. Discharges would particularly increase during construction and decommissioning, and the discharges would be staggered over time and localized. No available evidence indicates that the anticipated volumes and extents of discharges would affect benthic resources.

Electromagnetic fields (EMF): EMF, principally magnetic fields, would emanate from operating offshore wind facility transmission cables and existing cables connecting Nantucket and Martha's Vineyard to mainland Massachusetts. Under Alternative A, up to 1,253 miles of offshore export, inter-array, and inter-link cables would be added by projects in the RI/MA Lease Areas (except for the proposed Project), resulting in EMF in the immediate (less than approximately 33 feet) vicinity of each cable (CSA Ocean Sciences Inc. and Exponent 2019). Submarine power cables in the geographic analysis area are assumed to be installed with appropriate shielding and burial depth to reduce potential EMF to very low levels. Wherever a cable is not buried or is closer to the aerobic surficial sediments (i.e., with shallow burial), the exposure of benthic resources to magnetic fields may be stronger. EMF of any two sources would not overlap because developers typically allow at least 330 feet between cables (even for multiple cables within a single OECC), EMF strength diminishes rapidly with distance, and detectable, potentially meaningful EMF would likely extend less than 50 feet from each cable (McCormick et al. 2008). Some benthic species can detect EMF, although EMF from direct current (DC) or AC cables does not appear to present a barrier to animal movement (Hutchison et al. 2018). Burrowing infauna may be exposed to stronger EMF, but little information is available regarding the potential consequences. For example, BOEM's search of the available literature revealed no documented long-term impacts from EMF on clam habitat as a result of the existing power cables connecting Nantucket Island to mainland Massachusetts. There is little to no information on the EMF sensitivity of any taxa that are not commercially important. EMF at the levels expected from marine renewable energy activity is considered unlikely to impact receptive species (Copping et al. 2016; CSA Ocean Sciences Inc. and Exponent 2019; Gill and Desender 2020).

During operations, powered transmission cables would produce heat (Taormina et al. 2018). Studies of heat from buried cables have estimated that temperatures directly above a cable could rise by approximately 0.3 degrees Fahrenheit [°F]) in sediment and by 0.00001 °F in the water, which is insignificant (RI-CRMC 2010) and not anticipated to affect benthic fauna (Taormina et al. 2018).

Noise: Noise from construction, pile driving, geological and geophysical (G&G) survey activities, operations, and trenching/cable burial could contribute to impacts on benthic resources. The most impactful noise is expected to result from pile driving, which would occur during installation of foundations for offshore structures. This noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or 4 to 6 hours per day for the installation of two foundations per day. One or more projects may install more than one foundation per day, either sequentially or simultaneously. Construction of offshore wind facilities in the geographic analysis area would likely occur from 2023 through 2030 and beyond, and pile-driving may occur year-round (excluding January through April). Little current research exists regarding the impacts of and sensitivity of benthic resources to underwater noise, including both sound pressure and particle motion (Roberts et al. 2016a; Roberts and Elliott 2017; Popper and Hawkins 2018). Nonetheless, marine invertebrates are expected to be sensitive to underwater noise and vibrations and may experience behavior changes, signs of physiological stress, injury, or mortality when noise or vibration levels exceed background levels such as in the presence of pile driving (Nedelec et al. 2014; Solan et al. 2016; Roberts and Elliott 2017). Noise transmitted through water and/or through the seabed is assumed to have the potential to cause injury and/or mortality to benthic resources in a limited area around each pile and cause short-term stress and behavioral changes to individuals over a greater area. The extent of these impacts would depend on pile size, hammer energy, and local acoustic conditions, as well as benthic resource sensitivity, which is unknown. The affected areas would likely be recolonized in the short term. Noise from pile driving that causes behavioral changes could affect the same populations or individuals multiple times in a year or in sequential years. The difference in impacts on benthic faunal resources between sequential or concurrent pile driving is unknown.

Noise from G&G surveys of cable routes and other site characterization surveys for offshore wind facilities could also disturb benthic resources in the immediate vicinity of the investigation and cause temporary behavioral changes. G&G noise would occur intermittently from 2023 through 2030 and beyond. G&G noise resulting from offshore wind site characterization surveys is less intense than G&G noise from seismic surveys used in oil and gas exploration; while seismic surveys create high-intensity impulsive noise to penetrate deep into the seabed, offshore wind site characterization surveys typically use sub-bottom profiler technologies that generate less-intense sound waves for shallow penetration of the seabed. Seismic surveys are not expected in the geographic analysis area for benthic resources. Detectable impacts of G&G noise on benthic resources would rarely, if ever, overlap from multiple sources but may overlap with behavioral impacts of pile-driving noise. Overlapping sound sources are not anticipated to result in a greater, more intense sound; rather, the louder sound prevents the softer sound from being detected.

Noise from trenching/cable burial and construction activities other than pile driving are expected to occur but would have little impact on benthic resources. Noise from trenching of inter-array and export cables would be temporary, local, and extend only a short distance beyond the emplacement corridor. Impacts of trenching noise are typically less prominent than the impacts of the physical disturbances discussed under cable emplacement and maintenance and sediment deposition and burial IPFs. Noise from construction activities other than pile driving may occur; however, little of that noise propagates through the water, and it would not be likely to cause any detectable impact on benthic resources.

Port utilization: Increases in port utilization due to other offshore wind projects would lead to increased vessel traffic. At least two projects are contemplating use of expanded or modified ports in Vineyard Haven, New Bedford, and Montauk. It is likely that other east coast ports will be upgraded with some expansion attributable to supporting the offshore wind industry. The increase in vessel traffic associated with offshore wind would be at its peak during construction activities, would decrease during operations, and would increase again during decommissioning. In addition, any port expansion and construction activities related to the additional offshore wind projects would add to the total amount of disturbed benthic area, resulting in mortality of individuals and temporary to permanent habitat alteration. Future port projects would likely implement BMPs to minimize impacts (e.g., stormwater management, turbidity curtains). Impacts on benthic resources would likely be undetectable outside the immediate vicinity of port expansion activities, except near Vineyard Haven, which is within the geographic analysis area.

Presence of structures: The presence of structures from future offshore wind projects can affect benthic resources through entanglement and gear loss/damage, hydrodynamic disturbance, fish aggregation resulting in increased predation on benthic resources, and habitat conversion. These impacts may arise from foundations, scour/cable protection, buoys, and met towers. Future offshore wind projects within the geographic analysis area would include up to 681 WTG and ESP foundations, 1,954 acres of new scour protection for foundations, and 233 acres of hard protection for cables (Appendix E). In the geographic analysis area, structures are anticipated predominantly on the sandy bottom, except for cable protection, which is most likely to be needed where cables pass through hard-bottom habitats. Projects may also install more buoys and met towers. Structures would be added intermittently from 2023 through 2030 and remain until decommissioning of each facility is complete. The potential locations of cable protection for future actions have not been determined at this time. Although the glacial moraine and till that broadly extends from Montauk through Block Island, Martha's Vineyard, and Nantucket exhibits areas of gravel, cobble, and boulders, large hard structure (greater than 3 feet high) is rare in the geographic analysis area, primarily limited to a few rock outcrops (e.g., Spindle Rock) and human-made piles near shore; therefore, structure additions by future offshore wind activities would constitute a large change to the regional amount of large hard structures present.

The presence of structures would increase the risk of gear loss/damage by entanglement. The lost gear, moved by currents, could disturb, injure, or kill benthic resources. The intermittent impacts at any one location would likely be localized and short term, although the risk of occurrence would persist as long as the structures are present.

Human-made structures, especially tall vertical structures such as foundations, alter local water flow (hydrodynamics) at a fine scale. The consequences for benthic resources of such hydrodynamic disturbances are anticipated to be undetectable to small, localized, and to vary seasonally. Specifically, the bed material found in the southern New England area is made up of coarse substrates such as pebbles, shells, and gravel, and local currents can move grain sizes on the order of 1 to 1.5 millimeters (0.04 to 0.05 inch), which is smaller than the average local substrate. Addition of foundation from offshore wind structures was found to change the grain size that can be moved by +/- 0.3 millimeter (0.01 inch). Therefore, the predominant seabed sediments in the area would likely not be affected by the changes in the bed shear stress in average conditions due to the introduction of the offshore wind structures (Johnson et al. 2021).

Structures, including tower foundations, scour protection around foundations, and various means of protection atop cables create hard substrate with vertical relief in a mostly sandy seascape. Structure-oriented fishes would be attracted to these locations, which create reef-like habitats (Mavraki et al. 2021; Li et al. 2023). Increased predation upon benthic resources by structure-oriented fishes could affect benthic communities in the immediate vicinity of the structure. Additionally, the structures associated with future offshore wind projects may influence the conduct of fishing using bottom-tending gear within the geographic analysis area. The presence of wind farm structures may preclude use of towed bottom-tending gear (e.g., dredges, trawl nets) and could lead to increasing fishing pressure elsewhere (Section 3.9; Dannheim et al. 2020). These impacts are expected to be local and present as long as the structures remain.

The presence of structures would result in new hard surfaces that provide new habitat for hard-bottom species (Daigle 2011), including blue mussels and sea anemones, as seen at the Block Island Wind Farm (HDR 2020a; Kerckhof et al. 2019). The long-term cumulative impacts of these changes on marine biodiversity remain largely unknown. Offshore wind structures can span the entire water column and introduce intertidal habitat where previously there was none. These new surfaces could also be colonized by invasive species (e.g., certain tunicate species) found in hard-bottom habitats on Georges Bank (USGS 2004). Soft bottom is the dominant habitat type in the region, and species that rely on this habitat would not likely experience population-level impacts (Greene et al. 2010; Guida et al. 2017; Li et al. 2023). The potential impacts of wind farms on offshore ecosystem functioning have been studied using simulations calibrated with field observations (Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019; Li et al. 2023). These studies found increased biomass for benthic fish and invertebrates and indicate that offshore wind farms can generate beneficial impacts on the local benthic communities (Li et al. 2023).

Although it was generally believed that the loss of soft-bottom habitat may be adverse, this is a topic ongoing research. The presence of structures would effectively convert the existing sand-bottom habitats at these locations into a hard-bottom habitat. Additionally, ecological succession typically leads to changes in the community over time; in particular, new hard habitat related to offshore wind structures has been observed to initially exhibit high diversity, but to transition to low-diversity communities dominated by blue mussels and anemones after a few years (Kerckhof et al. 2019). These changes resulting from structure introductions and the loss of soft-bottom habitat may have impacts on benthic resources. The impacts on benthic resources would be present as long as the structures remain. A recently published study by Li et al. (2023) found that the artificial reef effect from wind farms in the North Sea could lead to a doubling of species richness and an increase of species abundance by up to two orders of magnitude. Although many wind farms within the North Sea prohibit bottom trawling, the conclusions on the results of trawling avoidance benefits remain inconclusive (Li et al. 2023). Li et al. concluded there are no net adverse impacts during the operation of a wind farm on the benthic communities that previously inhabited the sand bottom.

Ongoing commercial and recreational regulations for finfish and shellfish implemented and enforced by Massachusetts, towns, and/or NOAA, depending on jurisdiction, affect benthic resources by modifying the nature, distribution, and intensity of fishing-related impacts, including those that disturb the seafloor (e.g., trawling, dredge fishing). Offshore wind development could influence these regulated activities, possibly indirectly influencing when, where, and to what degree fishing activities affect benthic resources (Section 3.9). Fishing, in particular the use of bottom-tending gear, would impact benthic resources where such activities are permitted to occur.

Conclusions

Impacts of Alternative A. Under Alternative A, benthic resources would continue to follow the current regional trends described in Section 3.4.1 and 3.4.2.1 and respond to both ongoing and future offshore wind activities.

While the proposed Project would not be built under Alternative A, ongoing activities would have continuing temporary to permanent impacts (disturbance, injury, mortality, habitat degradation, habitat conversion) on benthic resources primarily through anchoring and gear utilization, cable emplacement and maintenance, pile-driving noise, the presence of structures during operations of future offshore facilities (i.e., cable protection and foundation scour protection), port utilization near Vineyard Haven, climate change, and ongoing seafloor disturbances caused by sediment dredging and fishing using bottom-tending gear. Throughout the geographic analysis area for benthic resources, the impacts of ongoing activities, especially seafloor disturbances caused by sediment dredging and fishing using bottom-tending gear, would be moderate. Planned activities other than offshore wind including increasing vessel traffic; increasing construction; marine surveys; marine minerals extraction; port expansion; channel deepening activities; and the installation of new towers, buoys, and piers would result in minor impacts. The combination of ongoing and planned activities would result in **moderate** impacts on benthic resources, primarily driven by ongoing dredging and fishing activities. **Moderate** beneficial impacts could occur from increasing biomass of benthic fish and invertebrates due to the presence of structures.

Cumulative Impacts of Alternative A. Under Alternative A, existing environmental trends and ongoing activities would continue, and benthic resources would continue to be affected by natural and human-caused IPFs. Planned activities, including offshore wind would contribute considerably to several IPFs, primarily cable emplacement and maintenance and the presence of structures, namely foundations and scour/cable protection. BOEM anticipates that the cumulative impacts of Alternative A would result in **moderate** adverse impacts. Studies have shown increased biomass for benthic fish and invertebrates associated with offshore wind on the local benthic communities could potentially generate **moderate** beneficial impacts.

3.4.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following primary proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on benthic resources:

- The number of vessels used during construction, operations, and decommissioning would potentially increase the risk of various IPFs (e.g., anchoring and gear utilization, accidental releases), resulting in increased potential impacts on benthic resources.
- The number of WTGs and ESPs and the amount of cable laid determines the area of seafloor disturbance and benthic resource exposure from installation. The area affected by WTGs is proportional to the number of WTGs installed. The benthic resources affected could differ depending on where the WTG and ESP are positioned within the geographic analysis area.
- Cable installation methods chosen, the amount of dredging, the duration of installation, and the chosen export cable routes (including variants within the OECC) would determine the type and number of benthic resources affected.
- Foundation type(s) used—namely monopiles, jackets, and bottom frame foundations (for Phase 2 only)—would change the level of benthic disturbance.
- The amount of scour/cable protection for the foundations, inter-array cables, and offshore export cables would alter the total amount of long-term habitat alteration. Less scour/cable protection would alter less habitat from soft-bottom to hard-bottom habitat.
- The time of year when foundation and cable installations occur can affect the level of benthic resource impacts. Potential impacts would have a greater magnitude if installation activities coincided with sensitive life stages for benthic organisms. Construction outside of the spring to summer window may have a lesser impact on benthic resources.

3.4.2.3 Impacts of Alternative B – Proposed Action on Benthic Resources

This section identifies the potential impacts of Alternative B on benthic resources. When analyzing the impacts of Alternative B on benthic resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for benthic resources. Except where otherwise stated, the impacts of Phase 1 decommissioning would be similar to those for Phase 1 construction for all of the IPFs described below.

Impacts of Phase 1

Construction of Phase 1 would affect benthic resources through the following primary IPFs during construction, operations, and decommissioning.

Accidental releases: As discussed in Section 3.4.2.1, non-routine events such as hazardous materials spills can have adverse or lethal impacts on marine life, including benthic resources. The risk of any type of accidental release would be increased primarily during construction or decommissioning but may also occur during operations of offshore wind facilities. Hazardous materials consist primarily of fuels, lubricating oils, and other petroleum compounds that tend to float in seawater; consequently, they are unlikely to contact benthic resources in most cases. For example, spills of sufficient size to reach shore could affect intertidal and shallow subtidal benthic resources via adsorption and sinking. Small spills would likely be unmeasurable and have a negligible impact on benthic resources. A large spill is unlikely, given the fuel storage capacities of proposed Project vessels and the safeguards to prevent spills from the WTGs, along with cleanup measures in place should a large spill occur, but could have a more significant impact on benthic resources due to impacts on water quality (Section G.2.2, Water Quality) and the potential for sinking and subsequent exposure of benthic resources.

Accidental releases of trash and debris are discussed in Section 3.4.2.1. Phase 1 construction would likely have no impact on benthic resources through the accidental release of trash and debris. In addition, accidental releases of invasive species could affect benthic resources if the invasive species become(s) established and out-compete(s) native fauna; the risk of this type of release would be increased by the additional vessel traffic associated with Phase 1 during construction. The potential impacts on benthic resources are described in Section 3.4.2.1. The increase in the risk of accidental releases of invasive species attributable to Phase 1 construction would be small in comparison to the risk from ongoing activities.

The risk of accidental releases of oil or chemical spills from monitoring and maintenance vessels is lower during operations due to the reduction of vessels used for this stage, compared to the construction or decommissioning stage. Small spills would likely be unmeasurable and have a negligible impact on benthic resources. A large spill is very unlikely given the fuel storage capacities of proposed Project vessels but could have a more significant impact on benthic resources due to impacts on water quality (Section 3.4.2.1), the potential for sinking within shallow marine benthic environments, and high-volume direct contact with fouling communities.

The impacts of accidental releases during Phase 1 decommissioning would be similar to construction: localized, temporary, and negligible.

Anchoring and gear utilization: Monitoring survey methods for Alternative B may include video, multibeam bathymetry, and grab sampling. As described in Section 3.4.2.1, survey gear could affect benthic resources through seafloor disturbance. Because the applicant would develop monitoring plans in coordination with BOEM, other federal and state agencies, other offshore wind developers, and other stakeholders (COP Volume I, Section 4.1.3; Epsilon 2023), BOEM assumes that survey procedures would have sufficient mitigation procedures in place to reduce potential impacts including, but not limited to, avoidance of sensitive benthic habitats. Therefore, impacts on benthic resources from monitoring surveys would be negligible based upon the limited extent and frequency of surveys and the short duration of sampling events.

Construction would be conducted from vessels utilizing spuds, jack-up legs, anchors, dynamic positioning, and securing to existing structures; therefore, limited anchoring would occur. The amount of seabed disturbance from jack-up, anchored vessels, cable installation, and metocean buoy anchors would be up to 421 acres as stated in the COP (Volume III, Section 6.5.2.1.1). The potential impacts on benthic resources from anchors, anchor drag, and rigging (chains, cables, ropes), nearshore intentional vessel groundings, spuds, or jack-up vessels include crushing of benthic fauna and disturbance of physical habitat structure. Impacts on benthic resources are greatest for sensitive benthic habitats (e.g., eelgrass beds, hard-bottom habitats). As discussed in Section 3.4.2.1, degradation of sensitive habitats, such as eelgrass beds and hard-bottom habitats, if it occurs, could be long term to permanent. Therefore, these sensitive habitats would be avoided where possible during construction. The relatively limited extent and spatial discontinuity of impacts from anchoring and gear utilization within the geographic analysis area is estimated to be minor on benthic resources if sensitive habitats are avoided and moderate if sensitive habitats are not avoided. The impacts of anchoring during Phase 1 decommissioning would be similar to construction: minor to moderate.

Cable emplacement and maintenance: Despite unavoidable mortality, injury/damage, or displacement of benthic invertebrate organisms, the area affected by the 278 acres of temporary cable emplacement footprint in the offshore proposed Project area (COP Volume III, Appendix III-T; Epsilon 2023) would be 0.2 to 0.3 percent of the SWDA (101,590 to 111,939 acres). The SWDA is comprised entirely of unconsolidated substrate, predominantly sand and mud (soft bottom). The seafloor would be disturbed by cable trenches, skid tracks, and spud prints. Although active construction would temporarily disturb benthic habitat, non-complex habitats would rapidly return to pre-Project conditions following impacts from burial. Although the recovery times for benthic communities vary, the available evidence indicates that recovery of benthic habitats would begin quickly and likely be relatively rapid (Degraer et al. 2020; Hutchison et al. 2020a; Boyd et al. 2005), but full recovery of the community can take years, especially in sensitive or complex habitats (Tamsett et al. 2010). The fine- and medium-grained sand of the SWDA provides uniform and simple (non-complex) habitat for benthic infaunal organisms typical of this region. Sand waves are present in the OECC (COP Volume III, Section 6; Epsilon 2023), and disturbance of sand waves would be temporary, given that sand waves are ephemeral, mobile features. Complex habitats may take longer to recover but would still recover completely (HDR 2020a). The impacts would likely be short term, considering the natural mobility of sand in the SWDA and OECC, although full recovery of the benthic faunal assemblage may require several years (Boyd et al. 2005). Population-level impacts are not expected to occur for benthic species (i.e., generally accepted ecological and fisheries methods would be unable to detect a change in population) as a result of Phase 1. Neighboring benthic communities that have similar habitats and assemblages would colonize disturbed areas over time that have not been displaced by new structures.

The cable would be buried using a jet trench, trench former, chain cutting, hydroplow, mechanical trenching plow, or a mechanical cutter to create a trench along the seabed; all are mechanisms in which the cable is simultaneously laid and buried in a single pass. Cable burial would result in an increase in suspended sediments and an increase in the water content of seafloor sediments (i.e., the ratio of liquid to solid mass) within the trench. Predictive modeling indicates that most of the sediments settle out quickly and are not transported for long by the currents (COP Volume III, Appendix A; Epsilon 2023). Sediment deposition greater than 1 millimeter is generally confined within 328 to 492 feet of the installation alignment with maximum deposition usually less than 5 millimeters (COP Volume III, Appendix A; Epsilon 2023). In areas where displaced sediment results in thick deposition, organisms may be smothered, which would result in mortality. Smit et al. (2008) evaluated the significance of depositional thickness on benthic community impacts with median (50 percent) and low (5 percent) effect levels of 54 millimeters and 6.3 millimeters of sediment deposition, respectively. Since most benthic resources in the geographic analysis area are adapted to the turbidity and periodic sediment deposition that occurs naturally, impacts on benthic resources would be minor.

As the export cables approach the shoreline, the ocean-to-land transition at the selected landfall sites would be made using HDD, which would avoid or minimize impacts on the beach, intertidal zone, and nearshore areas and achieve a burial significantly deeper than any expected erosion. Therefore, negligible impacts on benthic resources would occur from the landfall transition.

Actual water withdrawal volumes associated with jet plowing were not provided in the COP, but Cape Wind estimated a standard jet plow withdraws 4,500 gallons of water per minute and moves on average 300 feet per hour (USDOI and MMS 2009), and the South Fork Wind Project performed an entrainment study that estimated 6,000 gallons of water withdrawal per minute (BOEM 2021c). Using the Cape Wind withdrawals, this would result in average daily (24 hours) water withdrawals of 6,480,000 gallons, and using the South Fork Wind withdrawals, this would result in 8,640,000 gallons for conventional jet plowing. By contrast, the stationary water withdrawal from the previous Brayton Point station resulted in the annual mortality of at least 16 billion fish eggs and larvae annually (Saila et al. 1997). Therefore, the loss of adults based on proposed Project-related water withdrawal activities would be negligible due to the rate of survival of many of the local species.

During cable emplacement and installation, pre-construction grapnel runs would extend beyond the area affected by cable emplacement, which could lead to short-term impacts including habitat alteration, injury, and mortality. Much of the offshore proposed Project area is characterized as unconsolidated soft sediment arranged in waves, megaripples, and ripples, with some isolated patches of mud and gravel. These features would temporarily be disturbed by pre-construction grapnel runs; seabed preparation; possible sand wave dredging; foundation placement; scour protection installation; anchoring, clearing, and trenching for offshore export and inter-array cable installation; and cable protection activities. Sand ripples and waves disturbed by offshore export and inter-array cable installation would naturally reform within days to weeks under the influence of the same tidal and wind-forced bottom currents that formed them initially (Kraus and Carter 2018). The seabed profile alterations are expected to recover without mitigation; therefore, the impacts would be minor.

At locations with large sand waves, dredging may be necessary to allow the offshore export cable to be buried in stable seabed. The applicant anticipates that, where necessary, dredging would occur within a corridor that is 50 feet wide at the top of the sand wave, with side slopes of approximately 1:3, and a depth averaging approximately 1.6 feet and a maximum depth of up to 17 feet. If needed, a TSHD would remove sediment using suction, store the sediment in a hopper, and dump the sediment in piles on the seafloor at a different place within the OECC, several hundred yards away from the dredged area. In the maximum-case scenario, the use of dredging for Phase 1 could affect up to approximately 67 acres of bottom habitat. If use of a TSHD is required during export cable installation, the applicant may be required to obtain a Marine Protection, Research, and Sanctuaries Act Section 103 permit from USACE to identify specific dumping locations for dredge material and the potential impacts of disposing dredge material in those locations. Under Section 103 of the Marine Protection, Research, and Sanctuaries Act, USACE regulates the transportation of dredged material for purposes of dumping it into ocean water. At this time, the potential for use of a TSHD is low, and the applicant is not currently pursuing a Section 103 permit. Should the applicant determine the definitive need for the use of a TSHD during export cable installation, the applicant will coordinate with USACE regarding Section 103 permitting and supplemental NEPA review, as applicable, prior to conducting dredging activities as part of export cable installation. Considering the area affected in relation to the expanse of surrounding sand wave habitat, impacts would likely be minor.

Overall, the impacts from cable emplacement and maintenance are expected to be notable and measurable, but resources would recover completely without remedial or mitigation action; impacts on benthic resources from the proposed Project are, therefore, expected to be minor if sensitive habitats are avoided and moderate if sensitive habitats are not avoided.

Although construction would have the greatest impact on benthic resources, the maintenance of these cables would also result in potential impacts, specifically when cable repairs are required or cable protection is added. Cable protection would be needed where cable burial desired depth is not feasible. Methods of cable protection would include rocks, gabion rock bags, or concrete mattresses. The applicant estimates approximately 6 percent of the offshore export cables and approximately 2 percent of inter-array and inter-link cables would require cable protection due to insufficient burial depth, totaling approximately 35 acres of hard protection. Recovery rates of these disturbed surfaces would depend on the species present and their recovery capabilities and would result in minor to moderate impacts depending on the location of the maintenance. The impacts of cable removal during Phase 1 decommissioning would be similar to construction: minor to moderate.

Climate change*:* The surveying, construction, and decommissioning activities associated with Phase 1 would produce GHG emissions that can be assumed to contribute to climate change; however, these contributions would be minute (i.e., 6,990 metric tons) compared with aggregate global emissions. The impact of GHG emissions on benthic resources from the proposed Project would not be detectable and would, therefore, be negligible.

Phase 1 operations would marginally reduce or displace emissions from conventional power generation, thereby contributing to slowing or arresting global warming and associated climate change and having a long-term and negligible beneficial impact on benthic resources. Other future offshore wind projects would have similar beneficial impacts but on a larger scale (although the combined offshore wind projects would still displace a small share of global emissions). The impacts of Phase 1 decommissioning on GHGs would be similar to construction: temporary and negligible.

Discharges/intakes: The increase in vessel traffic for construction and increases the volume of discharges to the receiving waters, including bilge, wastewater, ballast, deck drainage, fire suppression system test water, condensate, and seawater cooling effluent, among others. This increase in discharges for Phase 1 activities is not anticipated to affect benthic resources and would have negligible impacts. Similarly, impacts from discharges and intakes during Phase 1 operations and decommissioning would have negligible impacts on benthic resources.

EMF: As discussed in Section 3.4.2.1, EMF production during the operation of power transmission cables can be detected by some benthic species but does not appear to present a barrier to movement. EMF impacts would be minimized by burying cables to the target depth of 5 to 8 feet below the seafloor. Little is known about the potential impacts of EMF; however, a few recent studies have focused on marine invertebrates. Albert et al. (2022) found no differences in valve activity or filtration rates (suggesting no hindrance of feeding behaviors) in adult blue mussels exposed to high-voltage DC of 300 microteslas (μT) compared to the control. Significantly lower filtration rates were found in lagoon cockles (*Cerastoderma glaucum*) that were exposed to 6,400 μT for 8 days (Jakubowska-Lehrmann et al. 2022). No changes in the respiration were noted, but ammonia excretion rates were significantly lower after exposure to EMFs. Modeling of proposed Project-specific cables was conducted to assess the potential impacts of EMF. Modeling of the 220 and 275 kV high-voltage AC cables demonstrated that magnetic fields at the seafloor from the buried cables decrease with distance, with a maximum magnetic field of 84.3 milligauss (8.43 μT) directly above the centerline that decreases to 5.6 milligauss (0.56 μT) at 20 feet from the centerline (Gradient 2020, 2021). These model results indicate that magnetic fields are likely only able to be sensed, if at all, directly over the buried cable centerline. Consistent with the modeled magnetic field levels and the findings on 60 hertz (Hz) AC EMF (CSA Ocean Sciences Inc. and Exponent 2019), and because cables in the proposed Project area would have a minimum target burial depth of approximately 5 feet, it is unlikely that benthic organisms would be affected by EMFs from the offshore cable system. Therefore, the impacts on benthic resources from EMF would be negligible during operations.

Noise*:* Phase 1 would result in construction-related noise from G&G surveys, vessel traffic, WTG installation, pile driving, and cable burial. The nature of these sub-IPFs and of their impacts on benthic resources are described in Section 3.4.2.1. Usual noise-producing activities under Alternative B include G&G survey activity, vessel activity, routine WTG operations, and vessel traffic. Some maintenance activities may require noise-producing equipment, though likely none greater than construction-level sounds. Phase 1 construction would produce noise from pile driving during installation of up to 64 foundations for approximately 2 to 3 hours per foundation or 4 to 6 hours per day for the installation of two foundations per day (COP Volume III, Section 6.3.7). This noise would occur intermittently for up to 62 days between May and December. Technical details related to pile-driving noise are analyzed for demersal and benthic fishes and commercially important invertebrates in Section 3.6. Limited research exists regarding the impacts of and sensitivity of benthic resources to underwater noise, including both sound pressure and particle motion. A recent summary of knowledge on how offshore wind activities affect the benthic environment indicated that the impact of sound on epibenthos is poorly understood and is generally lacking (Dannheim et. al. 2020). Popper and Hawkins (2018) describe that many acoustic studies only assess impacts from sound pressure and omit particle motion. At present, studies assessing the responses to particle motion and vibration from offshore wind on benthic or demersal species are lacking (Hogan et al. 2023). The oversight of the importance of particle motion increases the uncertainty in impact determination (Popper and Hawkins 2018). Marine invertebrates are likely sensitive to underwater noise and vibrations such as pile driving. Noise transmitted through water and/or the seabed is, therefore, assumed to have the potential to cause injury and/or mortality to benthic resources in a limited area around each pile and is assumed to cause short-term stress and behavioral changes to individuals over a greater area. Given that most benthic species in the region are either mobile as adults or planktonic as larvae, disturbed areas would likely be recolonized naturally. A recent study by van der Knaap et al. (2022) observed Atlantic cod (*Gadus morhua*) movement over a 4-month period where 50 monopile turbines were installed in the Belgian North Sea. The 14 tagged cod did not have an increase in their net movement as a result of nearby pile driving but did move closer to the scour-bed (hard substrate) and away from the sound source (van der Knaap et al. 2022). The long-term changes in energy expenditure from this movement will require further investigation.

The negligible (for most noises) to moderate (for pile-driving noise) impacts (disturbance, injury, and mortality) of Phase 1 on benthic resources would be in addition to the noise that would occur under Alternative A, which is expected to result in similar local temporary impacts. The most impactful noise is expected to come from pile driving.

The applicant is considering the use of a bubble curtain for far-field noise mitigation. The use of noise-reduction technologies during all pile-driving activities to achieve a minimum attenuation of 6 decibels (dB) would reduce the area of high noise levels during construction and subsequently minimize potential noise-related impacts on benthic resources. A bubble curtain system is a compressed air system (air bubble barrier) for sound absorption in water. Sound stimulation of air bubbles at or close to their resonance frequency effectively reduces the amplitude of the radiated sound wave by means of scattering and absorption effects. A bubble curtain functions as follows: air is pumped from a separate vessel with compressors into nozzle hoses lying on the seabed, and it escapes through holes that are provided for this purpose. Thus, bubble curtains are generated within the water column due to buoyancy. Noise emitted by pile-driving must pass through those ascending air bubbles and is attenuated. Bubble curtains are intended to minimize the potential impact of noise. However, the necessity of this mitigation for benthic resources is speculative since the impact of sound on epibenthos is poorly understood and generally lacking (Dannheim et al. 2020). The overall impact on benthic resources from pile-driving activities under Phase 1 is uncertain and conservatively expected to be moderate.

Noise from trenching/cable burial is expected to occur but would have limited impact on benthic resources. Noise from trenching/burial of inter-array and export cables would be temporary, local, and extend only a short distance beyond the emplacement corridor. Cable-laying and trenching noise is expected to have no measurable impacts on benthic resources; impacts are expected to be negligible.

Studies on potential impacts of turbine operational noise are ongoing. As measured at the Block Island Wind Farm, the low-frequency noise from WTG operation barely exceeds ambient levels at 164 feet from the WTG base (Thomsen et al. 2015). The continuous noise of turbine operation can shift in frequency depending on wind and rotation speed (Hogan et al. 2023). Cresci et al. (2023) studied behavioral impacts of continuous low- frequency (100 Hz) on the larvae of Atlantic cod in a fjord in Norway. They found that the sound exposure did not affect the swimming performance but may contribute to their orientation (Cresci et al. 2023). The significance of this adaptive larval orientation will require further investigation.

Noise impacts from Phase 1 decommissioning would be similar to construction, except that decommissioning would not involve pile driving. As a result, noise impacts during decommissioning would be moderate.

Port utilization: Because Phase 1 would cause no change in port utilization other than increased vessel traffic and use of already existing ports, Phase 1 port utilization would have negligible impacts on benthic resources during construction, operations, and decommissioning. Port facilities and staging areas are discussed further in Section G.2.7, Land Use and Coastal Infrastructure.

Presence of structures: The presence of structures can lead to impacts on benthic resources primarily through hydrodynamic disturbance, habitat conversion, entanglement and gear loss/damage, and displacement of fishing pressure. Phase 1 could result in up to 64 foundations (up to 2 of which would be ESPs, with the remainder for WTGs) foundations, up to 74 acres of foundations and scour protection, and up to 13 acres of cable protection that could cause temporary to permanent impacts, as discussed in Section 3.4.2.1. Up to approximately 6 percent of the offshore export cable in the OECC and 2 percent of the export cables in the SWDA would be covered with cable protection material to ensure that they remain covered during storms and other events that disturb the seafloor (COP Volume III, Section 2.2.1; Epsilon 2023).

Tall vertical structures, such as wind turbines, extract kinetic energy from the atmosphere, which can lead to changes in atmospheric patterns. Many of the past studies modeling atmospheric wakes incorporate data inputs from European ecosystems for the purposes of designing WTG layout and predicting potential scour. At a regional scale, if turbine spacing is close enough to create a cumulative impact, then wind wake impacts can lead to reduced wind stress and wave energy downwind with upwelling or downwelling dipoles as the edges of the wake (van Berkel et al. 2020). Christiansen et al. (2022) found that the sea level alterations in the North Sea wind farms did form dipoles at a large scale that can trigger lateral and vertical changes in water temperature and salinity distributions, but the magnitude of these changes is small and indistinguishable from the interannual variability.

Human-made structures, including wind turbines alter local water flow (hydrodynamics) at a fine scale (Johnson et al. 2021). BOEM conducted a modeling study to evaluate how wind farms can affect seasonal stratification patterns (Johnson et al. 2021). The model results suggest that offshore wind projects have the potential to alter local and regional physical oceanic processes (e.g., currents, temperature stratification) via their influence on currents from WTG foundations. However, the alterations are unlikely to be significant for water column stratification and larval dispersal patterns (Johnson et al. 2021). This study only considered two of the several wind energy areas within the region, so the potential impacts from the maximum-case scenario may provide differing results. The turbines reduce the current force, magnitude, and wave height, all while creating downstream wake (Johnson et al. 2021). van Berkel et al. (2020) conducted a synthesis of European studies and the implications for fishes. The study concluded that investigations of abundance and diversity were challenging in terms of distinguishing the wake impacts from the natural spatiotemporal variability (van Berkel et al. 2020). On a local scale, changes in nutrient upwelling and related primary productivity were observed, along with chlorophyll profiles and the demersal community structure near the turbines (less than approximately 164 feet [50 meters]). However, at a larger scale (greater than approximately 124 miles [200 kilometers]), these patterns do not stand out from a background of natural spatiotemporal variability (van Berkel et al. 2020). The overall impact on stratification is directly related to the scale of development (van Berkel et al. 2020; Carpenter et al. 2016). The introduction of nutrients from deep waters into the surface mixed layer can lead to a local increase in primary production (Floeter et al. 2017). These changes in the primary productivity are especially important with added structures, which provide new habitat for filter feeders such as blue mussels (Slavik et al. 2019).

European wind farms have served as the setting for many of the studies on ocean atmospheric interactions to date. Caution should be taken in extrapolating expected results to the Mid-Atlantic waters, as the environmental conditions are not equal. European wind farm facilities differ, as they are in shallower waters with weak seasonal stratification, in sheltered areas along the coasts, and are arranged with tight spacing of turbines (Lentz 2017; Hogan et al. 2023). Nevertheless, further investigations that incorporate the environment of the Mid-Atlantic OCS are necessary.

Once Phase 1 construction is complete, the presence of the WTG and ESP foundations would result in localized alteration of water column currents, which could produce sediment scouring and alter benthic habitats and dispersal patterns of planktonic larvae. However, the consequences of such hydrodynamic disturbances are anticipated to be countered by the placement of scour protection, resulting in negligible, localized, and seasonally variable impacts.

Phase 1 would alter the existing benthic habitat by adding hard surfaces, vertical relief, and habitat complexity, converting softbottom substrate to hardbottom substrate. Depending on the material used, the scour/cable protection could produce a reef effect that would support a succession of hardbottom benthic assemblages throughout the life cycle of the proposed Project in seafloor areas that are largely composed of unconsolidated sediments. As a byproduct of hardbottom community development, deposition of shell hash and other detritus is expected to build up around the monopile foundations (Causon and Gill 2018). Moreover, the presence of vertical structures in the water column creates turbulence that can transport nutrients upward toward the surface, increasing primary productivity at localized scales (Dannheim et al. 2020). These changes have been reported to increase food availability for filter feeders on and near the structures, which, in turn, leads to increased densities of mobile invertebrates (e.g., crabs, lobsters), attraction and diet modification of pelagic and demersal fish, and foraging opportunities for marine mammals (Coates et al. 2014; Dannheim et al. 2020; English et al. 2017). Conversely, these hard surfaces also provide additional attachment points for invasive species acting as stepping stones for range expansion, eliminate softbottom habitat, and create organic enrichment that can be detrimental if it occurs in oxygen deficient sediments (De Mesel et al. 2015; Wilding 2014). The presence of structures would increase long-term benthic habitat complexity for the duration of the proposed Project. The conversion of softbottom habitat to new hardbottom habitat from the placement of scour/cable protection would have a localized impact on softbottom communities, while hardbottom communities would benefit from the additional hard substrate. In general, this conversion of softbottom habitat to a more reeflike structure has potential moderate beneficial impacts on the surrounding biological community but also is expected to have moderate adverse impacts on the softbottom communities.

Regulated fishing can affect benthic resources by modifying the nature, distribution, and intensity of fishing-related impacts (mortality, bottom disturbance) (Tamsett et al. 2010; Kaiser et al. 2002, 2006; Collie et al. 2005). Phase 1 construction and structures could affect when, where, and to what degree fishing activities affect benthic resources. For example, potential displacement of towed bottom-tending gear (e.g., dredges, trawl nets) could result in localized recovery of benthic assemblages at a faster rate in soft-bottom sand habitats. However, recovery is expected to take longer in the complex or gravel habitats based on studies of the impacts within Georges Bank (Kaiser et al. 2002, 2006; Collie et al. 2005). Empirical studies of gravel habitat communities on the northeast peak of Georges Bank, subject to strong tidal currents and a well-mixed water column, have recovery times in excess of 10 years based on time-series monitoring (Collie et al. 2005; Tamsett et al. 2010). The changes in regulated fishing effort on benthic resources are uncertain but would likely result in moderate impacts on benthic resources, especially where bottom-tending gear is used. To the degree that offshore wind development results in regulatory exclusion of some currently fished areas from future fishing, Phase 1 would have moderate beneficial impacts on those areas.

The presence of structures would increase the risk of gear loss/damage by entanglement, as discussed in Section 3.4.2.1. The lost gear, moved by currents, could disturb, injure, or kill benthic resources. The intermittent impacts at any one location would likely be localized and short term, although the risk of occurrence would persist as long as the structures are present, resulting in minor impacts.

The presence of structures impacts from Phase 1 construction would have negligible to moderate impacts and moderate beneficial impacts on benthic resources. Currently, there is minimal large hard structure outside coastal zones, so the addition of structures from Phase 1 and other offshore wind projects would constitute a significant change to existing conditions. The structures and the consequential impacts would remain until decommissioning is complete.

The impacts of the removal of Phase 1 structures during decommissioning would be similar to construction: moderate and moderate beneficial where bottom-tending gear use was discontinued during operations.

Impacts of Phase 2

As described in this section, impact levels for Phase 2 are expected to be similar to those of Phase 1 (Section 3.4.4.1) due to the use of similar construction and decommissioning techniques.

Phase 1 and Phase 2 construction would each result in a similar number of vessels performing similar operations, construction methods, and component infrastructure. Phase 2 would include up to 89 foundations (up to 3 of which would be ESPs, with the remainder for WTGs), and could potentially use bottom-frame foundations for WTGs and ESPs (COP Volume I, Section 4.2.1; Epsilon 2023). As shown in Table C-3 in Appendix C, each bottom-frame foundation would require up to 1.7 acres of scour protection, compared to 1.2 acres for monopiles and 1.6 acres for each jacket foundation. As a result, Phase 2 impacts would be marginally larger than, but substantively similar to, those described for Phase 1 in Section 3.4.4.1.

If the applicant selects the SCV as part of the final Phase 2 design, some or all of the impacts on benthic resources from the Phase 2 OECC through Muskeget Channel may not occur,[18] while impacts along the SCV route would occur. The SCV would disturb up to 329 acres of seafloor, including approximately 41 acres of offshore export cable protection, but impacts would be localized, short term, and temporary. Based on available information, the impacts of SCV construction on benthic resources would be similar to those for the Phase 1 OECC and range from negligible to moderate; impacts would be largest if special benthic habitats such as EFH cannot be avoided. BOEM will provide a more detailed analysis of the SCV impacts on benthic resources in a supplemental NEPA analysis, if the SCV is selected.

Phase 2 operations would be similar to (and likely be combined with) Phase 1 and would, thus, result in negligible to minor impacts on benthic resources. Phase 2 decommissioning impacts are expected to be similar to those described for Phase 1 and would range from negligible to moderate.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-1 in Appendix G would contribute to impacts on benthic resources through the primary IPFs of anchoring and gear utilization, cable maintenance, noise, and the presence of structures. These impacts would primarily occur through bottom-disturbing activities that directly affect benthic resources. The cumulative impacts of all IPFs from ongoing and planned activities, including Alternative B, would be **moderate**, with a **moderate** beneficial impact from the presence of structures until decommissioning.

Conclusions

Impacts of Alternative B. Alternative B would have **moderate** impacts on benthic resources within the geographic analysis area based on all IPFs, as well as **moderate** beneficial impacts from the presence of structures. Alternative B would affect benthic resources by causing temporary habitat disturbance; permanent habitat conversion; and behavioral changes, injury, and mortality of benthic fauna. Impacts from Alternative B would include temporary and long-term consequences resulting from habitat

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[18] The applicant would be required to notify BOEM of a COP revision pursuant to 30 CFR § 585.634 if the applicant determines the SCV is necessary.

alteration, increased turbidity, sediment deposition, entrainment, increased noise, presence of structures, and EMF. The most prominent IPFs of Alternative B are expected to be cable emplacement and maintenance, presence of structures, noise (specifically from pile driving), and ongoing climate change (exclusive of Alternative B activities). In general, the impacts are likely to be local and not alter the overall character of benthic resources in the geographic analysis area. Despite mortality and temporary or permanent habitat alteration, the long-term impact on benthic resources from Alternative B would be moderate, as the impacts could be measurable on a site-level scale but not within the entire proposed Project area, and the resources would likely recover naturally over time. The applicant may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above but doing so would not likely result in different impact ratings than those described above.

Cumulative Impacts of Alternative B. The cumulative impacts on benthic resources within the geographic analysis area would be **moderate**, as well as **moderate** beneficial from the presence of structures and their potential reef effect. As with Alternative B alone, the most prominent IPFs for cumulative impacts would be cable emplacement and maintenance, presence of structures, noise (specifically from pile driving), and climate change. Cumulative impacts would only occur where the activities of Alternative B overlap with other ongoing or planned activities (i.e., within the SWDA and OECC).

3.4.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Benthic Resources

When analyzing the impacts of Alternative C on benthic resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for benthic resources. Alternatives C-1 and C-2, summarized below, would limit the number of export cables installed in the Eastern Muskeget route or Western Muskeget Variant but would not affect the number or placement of WTGs or ESPs for the proposed Project, compared to Alternative B. All other proposed Project components including construction, operations, and decommissioning would align with Alternative B:

- Alternative C-1 would avoid impacts on complex habitats in the Western Muskeget Variant by removing that route as an option for Phase 2. Under this alternative, all three Phase 2 cables would be installed in the Eastern Muskeget route.
- Alternative C-2 would limit the number of export cables installed in the Eastern Muskeget route to three (two for Phase 1 and one for Phase 2) and include installation of up to two cables in the Western Muskeget Variant. This would reduce impacts on complex habitats in the Eastern Muskeget route.

Alternatives C-1 and C-2 would reduce or avoid impacts on benthic resources (compared to Alternative B) during construction, operations, and decommissioning in either the Western Muskeget Variant or Eastern Muskeget route. This would reduce the impacts from IPFs for anchoring and gear utilization, cable emplacement and maintenance, noise, and presence of structures in the specific area avoided.

The Western Muskeget Variant would affect less seafloor acreage than the Eastern Muskeget route; however, the Western Muskeget Variant is comprised of complex seafloor only, while the Eastern Muskeget route is comprised of complex seafloor, hard coarse deposits, and soft bottom (Table 3.4-2).

Table 3.4-2: Maximum Acres of Benthic Habitat Type: Western Muskeget Variant and Eastern Muskeget Route

Benthic Habitat Type	Western Muskeget Variant (acres)	Eastern Muskeget Route (acres)
Complex seafloor	861.3	777.8
Hard coarse deposits	0.0	159.9
Soft bottom	0.0	94.9
Total	861.3	1,032.6

Alternative C-1 would use only the Eastern Muskeget route, which would eliminate the impacts on benthic resources in the Western Muskeget Variant. The Eastern Muskeget route contains more types of benthic habitat than the Western Muskeget Variant, but less of the benthic habitat is complex seafloor. Using only the Eastern Muskeget in Alternative C-1 would, therefore, affect more benthic habitat types and a wider variety of benthic species inhabiting these habitats than if the Western Muskeget Variant alone were used. However, Alternative C-1 would affect less of the complex benthic habitat compared to Alternative B (which includes the potential use of the Western Muskeget Variant).

Alternative C-2 could use both the Eastern Muskeget route and the Western Muskeget Variant and, therefore, impact benthic resources in complex seafloor, hard coarse deposits, and soft bottom habitats across a larger area than Alternative C-1. Under Alternative C-2, dredging for Phase 2 cable installation could impact up to 73 acres and include up to 274,800 cubic yards of dredged material (compared to 67 acres and 235,400 cubic yards for Alternative B and Alternative C-1). The impacts of Alternative C-2 on benthic habitats in the Eastern Muskeget route would be less than Alternative C-1 and potentially less than Alternative B because Alternative C-2 would involve installation of fewer cables in the Eastern Muskeget route. The impacts of Alternative C-2 on benthic resources in the Western Muskeget Variant would be greater than Alternative C-1, due to the installation of up to two cables in that corridor (where no such cables would be installed under Alternative B or Alternative C-1). Overall, Alternative C-2 would have greater impacts on benthic resources in complex seafloor habitats due to impacts within both the Eastern and Western Muskeget.

Overall, the impacts of Alternatives C-1 and C-2 on benthic resources would remain **moderate**, as well as **moderate** beneficial from the presence of structures and their potential reef effect. Although Alternative C-1 would result in a slightly shorter cable route due to use of the Eastern Muskeget route only, compared to cable placement in both the Eastern Muskeget route and the Western Muskeget Variant, the differences in route length are not anticipated to be enough to reduce the impact determinations on benthic resources. The cumulative impacts of Alternatives C-1 and C-2 along with ongoing and planned activities, would be similar to those of Alternative B: **moderate** and **moderate** beneficial with the highest impacts occurring if sensitive benthic habitat cannot be avoided.

3.4.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Benthic Resources with the Western Muskeget Variant Contingency Option

Impacts on benthic resources from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.

- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B (Scenario 2 for Phase 2). While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce potential impacts on benthic resources by a negligible increment for both Phase 1 (3.2 acres[19] if a WTG foundation is eliminated or 3.9 acres[19] if a ESP foundation is eliminated) and Phase 2 (4.5 acres[19] if a WTG foundation is eliminated or 7.6 acres[19] if a ESP foundation is eliminated) as a result of one less foundation and associated scour protection and required construction vessel impacts (COP Volume III, Appendix III-T; Epsilon 2023). Additionally, impacts would be slightly less, as less pile driving would be required.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on benthic resources relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those impacts described for Alternative B. The Preferred Alternative would have **moderate** impacts on benthic resources within the geographic analysis area, as well as **moderate** beneficial impacts from the presence of structures. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **moderate** and **moderate** beneficial with the most impacts occurring if sensitive benthic habitat cannot be avoided.

[19] This acreage assumes that the foundation and associated scour protection, as well as seafloor disturbance, as a result of construction vessel impacts would not occur at a single position.

3.5 Coastal Habitats and Fauna

3.5.1 Description of the Affected Environment

3.5.1.1 Geographic Analysis Area

This section describes the existing conditions in the geographic analysis area for coastal habitats and fauna as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.5-1. This involves all lands and waters that are within a 1-mile buffer of the OECC and that fall within the 3-nautical-mile (3.5-mile) seaward limit of Massachusetts' territorial sea to 100 feet landward of the first major land transportation route encountered (a road, highway, rail line, etc.).

Under Section 404 of the CWA, (33 USC § 1344), USACE regulates the discharge of dredged or fill materials into the waters of the United States and has jurisdiction in tidal waters from the high tide line to the 3-nautical-mile (3.5-mile) limits of the territorial seas (33 CFR § 328.4). In addition, under Section 10 of the RHA, USACE regulates construction located in or affecting "navigable waters of the U.S." Tidal, navigable waters extend from the mean high water line to the seaward limit of the OCS (43 USC § 1333[e] and 33 CFR § 320.2). Therefore, the geographic analysis area for coastal habitats and fauna includes the tidal portion of USACE jurisdiction under CWA Section 404, as well as work and dredging regulated under Section 10 from the mean high water line to the 3-nautical-mile (3.5-mile) limit and structures from the mean high water mark to the seaward limit of the OCS.

The Massachusetts Office of Coastal Zone Management (CZM) manages coastal habitats and fauna within the geographic analysis area. The coastal habitats within the geographic analysis area are limited to portions of the OECC, the potential landfall sites, and the potential onshore cable crossings of the Centerville River (COP Volume I, Figures 3.3-5a through 3.3-5d; Epsilon 2023) and East Bay (COP Volume I, Figure 4.1-2; Epsilon 2023). The SWDA and the southernmost portion of the OECC (approximately 14 miles) are beyond the seaward limits of the territorial seas of Massachusetts and Rhode Island. Section 3.6 provides a broader discussion of impacts on essential fish habitat (EFH), finfish, and invertebrates (including shellfish); Section 3.4 discusses benthic resources; Section G.2.6 discusses non-tidal waters and wetlands; and Section G.2.5 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor (or Lower) Impacts, discusses terrestrial habitats and fauna.

3.5.1.2 Existing Resources

The potential Phase 1 landfall sites at Craigville Beach and Covell's Beach are in paved parking areas. Both Phase 1 landfall sites have been surveyed to identify sensitive nearshore habitats (COP Volume III, Section 6.4.1.1; Epsilon 2023). An eelgrass [*Zostera marina*] bed growing in an area with a hard bottom, is present offshore of these potential landfall sites in the vicinity of Spindle Rock. Otherwise, these potential landfall sites are free of offshore eelgrass and other sensitive habitats in the nearshore area. The potential Phase 2 landfall sites at Dowses Beach and Wianno Avenue are also in paved areas and have also been surveyed to identify any sensitive nearshore habitats (COP Volume III, Section 6.4.1.1; Epsilon 2023). The surveys identified a patch of eelgrass southwest of the OECC, suggesting the presence of an eelgrass bed and an area with complex habitat near the Dowses Beach Landfall Site.

The Centerville River estuary and East Bay contain soft-bottom habitats in areas of open water and also exhibit extensive areas of salt marsh near the shoreline. These connected bodies of water are known habitats for Quahog clams (*Mercenaria mercenaria*), and they also host spawning runs of river herrings. These bodies of water are currently listed as impaired by nutrient loading, partially caused by inadequate and failing septic systems (Cape Cod Commission 2017). The Town of Barnstable plans to mitigate this nutrient loading by expanding and upgrading municipal sewer systems over the next decade (Town of Barnstable 2020).

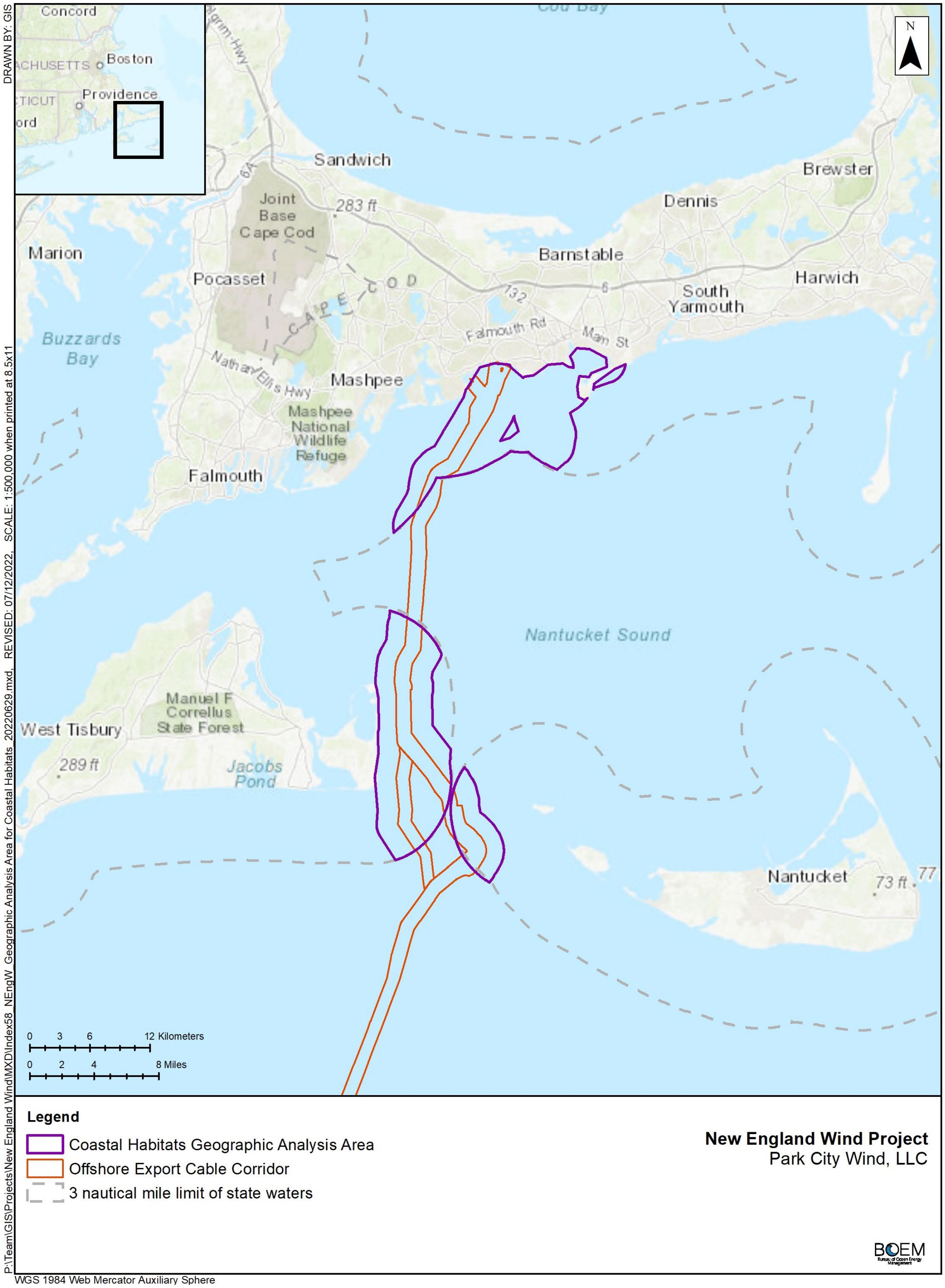
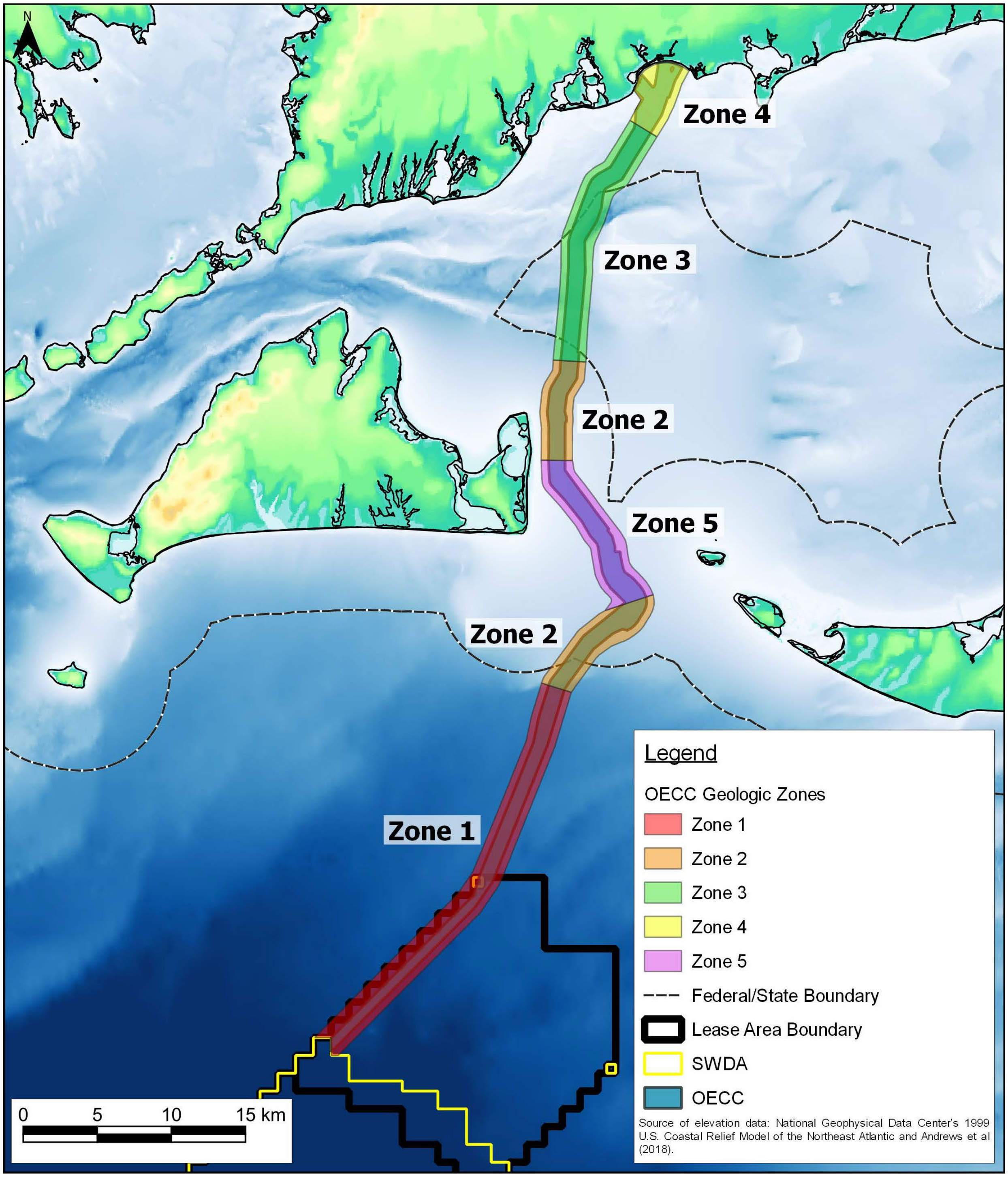


Figure 3.5-1: Geographic Analysis Area for Coastal Habitats and Fauna

Much of the OECC was described in Section 3.1 of the Vineyard Wind 1 Final EIS (BOEM 2021b) and reflects surveys conducted between 2016 and 2020. The portions of the OECC that were expanded for the proposed Project were surveyed in 2020. The OECC can be subdivided into five geological zones based on the physical characteristics and benthic substrates observed in proposed Project surveys (Figure 3.5-2). Coastal habitats are present in Zones 2, 3, 4, and 5 (COP Volume II-A, Section 2.1.3.1; Epsilon 2023). Typically, water depth in the geographic analysis area for coastal habitats and fauna ranges from 0 to 49.2 feet but can be as deep as 131.2 feet. Benthic grab samples and underwater video transects collected during 2016 through 2020 biological surveys helped determine habitat type (COP Volume II-A, Section 5; Epsilon 2023). Seafloor habitat types, based on the habitat categories defined in the COP (Volume II-A, Table 5.1-1; Epsilon 2023), are primarily sandy but vary across geographical zones. Zone 2 is subject to high currents and exhibits a mainly sand and gravel bed with ripples and sand waves mostly 3.3 to 4.9 feet high. Some Zone 2 habitats include biogenic structures (e.g., burrows and sessile unshelled organisms), shell aggregates, or gravel-cobble beds. Zone 3 exhibits mostly flat sand and silt substrate with ripples and sand waves 3.3 to 6.6 feet high; biogenic structures are less common. Zone 4 is also primarily flat sand and silt. A minority of areas include small sand waves, shell aggregates, or gravel-cobble beds, in addition to rock piles associated with Spindle Rock, Collier Ledge, Gannet Ledge, Eldridge Shoal, and Gannet Rock. Zone 5 is subject to remarkably high currents and exhibits coarser bed material with some hard-bottom patches and sand waves. The sand waves are mostly 3.3 to 13.1 feet high but range up to 29.5 feet high. Zone 5 also includes shell aggregates, cobble beds with and without sponge cover, sulfur sponge (*Cliona californiana*) beds, and a few isolated boulders.

Seafloor habitats can also be classified more broadly as biogenic structures, hard bottom, complex seafloor, and other, which would include the majority of flat sand and mud habitat in the OECC. Hard bottom in the geographic analysis area for coastal habitats and fauna typically consists of a combination of coarse deposits such as gravel, cobble, and boulders in a sand matrix. These coarse deposits form a stable surface over which sand waves forced by tidal currents periodically migrate. Certain hard-bottom areas also include piles of exposed boulders, but no bedrock outcrops are present in the OECC. Complex seafloor in the OECC consists of bedforms such as rugged fields of sand waves; although these mobile habitats are less amenable to benthic macroinvertebrates, they may be attractive to finfish. Maps delineating these habitats based on the results of surveys reported in Epsilon (2022) are shown on Figures 3.5-3 through 3.5-7. In addition, CZM has defined a hard/complex bottom habitat (CZM 2014; Commonwealth of Massachusetts 2021a), which would generally include all of the biogenic structures, hard bottom, and complex seafloor in the OECC. Section 3.4 discusses benthic organisms associated with these types of habitats. Coastal habitat types defined by CZM (2014) and the Commonwealth of Massachusetts (2021a) do not necessarily align with NMFS classifications of hard, complex, or sensitive habitats as pertaining to EFH. Section 3.6, Finfish, Invertebrates, and Essential Fish Habitat, and the EFH assessment (BOEM 2023a) discuss habitats from the perspective of finfish, invertebrates, and EFH.

NMFS has requested mapping of the following habitat types: soft-bottom habitats (i.e., mud and/or sand); complex habitats (i.e., submerged aquatic vegetation, shells/shellfish, and/or hard-bottom substrate); heterogeneous complex habitats (i.e., mix of soft and complex stations within a delineated area); large-grained complex habitats (e.g., large boulders or rock outcrops); and benthic features (i.e., ripples, mega-ripples, and sand waves) (NMFS 2021b). Maps of those habitat types can be found in the COP (Volume II-A, Figures 5.2-5b and 5.2-5c; Epsilon 2023). Compared to the habitat type definitions in the *Massachusetts Ocean Management Plan* (Commonwealth of Massachusetts 2021a) and the Vineyard Wind 1 Final EIS (BOEM 2021b), the definition of complex habitat in the NMFS (2021b) mapping recommendations has a smaller grain size threshold (at least 0.08 inch) and lower composition threshold (at least 5 percent gravel), making it a more conservative classification system. Therefore, more locations are now classified as complex, resulting in increased areas of complex or heterogeneous complex habitats than had been previously mapped in the Vineyard Wind 1 Final EIS (BOEM 2021b).



Source: COP Volume II-A, Figure 2.1-17; Epsilon 2023
OECC = offshore export cable corridor; SWDA = Southern Wind Development Area

Figure 3.5-2: Geological Zones Along the Offshore Export Cable Corridor

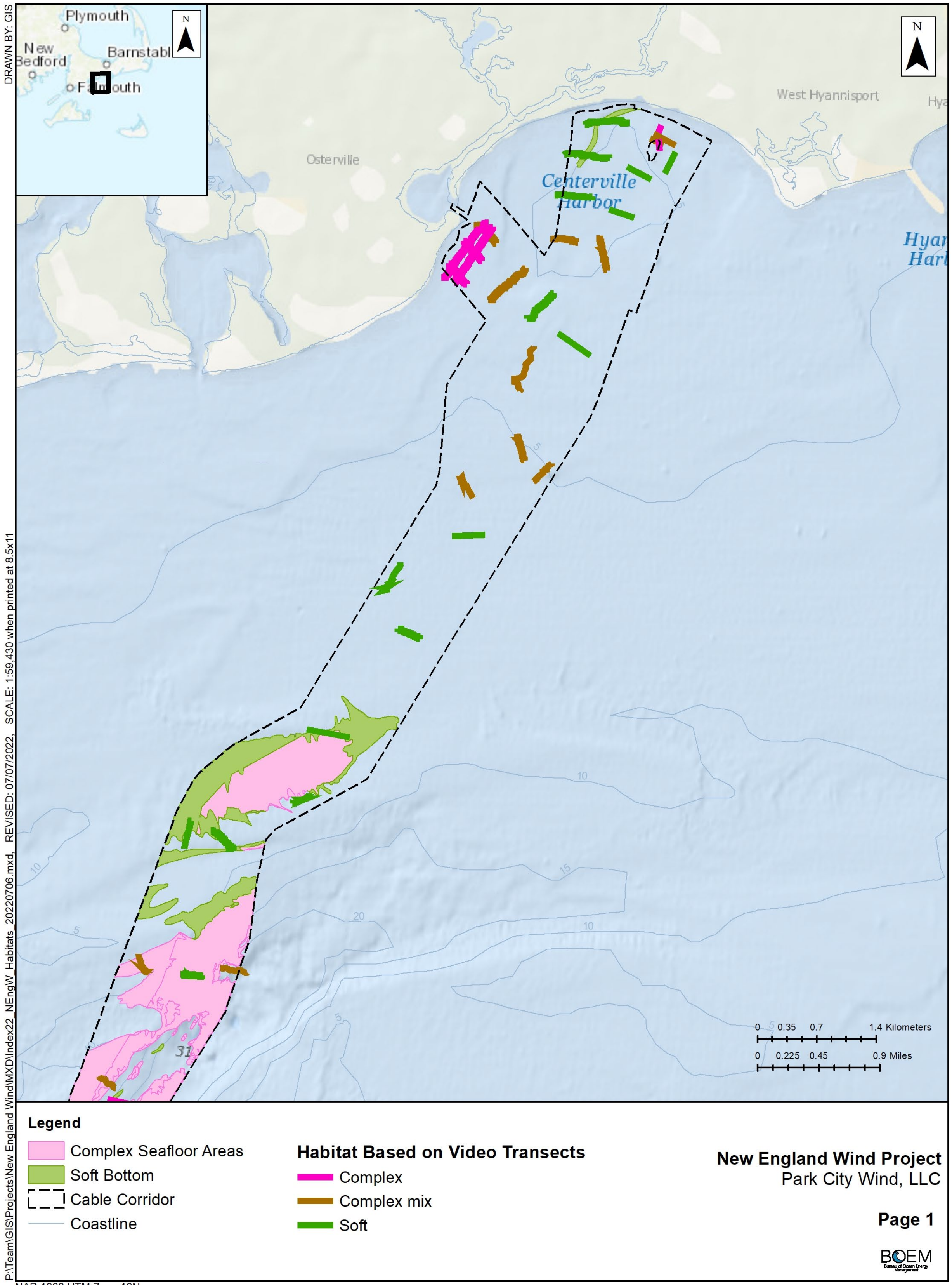


Figure 3.5-3: Seafloor Habitats Within the Offshore Export Cable Corridor (Page 1)

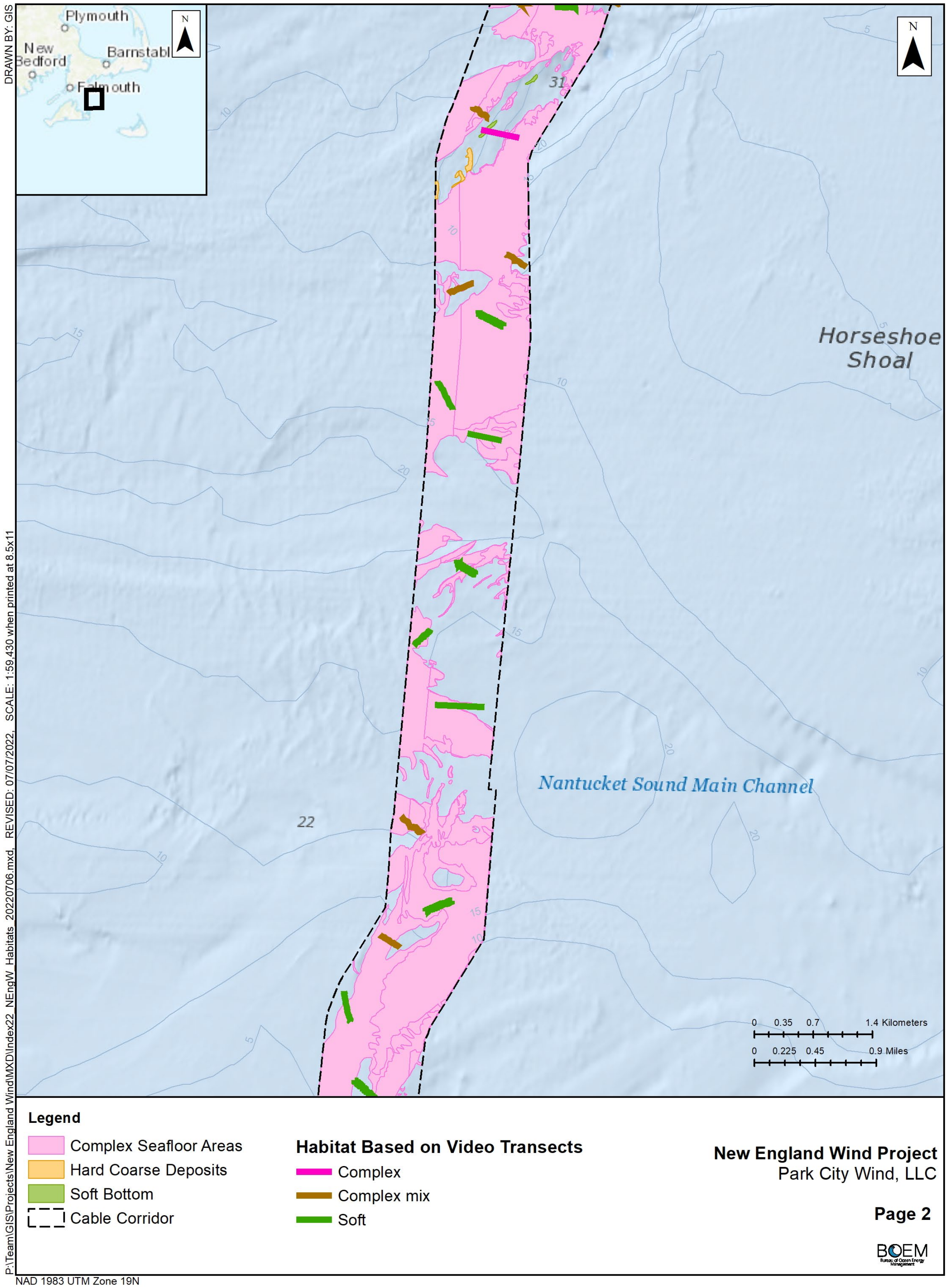


Figure 3.5-4: Seafloor Habitats Within the Offshore Export Cable Corridor (Page 2)

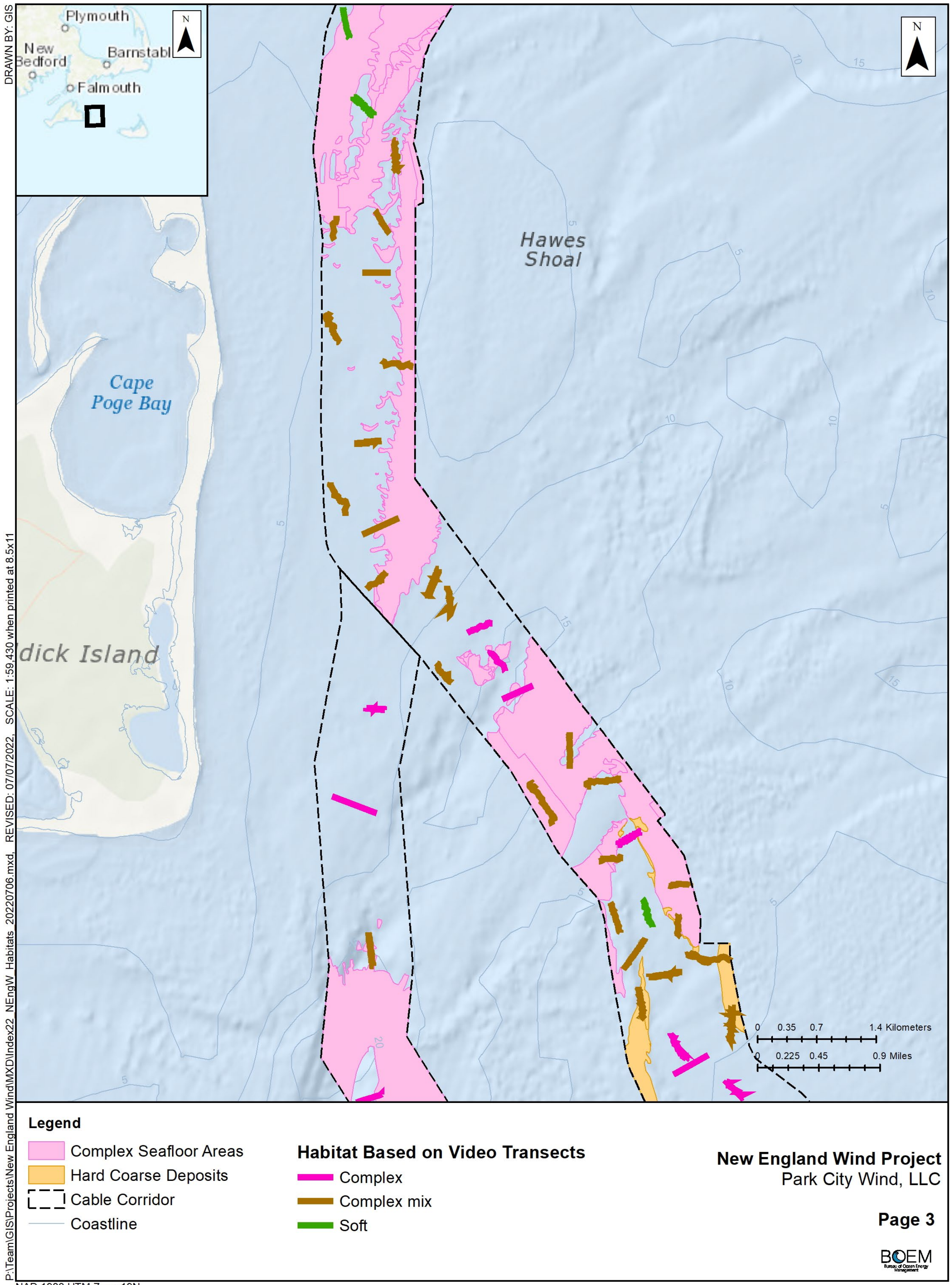


Figure 3.5-5: Seafloor Habitats Within the Offshore Export Cable Corridor (Page 3)

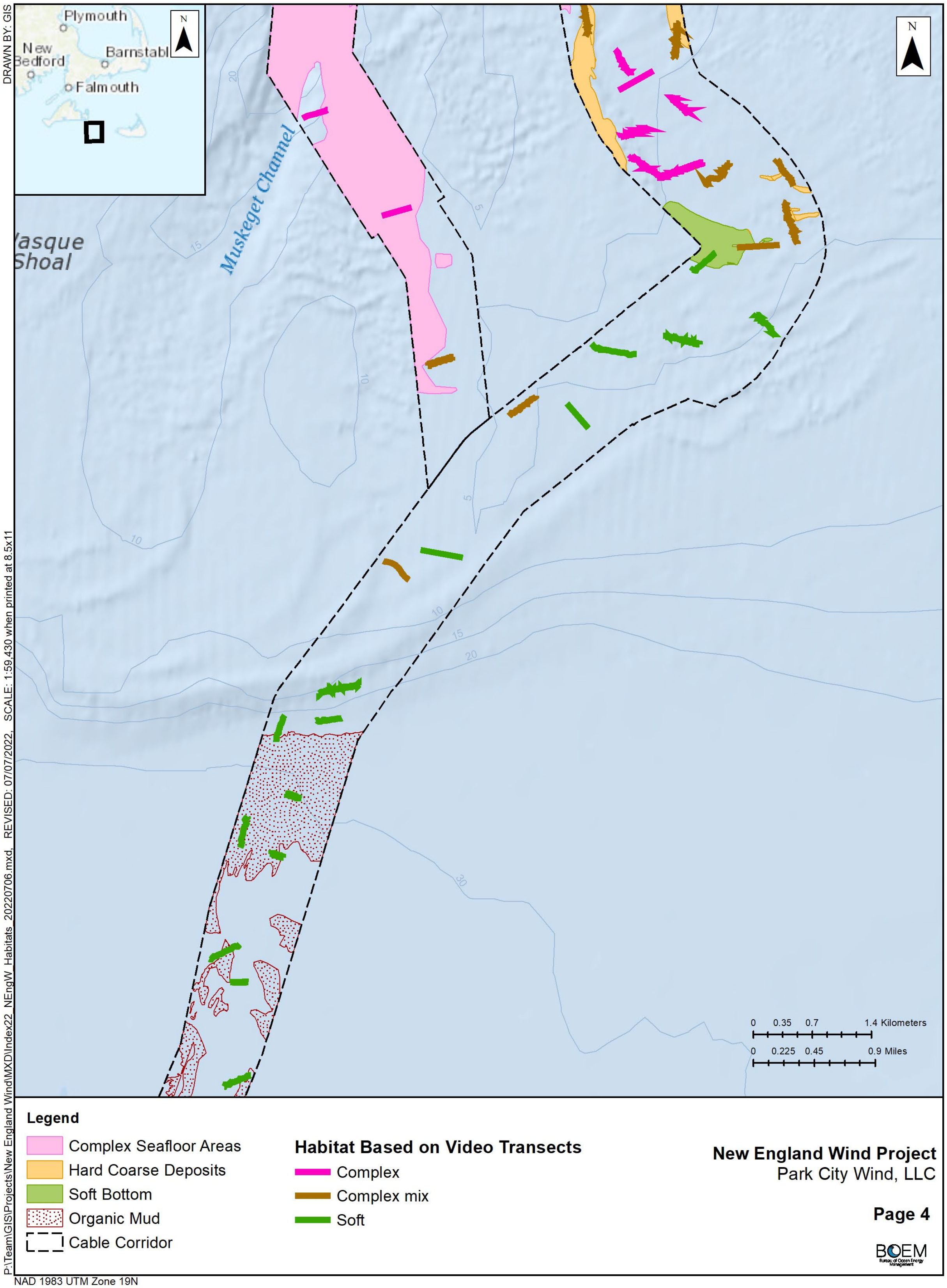


Figure 3.5-6: Seafloor Habitats Within the Offshore Export Cable Corridor (Page 4)

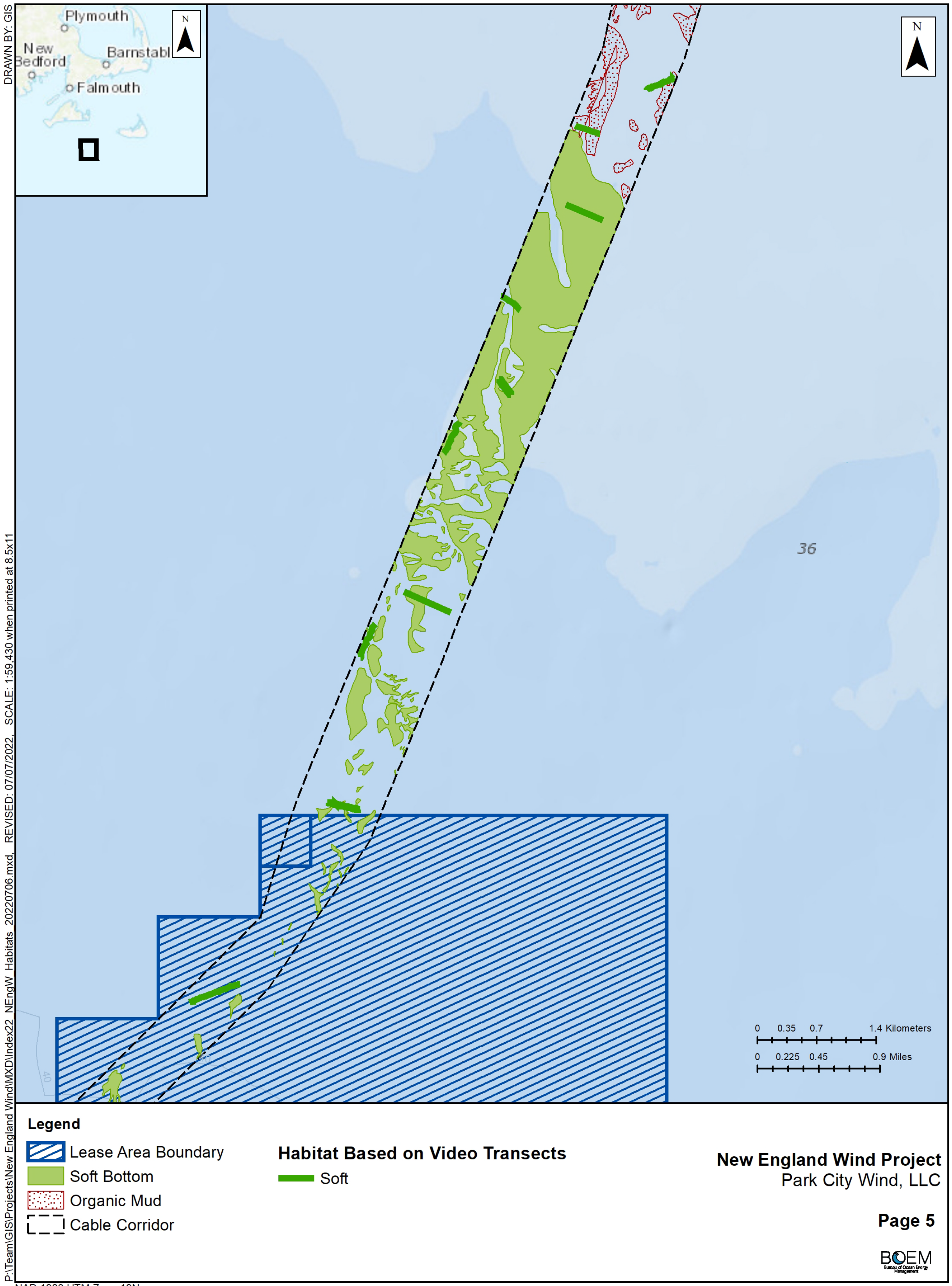


Figure 3.5-7: Seafloor Habitats Within the Offshore Export Cable Corridor (Page 5)

Benthic habitats and organisms recorded on video transect throughout the OECC were consistent from 2017 to 2020, with no major differences apparent. Within most of the OECC, the substrate is generally flat soft bottom, except for areas near Zone 5, which are coarser and more diverse (COP Volume II-A, Figure 5.1-3a; Epsilon 2023). In addition, biogenic structures (e.g., burrows, depressions, cerianthid anemones, and hydroid patches) are present along the final 19 miles of the OECC leading to the landfall sites. Complex habitat, as defined by NMFS (2021b), was found mainly in the vicinity of Muskeget Channel and was composed mostly of sandy gravel, gravelly sand, shell hash, and gravel, with isolated boulders; complex habitat consisting of gravelly sand and gravelly muddy sand was also found near the Dowses Beach Landfall Site (COP Volume III, Section 6.4.1.2.2; Epsilon 2023). Heterogeneous complex habitat, as defined by NMFS (2021b), was found scattered throughout the middle and northern portion of the OECC and within the southern portion of the Western Muskeget Variant (COP Volume II, Figures 5.2-5b and 5.2-5c; Epsilon 2023). Large-grained complex habitat, as defined by NMFS (2021b), was mapped at Spindle Rock and Collier Ledge; the boulders in Muskeget Channel were not found in high enough density to be mapped as large-grained complex habitat (COP Volume III, Section 6.4.1.2.2; Epsilon 2023). Benthic features consisting of ripples, mega-ripples, and sand waves occurred throughout the OECC, including within the Western Muskeget Variant (COP Volume III, Section 6.4.1.2.2; Epsilon 2023).

The Commonwealth of Massachusetts considers special, sensitive, and unique (SSU) habitats such as living bottom, hard/complex bottom, eelgrass areas, and certain specific marine mammal habitats identified in the *Massachusetts Ocean Management Plan* to be high priorities for avoidance if possible (Commonwealth of Massachusetts 2021a). The proposed Project's cable corridor survey data were compared to existing data to assess the potential for SSU habitats in the immediate vicinity of the OECC (COP Volume II-A; Epsilon 2023). The proposed OECC and historically mapped sensitive areas provided by Massachusetts are shown in the COP (Volume II-A, Figure 5.2-1a; Epsilon 2023). The applicant has routed the proposed OECC to avoid sensitive habitat to the greatest extent practicable (Figures 3.5-2 through 3.5-6). The areas of habitats within 328 feet of the offshore export cable centerline are provided in Table 3.5-1.

Table 3.5-1: Coastal Habitat Types

Habitat Type	Extent, Proposed Project OECC (Acres)	Share of Proposed Project OECC (%)	Extent, Western Muskeget Variant OECC (Acres)	Share of Western Muskeget Variant OECC (%)
Complex seafloor	4,281.7	20.7	861.3	36.3
Soft bottom	1,518.6	7.4	0.0	0.0
Hard coarse deposits	167.9	0.8	0.0	0.0
Organic mud	644.3	3.1	0.0	0.0
Other habitats	14,031.0	68.0	1,508.6	63.7
Total	20,643.5	100%	2,369.9	100%

Source: COP Volume II; Epsilon 2023

OECC = offshore export cable corridor

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

Eelgrass is a marine flowering plant that lives below the surface. Eelgrass beds provide the following:

- Nursery ground and refuge for commercially important organisms, such as bay scallops (*Argopecten irradians*), flounders, striped bass (*Morone saxatilis*), and tautog (*Tautoga onitis*), as well as other organisms such as seahorses;
- Habitat and food for waterfowl, shellfish, and finfish;
- Carbon capture and sequestration; and
- Sediment and shoreline stabilization (Heck et al. 1989).

A single eelgrass bed has been identified within the OECC, consisting of patches of eelgrass and macroalgae in the discontinuous sandy bottom in and around Spindle Rock, approximately 0.4 mile offshore of Covell's Beach (COP Volume III, Figure 6.4-1; Epsilon 2023). Section 3.6 discusses EFH and eelgrass beds. Spindle Rock also exhibits hard/complex bottom habitat.

Trends

Coastal habitats and fauna in the geographic analysis area are mostly relatively stable, although there is variability across space and time. Sand waves are mobile over the course of days to years. Eelgrass habitats in this region are in decline (Costello and Kenworthy 2011). Sandy beaches in these areas are subject to erosion and vulnerable to the effects of projected climate change and relative sea level rise (Roberts et al. 2015). The shoreline is partially developed with residences, and this development is likely to continue.

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

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

Historical maps of hard/complex bottom (CZM 2014; Commonwealth of Massachusetts 2021a) indicated the presence of such habitats in all of Muskeget Channel proper. In addition, surveys conducted in 2017 and 2018 (COP Volume II-A; Epsilon 2023) found hard/complex bottom covering much of the Muskeget Channel area. The areas of each coastal habitat type present along the OECC, as defined above, are shown in Table 3.5-1.

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

Shorelines in the geographic analysis area for coastal habitats and fauna are primarily sand beaches, rocky shores, salt marsh, and armored shorelines. Landward of the intertidal zone, coastal habitats in the geographic analysis area for coastal habitats are mostly a mixture of sandy beaches and developed spaces.

Coastal habitats on Martha's Vineyard and Chappaquiddick Island also include sand dune habitats, salt ponds, salt marshes, and scattered maritime forest. Sandy beaches in these areas are subject to erosion and vulnerable to the effects of projected climate change and relative sea level rise (Roberts et al. 2015). Mainland coastal habitats in the geographic analysis area for coastal habitats mostly consist of sandy beach and dune vegetation; much of this is developed for public beach and private residences (Thieler et al. 2013).

Coastal habitats are subject to pressure from ongoing activities, especially those that involve anchoring, seabed profile alterations, sediment deposition and burial, gear used for bottom trawling and dredge fishing, and climate change. The greatest concerns regarding potential impacts on coastal habitats are potential impacts on SSU habitats, especially living bottom, hard/complex bottom, eelgrass beds, and marine mammal habitats. Ongoing development, commercial fishery activities, and tourism in the area can affect the sensitive habitats (e.g., hard/complex bottom and eelgrass beds) in the geographic analysis area for coastal habitats.

Commercial fishing using bottom trawls, dredge fishing methods, dredging for navigation, marine minerals extraction, and/or military uses disturbs swaths of seafloor habitat. When this intersects SSU habitats, long-term disruptions can result. Their impacts are similar in nature but much greater in extent and severity than those caused by other bottom-directed IPFs such as pipeline trenching or cable emplacement and maintenance that create a relatively narrow trench and backfill in the same operation. Commercial and recreational regulations for finfish and shellfish implemented and enforced by either Massachusetts or the Town of Barnstable, depending on whether the fishery is within state or town waters, affect coastal habitats by modifying the nature, distribution, and intensity of fishing-related impacts.

Coastal habitats are also vulnerable to non-point-source nutrient pollution, much of which is due to discharges from septic systems onshore. Increased nutrient loading can affect coastal wetlands and other nearshore coastal habitats. Nutrient overloading in estuaries and coastal waters goes back several decades (Cape Cod Commission 2011). The Town of Barnstable's 2020 Comprehensive Wastewater Management Plan (Town of Barnstable 2020) would address nonpoint source nutrient pollution through sewer system upgrades and expansions, wastewater treatment upgrades, and other projects to be completed over a 30-year period. Discharges from vessels are not permitted within 3 nautical miles (3.5 miles) of shore.

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

3.5.2 Environmental Consequences

Definitions of impact levels for coastal habitats and fauna are described in Table 3.5-2.

Table 3.5-2: Impact Level Definitions for Coastal Habitats and Fauna

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

3.5.2.1 Impacts of Alternative A – No Action Alternative on Coastal Habitats and Fauna

When analyzing the impacts of Alternative A on coastal habitats and fauna, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for coastal habitats and fauna (Table G.1-2 in Appendix G). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for coastal habitats and fauna described in Section 3.5.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on coastal habitats and fauna include commercial bottom trawling and dredge fishing, anchoring, seabed profile alterations, sediment deposition and burial, climate change, and the construction of the Vineyard Wind 1 OECC. The impacts on coastal habitats and fauna from these ongoing and future non-wind activities would continue and result in similar impacts regardless of offshore wind energy development. The rate might be uncertain, but their impacts on coastal habitats and fauna would be detectable with monitoring of habitat structure and coverage.

Planned activities other than offshore wind that could affect coastal habitats and fauna include increasing vessel traffic; new submarine cables and pipelines; increasing onshore construction; marine surveys; marine minerals extraction; channel deepening activities; beach nourishment projects; the installation of new towers, buoys, and piers; and construction of the SouthCoast Wind OECC. These activities have the potential to affect coastal habitats and fauna by virtue of various associated IPFs as described in Appendix G.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind development activities would affect coastal habitats and fauna through the following primary IPFs.

Accidental releases: Accidental releases may increase as a result of future offshore wind activities. Section G.2.2, Water Quality, discusses the nature of releases anticipated. The risk of any type of accidental release would increase primarily during construction but also could occur during operations and decommissioning of offshore wind facilities. Accidental releases of fuel/fluids/hazardous materials have the potential to cause contamination of habitats and harm to the species that build biogenic coastal habitats (e.g., eelgrass, oysters, mussels, slipper limpets [*Crepidula fornicata*], salt marsh cordgrass [*Spartina alterniflora*]), either from the releases themselves and/or cleanup activities. The greatest risk of accidental releases in coastal habitats would be related to transportation of crews and equipment during construction and operations, as well as accidental releases from any nearshore activities associated with transmission cable installation. Accidental releases from offshore structures and offshore vessels would likely not reach coastal habitats. Onshore, the use of heavy equipment could result in releases of fuel and lubricating and hydraulic oils during equipment use or refueling.

Trash and debris may be released by vessels during construction, operations, and decommissioning of projects associated with Alternative A. BOEM assumes all vessels will comply with laws and regulations to minimize releases. In the event of a release, it would be an accidental, small event in the vicinity of work areas. There does not appear to be evidence that the volumes and spatial/temporal extent of accidental releases of trash and debris would have any impact on coastal habitats. The overall impacts of accidental releases on coastal habitats and fauna are likely to be localized, short term, and to result in little change to coastal habitats. As such, accidental releases from future offshore wind development would not be expected to appreciably contribute to overall impacts on coastal habitats.

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

Cable emplacement and maintenance: Installation of offshore submarine cables could cause short-term disturbance of seafloor habitats. If cable routes intersect eelgrass or hard-bottom habitats, impacts may be long term to permanent. Cable emplacement involves intense temporary disturbance of seafloor habitats during cable burial in an approximately 6.6-foot-wide path along the entire cable route. Assuming future projects use installation procedures similar to those proposed in the COP (Volume I, Section 3.3.1; Epsilon 2023), coastal habitats and fauna would recover following disturbance except in hard-bottom habitat, which may be permanently altered. Cable emplacement may affect coastal habitats and fauna multiple times, as different projects may install cable in consecutive or non-consecutive years, and maintenance may be required at any time. Any dredging necessary prior to cable installation could also contribute additional impacts, especially to eelgrass beds and hard-bottom habitats.

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

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

Climate change: Climate change, influenced in part by greenhouse gas (GHG) emissions, is expected to continue to contribute to a widespread loss of shoreline habitat from rising seas and erosion. Ocean acidification caused by atmospheric CO_2 may contribute to reduced growth or the decline of reefs and other habitats formed by shells. Section G.2.1, Air Quality, describes the expected contribution of offshore wind activities to climate change.

EMF: Operating transmission cables in coastal habitats would generate EMF. Section 3.4, Benthic Resources, discusses the nature of potential impacts. Submarine power cables are assumed to be installed with appropriate shielding and burial depth to reduce potential EMF resulting from cable operation to low levels. EMF of any two sources would not overlap because developers typically allow at least 330-foot spacing between cables, except where cables cross. EMF strength diminishes rapidly with distance, and potentially meaningful EMF would likely extend less than 50 feet from each cable. Where one cable crosses another, such as the SouthCoast Wind offshore export cables crossing the Vineyard Wind 1 offshore export cables, the intensity of the EMF would likely remain below the levels to which marine organisms are known to respond (Section 3.6 and Section 3.7, Marine Mammals). Any impacts of EMF on coastal habitats and fauna would likely be undetectable.

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

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

Noise: Noise from offshore wind construction activities, including pile driving, is not expected to be noticeable, due to the distance of all planned projects from coastal habitats, but noise from trenching of export cables and from G&G surveys could reach coastal habitats. The impacts of trenching noise or noise from other methods of cable burial are temporary and typically less prominent than the impacts of the physical disturbance and sediment suspension. Noise from G&G surveys of cable routes may also occur intermittently between 2023 and 2030 (Appendix E). G&G noise resulting from offshore wind site characterization surveys is less intense than G&G noise from seismic surveys used in oil and gas exploration; while seismic surveys create high-intensity impulsive noise to penetrate deep into the seabed, offshore wind site characterization surveys typically use sub-bottom profiler technologies that generate less intense sound waves more similar to common deep-water echosounders. Noise is anticipated to occur intermittently during the construction period for Alternative A, between 2023 and 2030 (Appendix E). The intensity and extent of the resulting impacts on coastal habitats and fauna are difficult to generalize but would likely be local and temporary. Overall, noise is not anticipated to cause any meaningful change to coastal habitats.

Presence of structures: Any new cable installed in coastal habitats would likely require hard protection atop portions of the route, potentially converting previously existing habitat (whether hard-bottom or soft-bottom) to a type of hard habitat. The new habitat may or may not function similarly to hard-bottom habitat typical in the region (BOEM 2019b; Kerckhof et al. 2019). Soft-bottom habitat is the dominant habitat type on the OCS, and structures do not meaningfully reduce the amount of soft-bottom habitat available (Guida et al. 2017; Greene et al. 2010). Thus, conversion of some abundant soft-bottom habitat to a rarer hard habitat may constitute a beneficial impact (NOAA 2007). Structures can also create an artificial reef effect, attracting a different community of organisms (English et al. 2017; Langhamer 2012; Paxton et al. 2020; Rousseau 2008). Cable protection is anticipated to be added incrementally from 2023 through 2030 (Appendix E). These changes would persist as long as the structures remain. Where cables would be buried deeply enough that protection would not be used, presence of the cable would have no impact on coastal habitats.

Conclusions

Impacts of Alternative A. Under Alternative A, coastal habitats and fauna would continue to be affected by existing environmental trends and ongoing activities. The overall impacts of Alternative A would include both **moderate** impacts and **minor** beneficial impacts. The majority of offshore structures in the geographic analysis area for coastal habitats and fauna would be attributable to the future offshore wind industry.

Cumulative Impacts of Alternative A. Planned activities for coastal and marine activity other than offshore wind include development of diversified, small-scale, onshore renewable energy sources and peaker plants; continued increases in the size of commercial vessels; and potential port expansion and channel deepening activities.

Ongoing impacts resulting from sediment dredging, dredge fishing and bottom trawling, and land disturbance would continue to be the most impactful IPFs influencing the condition of coastal habitats and fauna in the geographic analysis area. The future offshore wind industry would also be responsible for the majority of impacts related to new cable emplacement and maintenance. Except for those two IPFs, the impacts of the future offshore wind activities would be difficult to distinguish from the impacts of ongoing activities and future non-offshore wind activities. BOEM anticipates that the cumulative impacts on coastal habitats and fauna communities under Alternative A would be **moderate,** driven primarily by the continued operation of existing marine industries, increased pressure for environmental protection of coastal resources, and the need for port maintenance and upgrades; and may include **minor** beneficial impacts.

3.5.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters would influence the magnitude of the impacts on coastal habitats and fauna:

- OECC route near Muskeget Channel: The proposed OECC route and potential use of the Western Muskeget Variant (Phase 2 only) could have differing impacts on coastal habitats.
- Number of offshore export cables installed: Five total offshore export cables would be more impactful than four offshore export cables.
- Number and location of landfall sites selected: The Dowses Beach and Wianno Avenue landfall sites for Phase 2 could result in different impacts, and the applicant may elect to use both sites for Phase 2.
- Method for crossing the Centerville River and, possibly, East Bay: The onshore export cable for Phase 1 would cross the Centerville River, and the onshore export cable for Phase 2 may cross under East Bay. The applicant would use trenchless methods for the East Bay crossing, although that crossing would have a greater potential for impacts on submerged coastal habitats than other Phase 2 routes that avoid this crossing. Crossing the Centerville River using trenchless methods would likely be less impactful than building a new utility bridge.
- Dredging and cable installation methods: Among the proposed methods (see the cable emplacement and maintenance IPF below), use of a TSHD would likely cause greater impacts, both in the dredging corridor and spoils dumping areas, than jetting or mass flow excavation. Likewise, the applicant may be able to accomplish cable burial with fewer impacts if jetting were the primary burial method used, especially if it avoids the need for dredging.

3.5.2.3 Impacts of Alternative B – Proposed Action on Coastal Habitats and Fauna

This section identifies potential impacts of Alternative B on coastal habitats and fauna. When analyzing the impacts of Alternative B on coastal habitats and fauna, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for coastal habitats and fauna.

Except where otherwise stated, the impacts of Phase 1 decommissioning would be similar to those for Phase 1 construction for all of the IPFs described below. Section 3.4 includes a more complete description of seafloor impacts from cable emplacement and maintenance.

Impacts of Phase 1

Phase 1 would affect coastal habitats and fauna through the following primary IPFs during construction, operations, and decommissioning.

Accidental releases: Section 2.3 describes the non-routine activities associated with Phase 1. These activities, if they were to occur, would generally require intense, temporary activity to address emergency conditions, accidental spills of fuel, lubricating oils, HDD drilling mud, or other materials used inside equipment during construction, operations, and decommissioning. The applicant’s implementation of OSRPs (COP Appendix I-F; Epsilon 2023) would limit any impacts of accidental releases from Phase 1 to minor.

Anchoring and gear utilization: Anchoring may occur anywhere along the OECC (COP Volume I; Epsilon 2023). Anchoring would not be allowed within known eelgrass beds, and vessels deploying anchors would avoid SSU habitats to the greatest extent practicable. The applicant estimated that anchoring, grounding, spud legs, and jack-up vessels would disturb up to 35 acres in the OECC (excluding areas disturbed by anchor sweep), some of which would occur outside the geographic analysis area for coastal habitats and fauna—that is, offshore of the 3-nautical-mile (3.5-mile) seaward limit defining coastal habitats (COP Volume I, Section 3.3.1.13; Epsilon 2023). Anchoring would leave a temporary mark on the seabed. If the proposed Project anchored upon any hard/complex bottom or cobble-sponge beds, damage or destruction of that part of the habitat could result in moderate impacts. For those areas outside of SSU habitats, the impacts would be minor, as the disturbances would recover naturally. The minor to moderate incremental impact of anchoring under Phase 1 would result in temporary to permanent impacts on coastal habitats and fauna, depending on the nature of the habitat affected.

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

Cable emplacement and maintenance: After a pre-lay grapnel run and, possibly, boulder relocation, the applicant would bury the proposed offshore export cables within the OECC to a target depth of up to 5 to 8 feet below the seafloor (COP Volume I, Section 3.3.1.3; Epsilon 2023). Phase 1 would lay two offshore export cables within the OECC, as well as one or more fiber optic cables for communication purposes. The OECC for the proposed Project is largely the same OECC as that evaluated in the Vineyard Wind 1 Final EIS (BOEM 2021b), but it has been widened by approximately 984 feet to the west along the entire corridor and by approximately 984 feet to the east in portions of Muskeget Channel. The maximum length of each cable within the OECC is approximately 45 nautical miles (51.8 miles).

The applicant has proposed several cable burial methods that would be used in different portions of the OECC or in combination. Jetting, or mass flow excavation, uses water jets to push sediment aside, but this method is not able to remove as much sediment as dredging, which may be required on larger sand waves. For cable burial, jet plowing, which is a similar method to jetting, uses water pumped into the seabed to fluidize the bed and allow the cable to sink to the appropriate depth. Mechanical plowing would bury the cable behind a cutting edge that is pushed through the seabed. Mechanical trenching, which would be mostly used for coarser sediments, uses a rotating cutting tool to create a trench in which the cable can be installed and buried. Other possible installation techniques include precision installation by divers or ROVs and a blunt plow used to push aside boulders (COP Volume I, Section 3.3.1.3; Epsilon 2023).

Dredging may be necessary in areas of sand waves to bury the cable in stable seabed (see the cable emplacement and maintenance IPF and COP Volume II, Figure 3.2 3 [Epsilon 2023] for an example of places prone to large sand waves). Installation method selection would prioritize the achievement of adequate burial depth, while using the “least environmentally impactful [method] that is practicable for each segment of cable installation” (COP Volume I, Section 3.3.1.3.6; Epsilon 2023). If sufficient burial is not achieved on the first installation pass, the applicant would make subsequent attempts, possibly using other installation techniques to achieve sufficient burial. In certain areas, alternative installation methods may be needed. The installation methodologies are described in detail in the COP (Volume I, Section 3.3.1.3; Epsilon 2023). Table 3.5-3 summarizes the distribution of dredging within 3 nautical miles (3.5 miles) of the high tide line (the limit of USACE jurisdiction under CWA Section 404)—often referred to as “state waters”—and between the mean high water mark and the seaward limit of the OCS (the limit of USACE jurisdiction under RHA Section 10)—commonly referred to as “federal waters.” No drilling or blasting would be required. Although difficult to predict quantitatively, burial impacts would likely be minimized if jetting and/or plowing methods were used (BERR 2008), especially if these methods avoid the need for dredging, resulting in minor impacts.

Table 3.5-3: Phase 1 Impacts within U.S. Army Corps of Engineers Jurisdiction (Cubic Yards)

Habitat Type	State Waters[a]	Federal Waters[a]	Total
Dredge volume	109,800	66,600	176,300
Fluidized trench sediment volume[b]	148,322	0	148,322

Source: Epsilon 2022a

[a] State waters include open waters areas from the high tide line to 3 nautical miles (3.5 miles) from shore. Federal waters include open waters from the 3-nautical-mile limit to the seaward limit of the OCS.
[b] The applicant assumed that an area up 1 meter (3.3 feet) wide and 1.5 meters (4.9 feet) deep may be fluidized during installation with a jet plow.

The process of cable laying and burial would affect seafloor coastal habitats along the OECC (Figure 2.1-2). Although some of the OECC area is outside the 3-nautical-mile line that defines coastal habitats and fauna, cable installation along the entire OECC may temporarily affect up to 263 acres in the maximum-case scenario (COP Volume I, Section 3.3.1.13; Epsilon 2023). This process would affect coastal habitats and fauna through cable burial, sediment suspended by the burial process, and the installation of cable protection. Where the applicant would install the cable over coarse substrates (shell aggregates, pebble-cobble, etc.), the coarser material would likely settle first and become covered by the finer sandy and silty materials that settle more slowly. Thus, the proposed Project would likely convert some surface area to a simpler surface of lower habitat value.

The preliminary routing of the cables has avoided sensitive habitats including eelgrass, hard bottom, and complex bottom (i.e., sand waves) where feasible, but avoidance of all sensitive habitats is not always possible. It is expected that the identified eelgrass resources near Spindle Rock in proximity to the landfall sites would be avoided (COP Volume III, Figure 6.4-1; Epsilon 2023). It is also expected that isolated areas of hard bottom may be avoided, such as at Spindle Rock; however, in areas such as Muskeget Channel where hard bottom extends across the entire corridor, it would not be possible to avoid hard bottom. Regarding sensitive habitats in the OECC, the applicant has performed multiple years of investigations focused on identifying both suitable cable corridors from an engineering and cable design perspective and appropriate alignments aimed at avoiding SSUs and EFH while reducing environmental impacts. By the end of 2019, more than 2,655 miles of geophysical trackline data, 123 vibracores, 83 cone penetrometer tests (CPT), 82 benthic grab samples with still photographs, and 50 underwater video transects were gathered to support the characterization of the OECC. Additional survey data were collected for the expanded portions of the OECC in 2020; these data, in conjunction with the data already collected, will be used by the cable installation contractor (once selected) to further assess conditions present in the OECC, determine cable alignments within the OECC, and select cable installation tools that are appropriate for the site conditions. COP Volume II, Section 5.2.4 (Epsilon 2023) demonstrates that due diligence has been performed in selecting an OECC. The current OECC, which is largely the same OECC already approved by BOEM for Vineyard Wind 1 (BOEM 2021b), allows for less impact on sensitive habitats than other potential OECC routes that Park City Wind and Vineyard Wind evaluated.

Cable installation would disturb biogenic structures along the OECC leading to the landfall site (COP Volume II-A, Section 5.1.1.3; Epsilon 2023). The approach to the landfall site would pass near Spindle Rock's hard-bottom habitat and eelgrass bed but completely avoid both habitats (COP Volume III, Section 6.4.2.1.1; Epsilon 2023). At the landfall site, onshore impacts on coastal habitats and fauna would be non-existent to negligible because the use of HDD to transition from offshore to onshore would avoid coastal habitats and fauna in the shore area. The specific cable routes chosen in the OECC in the vicinity of Muskeget Channel may affect the level of impact. While both of the proposed route options through the Muskeget Channel area contain hard bottom and complex bottom, the applicant has selected the eastern option for the Phase 1 cables. The areas of each coastal habitat type present along the OECC are shown for each Muskeget Channel option in Table 3.5-1. The impacts on the hard-bottom habitat within either Muskeget option could result in moderate impacts, while flatter, sandier areas would likely experience minor impacts that may recover naturally.

Impacts on coastal habitats and fauna at the landfall site would be avoided because the sea-to-shore transition vault would be located in a paved area and HDD technology would be used to bury the cable beneath the beach. Estuarine coastal habitats associated with the Centerville River in the vicinity of the onshore export cable, especially salt marsh habitat, could be affected if the applicant selects a utility bridge as the crossing method. Although the applicant prefers microtunneling under the Centerville River, which would avoid impacts on coastal habitats and fauna, if a utility bridge were chosen, up to 48 square feet of salt marsh could be temporarily disturbed, of which up to 42 square feet could be permanently altered by bridge pilings (COP Volume III, Section 6.1.2.1; Epsilon 2023). The new abutment/foundation would require new piles to be driven within the existing riprap, and some riprap would also need to be removed and replaced. Based on the current conceptual design, the new abutment/foundation would result in a minimal amount of temporary and permanent impacts on salt marsh (COP Volume III, Figure 3.3-5d and Section 6.1.2.1.1; Epsilon 2023).

At locations with large sand waves, dredging may be necessary to allow the offshore export cable to be buried in stable seabed. The applicant anticipates that, where necessary, dredging would occur within a corridor that is 50 feet wide at the top of the sand wave, with side slopes of approximately 1:3, and a depth averaging approximately 1.6 feet and a maximum depth of up to 17 feet. If needed, a TSHD would remove sediment using suction, store the sediment in a hopper, and dump the sediment in piles on the seafloor at a different place within the OECC, several hundred yards away from the dredged area. In the maximum-case scenario, the use of dredging for Phase 1 could affect up to approximately 67 acres of bottom habitat, although some of this would occur outside of the geographic analysis area for coastal habitats and fauna. If use of a TSHD is required during export cable installation, the applicant may be required to obtain a Marine Protection, Research, and Sanctuaries Act Section 103 permit from USACE to identify specific dumping locations for dredge material and the potential impacts of disposing dredge material in those locations. Under Section 103 of Marine Protection, Research, and Sanctuaries Act, USACE regulates the transportation of dredged material for purposes of dumping it into ocean water. At this time, the potential for use of a TSHD is low, and the applicant is not currently pursuing a Section 103 permit. Should the applicant determine the definitive need for the use of a TSHD during export cable installation, the applicant will coordinate with USACE regarding Section 103 permitting and supplemental NEPA review, as applicable, prior to conducting dredging activities as part of export cable installation. Considering the area affected in relation to the expanse of surrounding sand wave habitat, impacts would likely be minor.

The applicant conducted a sediment transport analysis to model the potential distribution of suspended sediment during dredging and cable installation (COP Appendix III-A, Epsilon 2023). The model evaluated sediment suspension from dredging and jetting used for cable burial. The sediment model indicated that sediment deposition greater than 0.04 inch would be mostly limited to within approximately 328 feet of the cable centerline but can extend up to 1.4 miles from dredging activities (COP Appendix III-A; Epsilon 2023). Deposition of 0.04 to 0.2 inch would probably have a minor impact on seafloor habitat, as normal water movements would likely redistribute this thin layer of sediment, while deposition of lesser amounts would probably have a negligible impact on coastal habitats and fauna (Wilber et al. 2005). According to the model, deposition of 0.04 to 0.2 inch of sediment could potentially occur on up to 2,248 acres (although part of this area would lie outside of the geographic analysis area for coastal habitats and fauna), while deposition of 0.4 inch or more would be limited to approximately 91 acres along the OECC. The impact of such sediment deposition would likely be undetectable in habitats other than hard-bottom habitats. In hard-bottom habitats, the impacts would likely be minor and short term to permanent, depending on the thickness of deposited sediment, local currents, and the nature of the habitat affected (Wilber et al. 2005).

Sedimentation of eelgrass or shellfish beds could impact habitat quality, and any eelgrass beds within approximately 328 feet of the cable centerline would be vulnerable. The closest such habitat is the Spindle Rock eelgrass bed and hard-bottom habitat complex near the proposed OECC approaching the Covell's Beach Landfall Site. Using the preliminary cable alignment, the closest distance between the OECC alignment for the Covell's Beach Landfall Site and eelgrass beds is approximately 1,000 feet. The closest distance between the western cable and the hard-bottom habitat near Spindle Rock is approximately 300 feet. According to the results of the sedimentation model (COP Appendix III-A; Epsilon 2023), cable installation should not affect the eelgrass, given its distance from the cable. Given the distance between the hard-bottom habitat near Spindle Rock and the preliminary cable routes, most sediment deposition from cable installation would not affect this habitat, although there is the potential for the closest portion of the Spindle Rock complex to fall within the outer limits of the potential area of deposition.

Sediment deposition and burial would also occur where dredged materials, if any, are deposited. In addition to the area buried by the main part of each dredge spoils pile, sedimentation is predicted to extend a considerable distance from the pile; deposition greater than 0.8 inch may extend up to 0.5 mile from each disposal site and cover up to 34.6 acres (COP Appendix III-A; Epsilon 2023). Alternatively, jet excavation and/or jet plowing would minimize the movement of sediment outside of the immediate burial corridor and, thus, affect less area of coastal habitats along the OECC. Considering that the impacts of sediment deposition and burial would remain measurable until the impacting agents were removed, the impacts of sediment deposition under Phase 1 would likely be minor.

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

BOEM could require as a condition of COP approval, that the applicant restrict its dredging and cable installation methods and timing, as described in Appendix H. This could reduce the degree of new cable emplacement impacts compared to the maximum-case scenario, although the impacts described above would still occur; therefore, the level of these impacts would remain the same.

Regular operations activities would not cause further habitat alteration or impact coastal habitats and fauna. However, when cable inspection or repairs require excavation onshore or offshore, minor, short-term, and localized impacts could occur. Maintenance of the offshore export cables could affect submerged coastal habitats if vessel anchoring, seafloor dredging, or the removal of scour protection were necessary to affect cable repairs. The impacts would be similar in nature to initial cable installation but would be smaller in physical extent.

During decommissioning, the applicant may remove the offshore export cable and cable protection unless otherwise authorized by BOEM (COP Volume I, Section 3.3.3.4; Epsilon 2023). Impacts on coastal habitats and fauna from decommissioning would be similar to construction if decommissioning requires the removal of cables and cable protection. Any hard-bottom habitat created by the proposed Project would be removed, returning the habitat to its original type. If the cables were instead retired in place, the impacts of decommissioning on coastal habitats and fauna would be negligible.

Climate change: This IPF would contribute to the reduced growth or decline of some types of coastal habitats, the widespread loss of shoreline habitat from rising seas and erosion, and alterations to ecological relationships. The impacts on coastal habitats and fauna through this IPF would be the same as those under Alternative A. The intensity of impacts on coastal habitats and fauna resulting from climate change are uncertain but are anticipated to qualify as minor to moderate.

EMF: Considering the proposed cable burial depth and shielding, the extent of EMF would likely be less than 50 feet from any cable, and the intensity of impacts on coastal habitats and fauna would likely be negligible.

Land Disturbance. The applicant has proposed to cross the tidal Centerville River by using microtunneling to construct a concrete pipe under the river to house the onshore export cables. Other potential trenchless crossing methods could include HDD, direct pipe, or a parallel utility bridge. The utility bridge method would only be used if all other trenchless methods are infeasible (COP Volume I, Section 3.3.1.10; Epsilon 2023). Phase 1 would not directly affect any area of tidal waters or wetlands, except for removal of up to 48 square feet of estuarine marine deepwater wetlands in the Centerville River (including 42 square feet permanently converted to bridge infrastructure) if the applicant must use a utility bridge crossing. Removal of the utility bridge during decommissioning would enable the affected area to become a wetland again, although the type and function may differ from existing conditions. As a result, land disturbance from Phase 1 would have long-term, localized, and negligible impacts on coastal habitats and fauna.

Lighting: Phase 1 would not result in new lighted structures within the geographic analysis area for coastal habitats and fauna. Phase 1 would allow nighttime work only on an as needed basis, in which case the proposed Project would reduce lighting of vessels, so light from vessels would also be minimal. Therefore, light resulting from Phase 1 would likely lead to negligible impacts, if any, on coastal habitats and fauna. Light from structures and vessels during Phase 1 operations would lead to negligible impacts, if any, on coastal habitats and fauna because of the distance of the proposed Project from the coastline.

Noise: Noise from trenching and burial of export cables may occur during construction, although most of the export cables would likely be installed using a trenchless jet-plowing method. Trenching and burial noise would be temporary, local, and extend only a short distance beyond the emplacement corridor. Impacts of trenching and burial noise are typically less prominent than the impacts of the physical disturbance and sediment suspension. Noise from trenching and burial would likely have negligible impacts on coastal habitats and fauna. Phase 1 would also emit noise from G&G surveys used to inspect the cable routes before and after installation. G&G noise resulting from cable route surveys would cause temporary and negligible impacts in the immediate vicinity of the cable routes.

Onshore noise and human activity from cable installation at the landfall site and the crossing of the Centerville River would be temporary and localized to the cable route. Displaced wildlife could use adjacent habitat and would repopulate these areas once construction ceases. Because construction would predominantly occur in already developed areas where wildlife is habituated to human activity and noise regardless of the cable route chosen, this would be a temporary and negligible impact.

Phase 1 would have a negligible incremental impact on coastal habitats and fauna through noise related to G&G activities and trenching, while no noise impacts on coastal habitats and fauna from construction or pile driving can be attributed to Phase 1, although ongoing activities are expected to result in local, temporary impacts.

Presence of structures: If sufficient cable burial is not achieved, cable protection measures such as rock placement, gabion rock bags, concrete mattresses, half shell pipes, or similar techniques may be installed. The applicant estimates that approximately 6 percent of the OECC route may require such additional measures (COP Volume I, Section 3.2.1; Epsilon 2023). Given that most of the seabed in and near the proposed OECC is flat sand and silt, the addition of rock or concrete protection atop sections of the buried cable would change the nature of the seabed habitat. The applicant estimates that up to 22 acres within the OECC would need protection, although some of this could occur outside the geographic analysis area for coastal habitats and fauna. Approximately half of Phase 1 cable protection would be installed within 3 nautical miles (3.5 miles) of the high tide line (i.e., USACE jurisdiction under CWA

Section 404 [Epsilon 2022a]). By adding hard surfaces, vertical relief, and habitat complexity, such changes could lead to increases in faunal diversity (Langhamer 2012; Taormina et al. 2018). However, benthic monitoring at the Block Island Wind Farm has found that mussels and other organisms have failed to colonize concrete mattresses. Other hard surfaces at Block Island Wind Farm have seen rapid growth by mussels and other organisms (BOEM 2019b). Placement of cable protection, especially in areas of natural hard-bottom habitat, may cause additional minor impacts in the areas affected by new cable emplacement and maintenance. The conversion of some abundant soft-bottom habitat to a rarer hard habitat, and the increase in faunal diversity that is likely to result, would be considered a minor beneficial impact (NOAA 2007), although the new habitat may or may not function similarly to hard-bottom habitat typical in the region (BOEM 2019b; Kerckhof et al. 2019). Invertebrate and fish assemblages may develop around these reef-like elements within the first year or two after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (BOEM 2019b). Either way, the level of aggregation or attraction associated with cable protection in coastal areas is anticipated to mainly occur at the individual level, not a population level. However, if the applicant installs protection atop existing hard/complex bottom habitat, alteration of that portion of the habitat could occur; the change in habitat quality at any one of those sites may be positive or negative (Sheehan et al. 2020). In any case, there would likely be a period of reduced ecological function during installation and for some time afterward as the processes of colonization and succession occurred on the new substrate (Sheehan et al. 2020). Considering that much of the proposed OECC is not hard/complex bottom, it is possible that cable protection would add more hard-bottom habitat area than would be damaged by the cable protection installation. Thus, the hard protection aspect of Phase 1 may result in a minor beneficial and minor impact on coastal habitats and fauna.

Estuarine coastal habitats associated with the Centerville River in the vicinity of the onshore export cable, especially salt marsh habitat, could be affected if trenchless crossing methods are infeasible and the applicant must use a utility bridge as the crossing method. If a utility bridge were installed, up to 42 square feet of habitat could be permanently altered by the presence of bridge pilings, which would likely become colonized by oysters (COP Volume III, Section 6.1.2.1; Epsilon 2023).

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

Impacts of Phase 2

Phase 2 would involve similar components, activities, and types of potential impacts as Phase 1 but in different quantities and locations. The potential impacts from operations and decommissioning are the same for Phase 2 as for Phase 1. Therefore, the following analysis focuses on the differences between Phase 1 and Phase 2 construction.

If the applicant includes the SCV as part of the final proposed Project design, impacts associated with the SCV may occur either in place of or in addition to the impacts associated with the Phase 2 OECC through Muskeget Channel. Except where specifically discussed in this section, the impacts of the SCV in federal waters (3 miles or greater from shore) would have the same magnitude as those described for Phase 1. The portion of the SCV within 3 nautical miles (3.5 miles) of shore and onshore components of the SCV have not yet been defined. BOEM will provide a more detailed analysis of the impacts of the SCV on coastal habitats and fauna in a supplemental NEPA analysis, if the SCV is selected.

The potential impacts from accidental releases, EMF, light, noise, and climate change are the same for Phase 2 (with or without the SCV) as for Phase 1. The following IPFs could result in different impacts for Phase 2 than discussed for Phase 1.

Anchoring and gear utilization: The potential impacts of Phase 2 would be similar to those of Phase 1, except that Phase 2 would disturb up to 51 acres in the OECC (excluding areas affected by anchor sweep), some of which would occur outside the geographic analysis area for coastal habitats and fauna—that is, offshore of the 3-nautical-mile (3.5-mile) seaward limit defining coastal habitats (COP Volume I, Section 4.3.1.13; Epsilon 2023). The minor to moderate incremental impact of anchoring under Phase 2 would result in temporary to permanent impacts on coastal habitats, depending on the nature of the habitat affected.

The applicant has not estimated the anchoring impacts from the SCV in federal waters; however, BOEM assumes that these impacts would be similar to those described for Phase 2 without the SCV.

Cable emplacement and maintenance: The potential impacts of Phase 2 would be similar to those of Phase 1, except that Phase 2 would use the Dowses Beach Landfall Site and/or Wianno Avenue Landfall Site in the Town of Barnstable (COP Volume I, Figure 4.1-6; Epsilon 2023). Phase 2 would include two or three offshore export cables and one or more fiber optic cables for communication purposes. The maximum length of all Phase 2 offshore export cables (assuming three cables) is approximately 192 nautical miles (221 miles). Phase 2 would disturb up to an estimated 383 acres of seafloor within the OECC during cable installation (although some of these areas would lie outside of the geographic analysis area for coastal habitats and fauna). If detailed engineering or other technical issues arise demonstrating that installation of all Phase 2 cables within a portion of the main OECC in the Muskeget Channel is not feasible, the applicant would exercise the option to install one or two Phase 2 offshore export cables within the Western Muskeget Variant. The Western Muskeget Variant is the same corridor as the western Muskeget option evaluated in the Vineyard Wind 1 Final EIS (BOEM 2021b). Section 3.5.2.4 describes the potential impacts of various routing options using the Western Muskeget Variant.

Impacts on coastal habitats and fauna at the landfall site(s) would be avoided by locating the sea-to-shore transition vault in a paved area and, at the Dowses Beach Landfall Site, by using HDD to install the cable beneath the beach. The onshore export cable crossing of East Bay, if used, would use microtunneling, HDD, or other trenchless installation methods to pass beneath the bay and avoid impacts on coastal habitats. Neither approach to the Phase 2 landfall sites would pass near Spindle Rock's hard-bottom habitat and eelgrass bed.

The applicant only expects to use the Wianno Avenue Landfall Site if unforeseen challenges arise that make it infeasible to use the Dowses Beach Landfall Site to accommodate all of the Phase 2 offshore export cables. The cable(s) could be installed at this site using HDD or open trenching. The Wianno Avenue Landfall Site is suitable for open trenching because the shoreline consists of a riprap seawall, a portion of which would be temporarily removed to facilitate cable installation and replaced afterward (COP Volume I, Section 4.3.1.8.2; Epsilon 2023). If open trenching is used, the process would involve installing cofferdam, removing riprap, dewatering, trenching within the cofferdam, installing conduit, backfilling, removing cofferdam, and replacing riprap. Regardless of the landfall site construction method used, the area of state-mapped eelgrass near the end of Wianno Avenue would be avoided.

The potential impacts of Phase 2 would be similar to those of Phase 1, except that total dredging for the installation of up to three export cables could impact up to 67 acres within the main OECC or up to 73 acres if the Western Muskeget Variant is used, although some of this would occur outside of the geographic analysis area for coastal habitats and fauna (COP Appendix III-P; Epsilon 2023). Table 3.5-4 summarizes the distribution of dredging within state and federal waters (as defined in the discussion of Phase 1 impacts). The SCV would require up to 5 acres of dredging, potentially in addition to the protection for the main OECC or Western Muskeget Variant. The impacts would likely be minor.

Table 3.5-4: Phase 2 Impacts within U.S. Army Corps of Engineers Jurisdiction (Cubic Yards)

Habitat Type	State Waters[a]			Federal Waters[a]			Total		
Scenario[b]	**1**	**2**	**4**	**1**	**2**	**4**	**1**	**2**	**4**
Dredge volume	91,500	124,900	131,100	144,000	144,000	143,800	235,400	268,800	274,800
Fluidized trench sediment volume[c]	217,538	211,358	205,178	0	0	0	217,538	211,358	205,178

Source: Epsilon 2022b

[a] State waters include open waters areas from the high tide line to 3 nautical miles (3.5 miles) from shore. Federal waters include open waters from the 3-nautical-mile limit to the seaward limit of the OCS.
[b] Scenario 1 includes three offshore export cables through the Eastern Muskeget route; Scenario 2 includes two cables in the Eastern Muskeget route and one in the Western Muskeget Variant; Scenario 4 includes one cable in the Eastern Muskeget route and two cables in the Western Muskeget Variant.
[c] The applicant assumed that an area up 1 meter (3.3 feet) wide and 1.5 meters (4.9 feet) deep may be fluidized during installation with a jet plow.

The potential sedimentation impacts of Phase 2 (with or without the SCV) would be similar to Phase 1, except that Phase 2 would not approach Spindle Rock's hard-bottom habitat and eelgrass bed. However, if an eelgrass bed exists south of the proposed OECC approaching the Wianno Avenue Landfall Site, as possibly indicated by proposed Project surveys (COP Volume III, Section 6.4.1.1.2; Epsilon 2023), it may be vulnerable to sedimentation, which could affect habitat quality. The sediment transport modeling (COP Appendix III-A; Epsilon 2023) for the OECC was intended to be representative of Phase 1 or Phase 2; if the Western Muskeget Variant were selected, the area affected by sediment deposition would be similar to that affected if only the main OECC were used, due to the shorter length of the western route, although the maximum amount of dredging could be more (see the seabed profile alterations sub-IPF; COP Volume I, Section 4.3.1.3.5; Epsilon 2023). As with Phase 1, impacts of Phase 2 would likely be negligible to minor.

Installation of the SCV OECC would impact approximately 329 acres of seafloor beyond the 3-nautical-mile (3.5-mile) limit of territorial seas, including approximately 41 acres of hard protection for cables. The SCV would avoid hard-bottom habitats where feasible (Epsilon 2023). As a result, the impact magnitudes for SCV cable installation would be the same as those described for Phase 2 without the SCV.

Presence of structures: The potential impacts of Phase 2 would be similar to those of Phase 1. The applicant estimates that approximately 6 to 8 percent of the OECC route may require cable protection measures, totaling up to 32 acres within the main OECC, up to 38 acres if the Western Muskeget Variant is used, although some of the cable protection could be placed outside the geographic analysis area for coastal habitats and fauna (COP Volume I, Section 4.3.1.13; Epsilon 2023). Approximately half of the Phase 2 cable protection would be installed within 3 nautical miles (3 miles) of the high tide line (i.e., USACE jurisdiction under CWA Section 404 [Epsilon 2022a]). The SCV would require up to 41 acres of cable protection, potentially in addition to the protection for the main OECC or Western Muskeget Variant (Epsilon 2023). Phase 2 would not add any new structures in estuarine coastal habitats. The hard protection could result in a minor beneficial and minor impact on coastal habitats and fauna. Phase 2 would cause local and minor beneficial impacts and minor impacts on coastal habitats and fauna through this IPF.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in

Table G.1-2 in Appendix G would contribute to impacts on coastal habitats and fauna through the primary IPFs of anchoring and gear utilization, cable maintenance and emplacement, and climate change. These impacts would primarily occur through seafloor disturbance, sedimentation, and dredging. The impacts of Alternative B would only overlap with other ongoing and planned activities where cables from SouthCoast Wind cross the cables from the proposed Project, or where seafloor disturbance and sedimentation from the proposed Project affects the same area previously affected by installation of the Vineyard Wind 1 OECC. As a result, the cumulative impacts on coastal habitats and fauna would be **moderate** and **minor** beneficial due to the reef effect from hard protection areas.

Conclusions

Impacts of Alternative B. Alternative B would have **moderate** impacts and **minor** beneficial impacts on coastal habitats and fauna within the geographic analysis area based on all IPFs. Short-term impacts from anchoring and gear utilization and cable emplacement and maintenance (especially if dredging occurs) could lead to habitat and species disruption during construction and decommissioning. Impacts during operations would be less frequent and less extensive. Beneficial impacts would result from the reef effect from hard protection areas.

The applicant has committed to performing monitoring during and after construction for examining the disturbance and recovery of coastal and benthic habitats (COP Appendix III-U; Epsilon 2023) in the proposed Project area. Although this would involve localized disturbances of the seafloor habitat, the results would provide an understanding of the proposed Project's impacts, which would benefit future management of coastal resources in this area and could inform planning of other offshore developments. While the level of most impacts would remain the same, BOEM may include the following mitigation and monitoring measures to address impacts on coastal habitats and fauna, as described in detail in Table H-2 of Appendix H. The Final EIS lists the mitigation and monitoring measures that BOEM would require as a condition of COP approval:

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

While monitoring would not reduce impacts of Phase 1, BOEM could evaluate impacts, refine current knowledge of coastal habitats and fauna, and inform the applicant's decommissioning procedures, as well as planning similar future projects, to assist in selecting the least impactful method(s). BOEM may require the following monitoring measure conditioned as part of the COP approval (Appendix H):

- Provide additional review and comment on the benthic monitoring plan.

Cumulative Impacts of Alternative B. Cumulative impacts on coastal habitats and fauna would primarily occur during construction, especially where proposed Project construction overlaps spatially or temporally with construction of Vineyard Wind 1 or SouthCoast Wind. The impact ratings include the short-term **moderate** impacts during construction from anchoring and gear utilization and cable emplacement and maintenance (specifically dredging). Alternative B would also have long-term and **minor** beneficial impacts associated with the presence of structures, specifically where hard cover and cable protection are installed, which would result in the conversion of some soft-bottom habitat to a rarer hard habitat and an increase in faunal diversity.

3.5.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Coastal Habitats and Fauna

When analyzing the impacts of Alternative C on coastal habitats and fauna, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for coastal habitats and fauna. Alternatives C-1 and C-2, summarized below, would limit the number of export cables installed in the Eastern Muskeget route or Western Muskeget Variant but would not affect the number or placement of WTGs or ESPs for the proposed Project, compared to Alternative B. All other proposed Project components, including construction, operations, and decommissioning, would align with Alternative B:

- Alternative C-1 would avoid impacts on complex habitats in the Western Muskeget Variant by removing that route as an option for Phase 2. Under this alternative, all three Phase 2 export cables would be installed in the Eastern Muskeget route, as well as both cables for Phase 1.
- Alternative C-2 would limit the number of export cables installed in the Eastern Muskeget route to three (both Phase 1 cables and one Phase 2 cable) and would include installation of up to two cables in the Western Muskeget Variant. This would reduce impacts on complex habitats in the Eastern Muskeget route.

Alternatives C-1 and C-2 would reduce or avoid impacts on coastal habitats and fauna (compared to Alternative B) during construction, operations, and decommissioning in either the Western Muskeget Variant or Eastern Muskeget route. This would reduce the impacts from the IPFs described for Alternative B in Section 3.5.2.3, in the specific area avoided.

The Western Muskeget Variant would affect less seafloor acreage than the Eastern Muskeget route; however, the Western Muskeget Variant is comprised of complex seafloor only, while the Eastern Muskeget route is comprised of complex seafloor, hard coarse deposits, and soft bottom. Because of the rare habitats provided by complex and hard coarse deposit seafloor types, avoidance of disturbance of these habitats would also result in lower impacts on coastal habitats and fauna (additional discussion is provided in Section 3.4.2.4).

Alternative C-1 would use only the Eastern Muskeget route, which would eliminate impacts on coastal habitats and fauna in the Western Muskeget Variant. The Eastern Muskeget route contains more types of habitat than the Western Muskeget Variant but less of the habitat is complex seafloor. Using only the Eastern Muskeget route in Alternative C-1 would, therefore, impact more habitat types and a wider variety of species inhabiting these habitats than if the Western Muskeget Variant were used. However, Alternative C-1 would impact less of the complex habitat compared to Alternative B (which includes the potential use of the Western Muskeget Variant).

Alternative C-2 could use both the Eastern Muskeget route and the Western Muskeget Variant, impacting coastal habitats and fauna in complex seafloor, hard coarse deposits, and soft bottom habitats across a larger area than Alternative C-1. Under Alternative C-2, dredging for Phase 2 cable installation could impact up to 73 acres and include up to 274,800 cubic yards of dredged material (compared to 67 acres and 235,400 cubic yards for Alternative B and Alternative C-1). Because Alternative C-2 would involve installation of fewer cables in the Eastern Muskeget route, the impacts of Alternative C-2 on coastal habitats and fauna in the Eastern Muskeget route would be less than those under Alternative C-1, and potentially less than those of Alternative B because Alternative C-2 would involve installation of fewer cables in the Eastern Muskeget route. The impacts of Alternative C-2 on coastal habitats and fauna in the Western Muskeget Variant would be greater than Alternative C-1, due to the installation of up to two cables in that corridor (where no such cables would be installed under Alternative C-1 and most scenarios of Alternative B, as shown in Table 2.1-2 in Chapter 2, Alternatives). Overall, Alternative C-2 would have greater impacts than Alternative C-1 on coastal habitats and the fauna found in complex seafloor habitats due to impacts within both the Eastern and Western Muskeget.

Overall, similar to Alternative B, the impacts of Alternatives C-1 and C-2 on coastal habitats and fauna would remain **moderate** and **minor** beneficial due to the reef effect from hard protection areas. Although Alternative C-1 would result in a slightly shorter cable route due to use of the Eastern Muskeget route compared to cable placement in both the Eastern Muskeget route and the Western Muskeget Variant in Alternative C-2, the differences in route length are not expected to result in a difference of potential impacts on coastal habitats and fauna. The cumulative impacts from ongoing and planned activities, including Alternatives C-1 and C-2, would be similar to those of Alternative B: **moderate** and **minor** beneficial.

3.5.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Coastal Habitats and Fauna with the Western Muskeget Variant Contingency Option

Impacts on coastal habitats and fauna from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B. While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential for up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would not change the potential impacts on coastal habitats and fauna, as reducing the number of WTG and/or ESP foundations to be installed in the SWDA would not change proposed Project activities or impacts within the OECC.

The Preferred Alternative would result in the same level of adverse impacts as Alternative B. The Preferred Alternative would have **moderate** impacts on coastal habitats and fauna within the geographic analysis area, as well as **minor** beneficial impacts from the reef effect caused by hard cable protection areas. The cumulative impacts of the Preferred Alternative would be the same as Alternative B: **moderate** adverse impacts during construction from anchoring and gear utilization and **minor** beneficial impacts associated with the presence of structures and hard cable protection.

3.6 Finfish, Invertebrates, and Essential Fish Habitat

3.6.1 Description of the Affected Environment

3.6.1.1 Geographic Analysis Area

This section discusses existing finfish and invertebrate resources and their respective designated EFH in the geographic analysis area, as defined in Table D-1 in Appendix D, Geographical Analysis Areas, and illustrated on Figure 3.6-1. Specifically, the geographic analysis area for finfish, invertebrates, and EFH spans the southern New England subregion of the Northeast U.S. Continental Shelf Large Marine Ecosystem (LME), which extends from the southern edge of the Scotian Shelf (in the Gulf of Maine) to Cape Hatteras, North Carolina. The northern portion of the geographic analysis area includes only U.S. waters (Figure 3.6-1). Although EFH and most benthic invertebrates could be affected by the proposed Project and other activities only within the proposed Project area and a small distance beyond, migratory species and planktonic life stages of finfish and invertebrates could also be affected by other factors when the species move elsewhere within the broader geographic analysis area.

The following are agencies, commissions, councils, and regulations responsible for managing the finfish, invertebrates, and EFH in the geographic analysis area:

- The Atlantic States Marine Fisheries Commission (ASMFC) is responsible for managing or co-managing 27 coastal shellfish, marine, and diadromous fish species in state waters in cooperation with NOAA (ASMFC 2018).
- The New England and Mid-Atlantic Fishery Management Councils manage a total of 40 species in federal waters in cooperation with NOAA.
- NOAA uses a single Fisheries Management Plan (FMP) under the MSA (NOAA 2021) to manage 43 Atlantic highly migratory species (HMS) in the Exclusive Economic Zone, which extends from the 3-nautical-mile (3.4-mile) limit to the 200-nautical-mile (230-mile) limit.
- Section 7(a)(2) of the ESA requires federal agencies to ensure that any action they authorize, fund, or carry out is unlikely to jeopardize an endangered or threatened species, in consultation with the relevant agency(ies). BOEM has identified 6 listed species and 15 candidate species or species of concern as potentially occurring in the SWDA and OECC (BOEM 2019c).
- Section 305(b)(2) of the MSA requires federal agencies to consult with NMFS regarding any of their actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect EFH (50 CFR § 600.920).

3.6.1.2 Existing Conditions

The proposed Project area is located south of Cape Cod in the northern Mid-Atlantic Bight (MAB), part of the Northeast U.S. Continental Shelf LME (Figure 3.6-1). The benthic habitat in the SWDA is predominantly flat with sand or sand-dominated substrate that becomes increasingly muddy toward the south end of the SWDA and increasingly gravelly toward the northwest corner (COP Volume II, Section 2; Epsilon 2023). The northern MAB supports a diverse finfish and invertebrate assemblage (COP Volume I, Section 3.3.1 and Volume III, Section 6.6.1; Epsilon 2023). Additional descriptions of fish and invertebrate species in the proposed Project area can be found in other BOEM EISs for offshore wind projects in the region (BOEM 2012a, 2012b, 2014a). The Programmatic EIS for Alternative Energy Development (MMS 2007) also describes the affected environment for this section of the OCS.

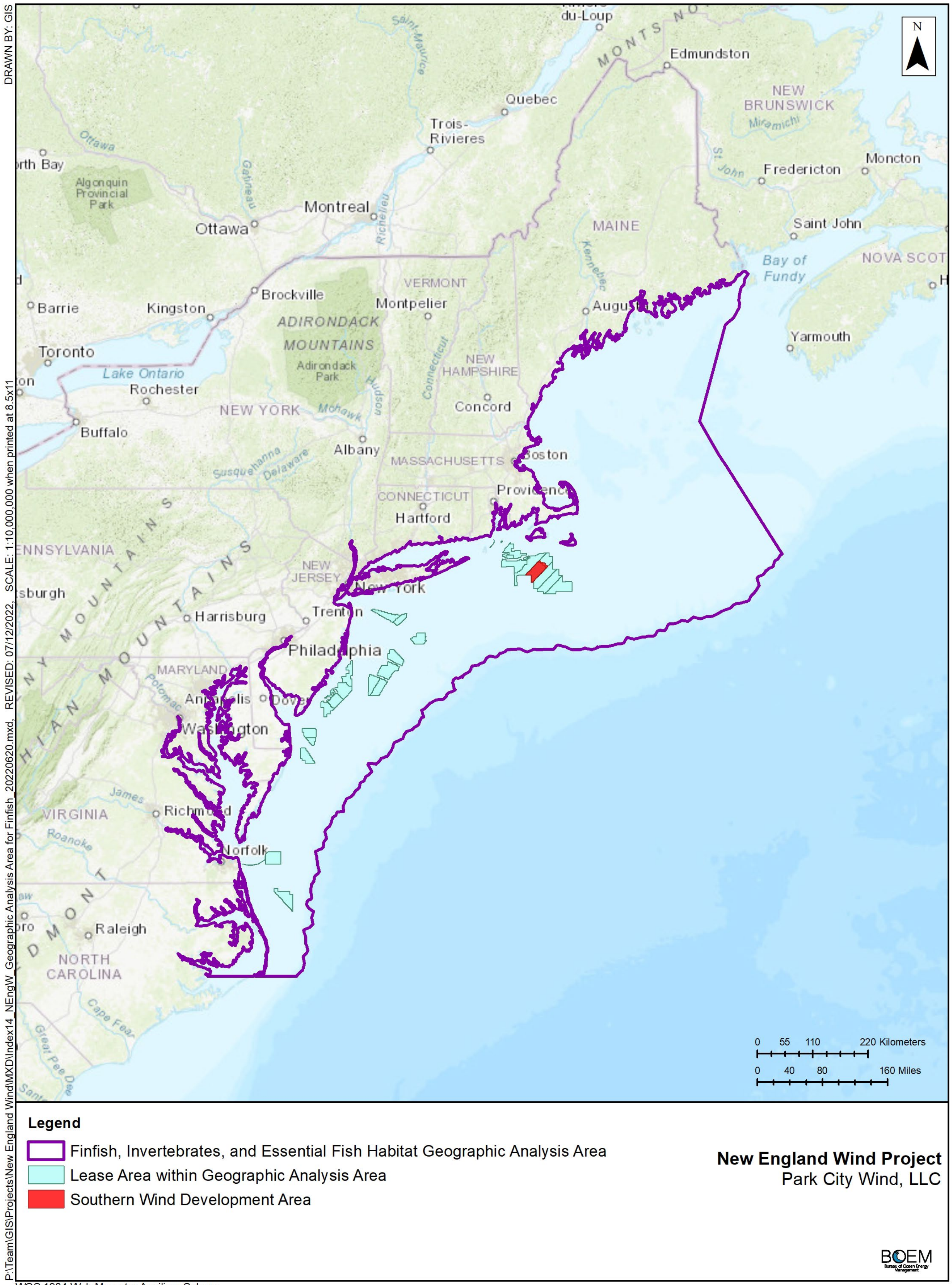


Figure 3.6-1: Geographic Analysis Area for Finfish, Invertebrates, and Essential Fish Habitat

The finfish that inhabit the proposed Project area located within the southern New England subregion are a mix of demersal, coastal pelagic, and oceanic pelagic HMS with boreal, cold temperate, and warm temperate affinities. This subregion differs from others in productivity, species assemblage composition, and habitat features (Cook and Auster 2007). The COP (Volume III, Table 6.6-1; Epsilon 2023) lists 87 species of finfish and invertebrates that have been collected within the region and within the SWDA. The species list was prepared from various sampling efforts using mainly trawl sample data collected by the Northeast Fisheries Science Center (NEFSC) since 1977 and data collected during the University of Massachusetts Dartmouth School for Marine Science and Technology fisheries surveys for Vineyard Wind 1 (Bethoney et al. 2019; COP Volume III, Section 6.6.1; Epsilon 2023; Stokesbury et al. 2020).

The demersal fish assemblages found in the region are distributed primarily in relation to water depth and temperature (Overholtz and Tyler 1985; Gabriel 1992; Mahon et al. 1998; BOEM 2014a). These demersal finfish are represented by skates, dogfishes, requiem sharks, sea robins, hakes, anglerfishes, sculpins, seabasses, drums, tautog (*Tautoga onitis*), scup (*Stenotomus chrysops*), and flatfishes. The demersal species listed also include commercially and recreationally important species such as spiny dogfish (*Squalus acanthias*), skates, Atlantic cod (*Gadus morhua*), butterfish (*Peprilus triacanthus*), flounders, scup, black sea bass (*Centropristis striata*), silver hake (*Merluccius bilinearis*), and tautog. Many of the demersal species listed are NMFS-managed and have EFH designations. These species have defined habitat and forage preferences and life history characteristics outlined in the EFH assessment for the proposed Project (BOEM 2023a). Information concerning the commercially and recreationally important demersal species can be found in Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing.

Pelagic species found in the geographic analysis area are represented by 31 species listed in Table 6.6-1 of the COP (Volume III, Section 6.6.1; Epsilon 2023). These species represent a diverse suite of finfish families including sharks, herrings, mackerels, cobia, striped bass, bluefish, and butterfishes. Many coastal pelagic species rely on coastal wetlands, seagrass habitats, and estuaries to provide habitat for specific life stages, and many of these species migrate north and south along the Atlantic Coast during some periods of the year. In general, movement is related to sea surface temperature. These fishes use the highly productive coastal waters within the Atlantic region during the summer months and migrate to deeper and/or more distant waters for the rest of the year. General patterns include cross-shelf movements to offshore spawning areas, movements along the shelf to southerly spawning areas, and movements between coastal rivers and the coastal ocean for spawning or the reverse (diadromy) (BOEM 2015; Jacobs Engineering Group Inc. 2019; COP Volume III, Section 6.6.1; Epsilon 2023).

HMS often migrate from southern portions of the South Atlantic to as far north as the Gulf of Maine. Migrations are correlated with sea surface temperature, and these species generally migrate to northern waters in the spring, where they remain to spawn or feed until the fall or early winter (COP Volume III, Section 6.6.1; Epsilon 2023). Examples of these species with ranges that overlap the SWDA include Atlantic bluefin tuna (*Thunnus thynnus*) and basking shark (*Cetorhinus maximus*).

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

The American lobster (*Homarus americanus*) (southern New England stock) is present in this region, and the waters south of Massachusetts contain important commercial lobster fishing grounds. However, catches in southern New England have declined sharply since the late 1990s, with the largest declines occurring in the inshore fishery (Figure 1.1 in ASMFC 2015a; this figure shows statistical area 538, which includes large portions of the OECC, and statistical areas 539 and 611, which are outside of the SWDA and OECC). The commercial importance of other species, like whelks (*Buccinum undatum*) and Jonah crab (*Cancer borealis*), has increased with the decline of the American lobster fishery, with Massachusetts accounting for 68 percent of the 15 million pounds of Jonah crab landed in 2016 (ASMFC 2015b). More than 70 percent of the Jonah crab catch in southern New England came from the region that includes portions of the SWDA and OECC (statistical area 537 of Figure 4 in ASMFC 2015b). Jonah crab are typically associated with rocky habitats and soft sediment, while lobster prefer hard-bottom habitat (ASMFC 2015a; Collie et al. 2019). Atlantic horseshoe crab (*Limulus polyphemus*) stocks are in decline (ASMFC 2013). According to the MA DMF (2016b, 2018), nesting Atlantic horseshoe crabs use Covell's Beach from late spring to early summer.

MA DMF identified a total of 85 species (or higher taxa) during spring sampling (1978 to 2018) and 115 taxa during fall sampling (1978 to 2017). The top five most commonly encountered species in spring samples based on percent occurrence in descending order were spider crabs, longfin squid, winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), and northern sea robin (*Prionotus carolinus*). During fall sampling, the most commonly encountered species were scup, longfin squid, butterfish, black sea bass, and spider crabs (Camissa, Pers. Comm., July 25, 2018).

HMS with ranges overlapping the SWDA and OECC are identified and described in BOEM (2014a) and in Epsilon 2023 (Volume III, Section 6.6.1.1). Several of these HMS have designated EFH within the SWDA and OECC (COP Appendix III-F, Section 4.0; Epsilon 2023). NEFSC captured a total of 71 taxa during the winter/spring trawl and 81 taxa in the summer/fall trawl (Guida et al. 2017), indicating the SWDA is located within an area of relatively high species richness (COP Volume III, Figure 6.6-1; Epsilon 2023). Biomass is low across the SWDA in spring but is high during the fall (COP Volume III, Figure 6.6-2; Epsilon 2023).

The finfish and invertebrate resources identified in the MA DMF OECC trawl surveys vary seasonally, with commercial species like longfin squid and winter flounder more prevalent in the spring; and scup, longfin squid, and butterfish more commonly captured in the fall (Camissa, Per. Comm., July 25, 2018). Longfin squid occurred in 89.6 percent of the spring surveys (1978 to 2018) and in 99.7 percent of the fall surveys (1978 to 2007). Longfin squid are typically most abundant in southern New England in the spring through fall, whereas shortfin squid juveniles are typically found in spring and summer (BOEM 2014a). Longfin squid in this region spawn throughout the summer and early fall (MA DMF 2020). Longfin squid egg mops, which are demersal, were more prevalent during spring surveys (8.2 percent occurrence) than in fall surveys (5.5 percent occurrence) (Camissa, Per. Comm., July 25, 2018). Egg mop mapping by MA DMF indicates that egg mops are routinely identified along the OECC route (COP Volume III, Section 6.6, Figures 6.6-10, 6.6-11; Epsilon 2023).

3.6.1.3 Essential Fish Habitat

The MSA requires federal agencies to consult on activities that may affect EFH identified in FMPs. In the northern region on the MAB, NMFS works with the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council (MAFMC), and the South Atlantic Fishery Management Council, and the Atlantic Office of Highly Migratory Species to define EFH for managed species within New England waters. As presented in the EFH assessment (BOEM 2023a), 48 federally managed finfish and invertebrate species have at least one life stage with EFH within the SWDA and OECC (COP Appendix III-F, Section 4.0; Epsilon 2023). Both substrate and water habitats are cited as EFH within both the SWDA and OECC. The EFH assessment provides a formal EFH assessment including relevant managed species within each of the fishery management councils within the proposed Project SWDA and OECC.

Three basic marine habitat types occur in the region: pelagic (water column), soft bottom, and hard bottom. In inshore waters, additional biogenic habitats such as emergent vegetation, submerged vegetation, and oyster reefs are important. Various managed species use these inshore habitats for shelter, feeding, growth, and reproduction. The northern MAB pelagic habitats support longfin inshore squid (*Doryteuthis pealeii*) and northern shortfin squid (*Illex illecebrosus*); coastal pelagic fishes such as Atlantic mackerel (*Scomber scombrus*), Atlantic herring, butterfish, bluefish (*Pomatomus saltatrix*), and spiny dogfish; and oceanic pelagic fishes such as tunas, swordfish (*Xiphias gladius*), and sharks. Members of the oceanic pelagic group (e.g., HMS) can span the entire geographic analysis area through migratory, feeding, and reproductive activity (NMFS 2006, 2017). Within this group, NMFS has developed FMPs for 12 Atlantic species that can range from the South Atlantic Bight up into the northern MAB on a seasonal basis (NMFS 2017; BOEM 2015).

Managed soft-bottom demersal species include Atlantic surf clam, Atlantic sea scallop, and ocean quahog. Soft-bottom fishes with EFH in the proposed Project area include summer flounder (*Paralichthys dentatus*), scup, monkfish (*Lophius americanus*) and spiny dogfish and a suite of species included in the New England Fishery Management Council's Northeast Multispecies (groundfish) FMP. The NEFSC plan includes 12 soft-bottom species that are generally found within the Gulf of Maine and Georges Bank, but the range for some of these managed species can extend from Cape Hatteras, North Carolina, to the U.S./Canada border and beyond. The three most valued species within this group include Atlantic cod, haddock (*Melanogrammus aeglefinus*), and the yellowtail flounder (*Limanda ferruginea*).

Black sea bass is an example of a hard-bottom species with EFH in the proposed Project area. Inshore habitats provide shelter for early life stages of summer flounder, striped bass (*Morone saxatilis*), bluefish, weakfish (*Cynoscion regalis*), black seabass, and scup. All major MAB habitats will produce prey such as benthic invertebrates, anchovies, silversides, herrings, and sand lances, which are important to many managed species (Kritzer et al. 2016).

The fishery management councils also identify habitat areas of particular concern (HAPC). HAPCs are discrete subsets of EFH that provide important ecological functions or are especially vulnerable to degradation. One recently developed HAPC is located within the SWDA (152,940.4 acres), and HAPCs for summer flounder (20,643.3 acres) and juvenile Atlantic cod (14,633.7 acres) occur within the OECC. Recent research completed and published by The Atlantic Cod Stock Structure Working Group (McBride and Smedbol 2022) indicate that distinctive subpopulations designated as the Southern New England stock spawn within the SWDA from November through March. Atlantic cod-spawning activity has been associated with specific seafloor features such as Cox Ledge. Although research is ongoing, no specific recurring aggregations or features have been identified within the SWDA (Van Hoeck et al. 2023). To further manage habitat for all Atlantic cod life stages and other managed species, NEMFC has designated a new Southern New England HAPC. On July 18, 2022, the New England Fishery Management Council approved a new 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 6.2-mile buffer around the RI/MA Lease Areas and Massachusetts wind energy areas (NEFMC 2022), as presented in the EFH assessment (BOEM 2023a). The designation is intended to protect important complex habitats within this area, emphasizing currently known and potentially suitable areas used by Atlantic cod for spawning (Van Hoeck et al. 2023; NEFMC 2022). Complex habitats within this HAPC are not only important to Atlantic cod but also for other managed species, including Atlantic herring, Atlantic sea scallop, little skate, monkfish, ocean pout (*Macrozoarces americanus*), red hake, silver hake, windowpane flounder, winter flounder, winter skate, and yellowtail flounder.

Listed Endangered Species

Fish species that might occur within the SWDA, OECC, and areas of activity within the geographic analysis area that are listed under the ESA and identified by NOAA (NOAA 2022a) to be within the New England/MAB region include the endangered Atlantic salmon, (*Salmo salar*), shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrhynchus oxyrinchus*), giant manta ray (*Manta birostris*), oceanic whitetip shark (*Carcharhinus longimanus*), and scalloped hammerhead sharks (*Sphyrna lewini*; BOEM 2023a; NOAA 2022a, 2022b). More information on these ESA-listed species may be found in the Biological Assessment (BA) for the proposed Project (BOEM 2023b).

The Atlantic salmon geographic range of the Gulf of Maine distinct population segment (DPS) is the Dennys River watershed to the Androscoggin River (74 Fed. Reg. 29343 [June 19, 2009]). Freshwater habitats in the Gulf of Maine provide spawning habitat and thermal refuge for adults; overwintering and rearing areas for eggs, fry, and parr; and migration corridors for smolts and adults (Bardonnet and Bagliniere 2000). Atlantic salmon in the Gulf of Maine are known to migrate far distances in the open ocean to feeding areas in the Davis Strait between Labrador and Greenland, which is approximately 2,486 miles from their natal rivers (Danie et al. 1984; Meister 1984). Most Atlantic salmon (about 90 percent) from the Gulf of Maine return after spending two winters at sea; usually less than 10 percent return after spending one winter at sea, and approximately 1 percent of returning salmon are either repeat spawners or have spent three winters at sea (Baum 1997).

The shortnose sturgeon is anadromous, spawning and growing in freshwater and foraging in both the estuary of its natal river and shallow marine habitats close to the estuary (Bain 1997; Fernandes et al. 2010). Shortnose sturgeon occur in the Northwest Atlantic but are typically found in freshwater or estuarine environments. Historically, the species was found in coastal rivers along the entire east coast of North America. Within the geographic analysis area, shortnose sturgeon are found in the Saint John, Housatonic, Connecticut, Hudson, and Delaware rivers (Shortnose Sturgeon Status Review Team 2010). Generally, shortnose sturgeon spawning occurs far upstream in their natal rivers, with individuals moving downriver to the estuaries to feed, rest, and spend most of their time. They are primarily a benthic species that are rarely known to leave their natal freshwater rivers (Kieffer and Kynard 1993; NMFS 2015); therefore, their presence in the marine environment is uncommon (Baker and Howsen 2021). Movement of shortnose sturgeon between rivers is rare, though there have been some reported migrations between the Connecticut and Hudson rivers (Shortnose Sturgeon Status Review Team 2010).

The Atlantic sturgeon is a large, long-lived, benthic fish found from Canada to Florida in river, estuarine, marine coastal, and OCS habitats. Individuals can reach lengths of up to 13 feet and weigh 600 pounds or more. Atlantic sturgeon are anadromous, meaning they are born in freshwater, migrate to sea, and then back to freshwater to spawn. There are 22 rivers along the U.S. east coast that currently host spawning Atlantic sturgeon (NMFS 2023a). Spawning in rivers from Delaware to Canada occurs from spring to early summer; some rivers may support a second fall spawning population, though supporting data are limited (NMFS 2023a). Juveniles typically remain in their natal river for 2 to 3 years before migrating into coastal and ocean waters (NMFS 2023a). Subadults move out to estuarine and coastal waters in the fall; adults inhabit fully marine environments and migrate through deep water when not spawning (ASSRT 2007). While most individuals are most common near their natal river, extensive migrations within the marine environment have been documented for both adults and subadults, with some individuals traveling thousands of kilometers from their natal rivers (Kazyak et al. 2021). Five genetically DPSs make up the U.S. east coast population; the proposed Project area falls within the New York Bight DPS and also includes the Gulf of Maine DPS. However, given the species' proclivity to migrate, with extensive movements up and down the U.S. east coast and into Canadian waters, Atlantic sturgeon encountered within the proposed Project area may originate from any of the five DPSs (Kazyak et al. 2021).

The giant manta ray is the world's largest ray and can be found worldwide in tropical, subtropical, and temperate waters between 35°N and 35°S latitudes. In the western Atlantic Ocean, this includes South Carolina south to Brazil and Bermuda. However, the giant manta ray is known to follow warm Gulf Stream water intrusions into areas north of 35°N, typically in late summer and early fall when sea surface temperatures are the highest (Farmer et al. 2022). Sighting records of giant manta rays in the Mid-Atlantic and New England are, therefore, rare, but individuals have been observed as far north as New Jersey (Miller and Klimovich 2017) and Block Island (Gudger 1922). Additionally, these rays frequently feed in waters at depths of 656 to 1,312 feet (NMFS 2022a), depths much greater than waters found within the proposed Project area. Giant manta rays travel long distances during seasonal migrations and may be found in upwelling waters at the shelf break south or east of the proposed Project area. There is a small chance that the transport of foundation and WTG components from Europe could traverse some upwelling areas. Additionally, vessels transiting between the proposed Project area and Paulsboro could potentially encounter giant manta rays off New Jersey.

Scalloped hammerhead sharks are moderately large sharks with a global distribution. Scalloped hammerhead sharks from the Eastern Atlantic DPS, which occur in the Eastern Atlantic and Mediterranean Sea (79 Fed. Reg. 38213 [July 3, 2014]), are not expected within the proposed Project area. The primary factors responsible for the decline of the listed scalloped hammerhead shark DPSs are overutilization, due to both catch and bycatch of these sharks in fisheries, and inadequate regulatory mechanisms for protecting these sharks, with illegal fishing identified as a significant problem (79 Fed. Reg. 38213 [July 3, 2014]). There is no information to suggest that the data collection, construction, operations, or decommissioning activities associated with the Proposed Action would have any impact on this species.

The oceanic whitetip shark, listed as threatened in 2018 (83 Fed. Reg. 4153 [January 30, 2018]), is usually found offshore in the open ocean, on the OCS, or around oceanic islands in deep water greater than 184 meters. As noted in the status review for whitetip shark (Young et al. 2017), the species has a clear preference for open ocean waters between 10°N and 10°S but can be found in decreasing numbers out to latitudes of 30°N and 35°S, with abundance decreasing with greater proximity to continental shelves. In the western Atlantic, oceanic whitetips occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. Oceanic whitetip sharks are not known to occur in waters less than 328 feet in the proposed Project area. There is no information to suggest that the data collection, construction, operations, or decommissioning activities associated with the Proposed Action would have any impact on this species.

Trends

Finfish, invertebrates, and EFH in the geographic analysis area are subject to pressure from ongoing activities, especially harvest, bycatch, water quality issues, dredging and bottom trawling, and climate change. In the 2000s, the majority of commercially exploited stocks within the geographic analysis area were categorized as overfished. An overfished conditioned means that the fisheries harvest is at a rate that surpasses its ability to replenish the population at a maximum sustainable yield (NMFS 2021c).

A 2015 assessment of 20 groundfish species in the southern New England subregion indicates that while the number of overfished stocks has generally decreased, depletion continues for certain stocks (NEFSC 2015). In particular, winter flounder, yellowtail flounder, and Atlantic wolffish (*Anarhichas lupus*) remain overfished (NEFSC 2015). Recent assessments indicate that 17 fish stocks are currently overfished, while another 5 stocks are subject to overfishing, meaning that the harvest rate exceeds the maximum sustainable yield (NMFS 2021c). Stock assessments for the American lobster within southern New England have demonstrated a precipitous decline since the early 2000s (ASMFC 2020). Lobster fisheries in the Gulf of Maine and Georges Bank are considered in good standing, although the lobster fishery in southern New England is considered depleted but not overfished. This may be indicative of the overall population trend of fish stocks; however, ongoing commercial and recreational regulations for finfish and shellfish implemented and enforced by states, municipalities, and/or NOAA, depending on jurisdiction, affect finfish, invertebrates, and EFH by modifying the nature, distribution, and intensity of fishing-related impacts, including those that disturb the seafloor (trawling, dredge fishing).

The understanding and rebuilding of finfish and invertebrate stocks are complicated by variables such as long-term shifts occurring at the base of the food web (Perretti et al. 2017) and warming ocean temperatures (Hare et al. 2016). Commercial and recreational fishing results in mortality of finfish and invertebrates through harvest and bycatch of undersized individuals or non-target species. Commercial and recreational fishing gear are periodically lost, but they can continue to capture or otherwise harm finfish and invertebrates; the lost gear, moved by currents, create small, short-term, localized impacts.

Water quality impacts from ongoing onshore and offshore activities affect nearshore habitats and food webs. Dredging for navigation, marine minerals extraction, and/or military uses, as well as commercial fishing using bottom trawls and dredge fishing methods, disturbs seafloor habitat on a recurring basis. Ongoing impacts resulting from fishing pressure, especially via dredging and bottom-trawling gear, will continue regardless of the offshore wind industry. Dredging for navigation, marine minerals extraction, and/or military uses disturbs swaths of seafloor habitat. Their impacts are similar in nature but much greater in extent (spatially and temporally) than those caused by other bottom-directed activities, such as pipeline trenching or submarine cable emplacement that create a relatively narrow trench and backfill in the same operation. See Section G.2.2 for more information on water quality.

Recent NMFS recovery programs have returned some fisheries stocks to stable levels within the geographic analysis area, but assessments of fisheries distributions have shown shifts of species ranges related to warming trends within the mid-Atlantic (NMFS 2021d). For example, unseasonably high water temperatures resulting from a shift in the Gulf Stream toward the New England coast and elevated pH levels in southern New England and MAB have caused a shift in the distribution of surf clam and ocean quahogs (NMFS 2021d). The ranges of both species have begun to overlap, with surf clam and ocean quahog distributions moving into deeper water and trending to the northeast (NMFS 2021d). Regional water temperatures that increasingly exceed the thermal stress threshold (20°C) may affect the recovery of the American lobster stock (ASMFC 2015a). Impacts on finfish, invertebrates, and EFH depend on many factors but can be widespread and permeant due to climate change.

Invasive species are periodically released accidentally during ongoing activities, including the discharge of ballast water and bilge water from marine vessels; the resulting impacts on finfish, invertebrates, and EFH depend on many factors but can be widespread and permanent, especially if the invasive species becomes established and out-competes native fauna.

3.6.2 Environmental Consequences

Definitions of impact levels for finfish, invertebrates, and EFH are described in Table 3.6-1.

Table 3.6-1: Impact Level Definitions for Finfish, Invertebrates, and Essential Fish Habitat

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

3.6.2.1 Impacts of Alternative A – No Action Alternative on Finfish, Invertebrates, and Essential Fish Habitat

When analyzing the impacts of Alternative A on finfish, invertebrates, and EFH, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for finfish, invertebrates, and EFH (Table G.13 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for finfish, invertebrates, and EFH described in Section 3.6.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on finfish, invertebrates, and EFH include increasing vessel traffic; new submarine cables and pipeline; increasing onshore construction; marine surveys; marine minerals extraction; port expansion; channel-deepening activities; beach nourishment projects; the installation of new towers, buoys, and piers; and construction of approved offshore wind projects such as Vineyard Wind 1, Revolution Wind, and others listed in Appendix E.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind development activities would affect finfish, invertebrates, and EFH through the following primary IPFs.

Accidental releases: Accidental releases may increase as a result of future offshore wind activities. As discussed in Section G.2.2, Water Quality, releases could expose coastal and offshore waters to contaminants in the event of a spill or release during routine vessel use, collisions and allisions, or equipment failure of a WTG or ESP. The risk of any type of accidental release would be increased primarily during construction but also during operations and decommissioning of offshore wind facilities. The 3,104 WTGs and ESPs under Alternative A collectively hold approximately 119 million gallons of fuel/fluids/hazardous materials contained in all offshore wind facilities. The risk of a release from any one of these structures would be low. A release of 128,000 gallons is likely to occur no more often than once per 1,000 years, and a release of 2,000 gallons or less is likely to occur every 5 to 20 years (Bejarano et al. 2013). The likelihood of a spill occurring from multiple WTGs and ESPs at the same time is very low and, therefore, the potential impacts from a spill larger than 2,000 gallons are largely discountable. Based on these rates, the additional impact of releases from future offshore wind facilities, the risk of which would primarily exist during construction but also during operations and decommissioning, would fall within the range of accidental releases that already occur on an ongoing basis.

Invasive species can be released accidentally, especially during ballast water and bilge water discharges from marine vessels. Increasing vessel traffic related to the offshore wind industry would increase the risk of accidental releases of invasive species, primarily during construction. The impacts of releases of invasive species on finfish, invertebrates, and EFH depend on many factors but could be widespread and permanent. Releases of invasive species may or may not lead to the establishment and persistence of invasive species. Invasive species becoming established as a result of offshore wind activities is possible. As documented in observations of colonial sea squirt (*Didemnum vexillum*) at the Block Island Wind Farm (HDR 2020b), the impacts of invasive species on finfish, invertebrates, and EFH could be strongly adverse, widespread, and permanent if the species were to become established and out-compete native fauna or modify habitat. The increase in this risk related to the offshore wind industry would be small in comparison to the risk from ongoing activities. For example, colonial sea squirt is already an established species in New England with documented occurrence in subtidal areas, including on Georges Bank, where numerous sites within a 56,834-acre area are 50 to 90 percent covered by colonial sea squirt (Bullard et al. 2007).

Trash and debris accidentally released into the marine environment can harm marine animals through entanglement and ingestion. These releases would be infrequent because operators would comply with federal and international requirements for management of shipboard trash, which are covered in more detail in Table H-2 in Appendix H, Mitigation and Monitoring, and the extent of an accidental release would be limited to the localized area.

Overall, accidental releases are anticipated to be short term and localized and result in little change to finfish, invertebrates, and EFH. As such, accidental releases from future offshore wind development would not be expected to contribute appreciably to overall impacts on finfish, invertebrates, and EFH, with the exception of invasive species, which could cause permanent alterations to the ecosystem.

Anchoring and gear utilization: Ongoing and planned offshore wind activities are likely to include monitoring surveys in the offshore wind lease areas. These could include acoustic, trawl, and trap surveys, as well as other methods of sampling the biota in the area. The presence of monitoring gear could affect finfish, invertebrates, and EFH by entrapment, entanglement, or seafloor disturbance; however, it is expected that monitoring plans would have sufficient mitigation procedures in place to reduce potential impacts. Impacts from gear utilization from other offshore wind activities are expected to occur at short-term, regular intervals over the lifetime of the projects and have no perceptible consequences to individuals, populations, or habitat. However, the potential extent of potential impacts cannot be determined without proposed Project-specific information. Vessel anchoring can cause temporary to permanent impacts in the immediate area where anchors and chains meet the seafloor. Alternative A could also include increased anchoring and mooring of met towers or buoys. Anchoring would cause increased turbidity levels and have the potential to cause mortality of finfish and invertebrates and, possibly degradation of sensitive habitats. The actual impact of each anchoring event would depend on location, habitat type, and time of year. Impacts on finfish, invertebrates, and EFH are greatest for sensitive EFH (e.g., eelgrass, hard bottom) and sessile or slow-moving species (e.g., corals, sponges, and sedentary shellfish). Alternative A would include increased vessel anchoring during survey activities and construction, maintenance, and decommissioning of offshore components. Anchoring of vessels under Alternative A during cable installation could affect up to approximately 7,414 acres beginning in 2023 and continuing through 2030 and beyond. All impacts would be localized, turbidity would be temporary, and mortality from physical contact would be recovered in the short term. Degradation of sensitive habitats, if it occurs, could be long term to permanent. Anchoring is a series of separate events, each affecting only a small area of seafloor; therefore, even when multiple projects in a region occur simultaneously or consecutively, it is unlikely that a second anchor or chain would contact a portion of seafloor affected by an earlier anchor or chain.

Cable emplacement and maintenance: Cable emplacement and maintenance activities could disturb, displace, and injure finfish and invertebrates and result in temporary turbidity and short-term to long-term habitat alterations. The intensity of impacts would depend on the time (season) and place (habitat type) activities occur. This IPF would cause impacts during construction. Assuming other offshore wind projects use installation procedures similar to those described for the proposed Project (COP Volume I, Section 3.3.1.3; Epsilon 2023), the extent of impacts would be anticipated to include an up to 3.3-foot-wide cable installation trench and an up to 10-foot-wide temporary disturbance zone from the skids/tracks of the cable installation equipment. Finfish, invertebrates, and most EFH would recover following disturbance, although some habitats would not fully return to their previous conditions (Hemery 2020). The cable routes for future offshore wind projects have not been fully determined at this time. Cables for other future offshore wind projects within the geographic analysis area are anticipated to occur over the next 8 years and beyond. The total area of seafloor disturbed by cable emplacement for offshore wind facilities on the Atlantic OCS is estimated to be up to 70,706 acres (Appendix E). The geographic analysis area for finfish, invertebrates, and EFH contains over 16 million acres of gravel or hard bottom, over 46 million acres of sand bottom, and over 15 million acres of silt/mud bottom (The Nature Conservancy 2014). The affected area for any one of those sediment types would be less than 0.1 percent of the total area of that type. Short-term impacts on populations could occur in the immediate vicinity of installation activities. Turbidity would be increased during construction for 1 to 6 hours at a time. Cable routes that intersect HAPCs including, but not limited to, eelgrass and hard-bottom habitats may cause long-term to permanent impacts on those resources; otherwise, impacts of habitat disturbance and mortality from physical contact would be recovered in the short term.

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

Dredged material disposal during construction would cause temporary, localized turbidity increases and long-term sedimentation or burial at the immediate disposal site. Cable emplacement and maintenance activities (including dredging) during construction or operations of future offshore wind projects could cause sediment suspension for 1 to 6 hours at a time, after which the sediment is deposited on the seafloor. Sediment deposition could have impacts on demersal eggs and larvae, such as longfin squid eggs (which are known to have high rates of mortality if egg masses are exposed to abrasion or burial), winter flounder eggs, and shellfish larvae. Impacts may vary based on season or time of year and location (i.e., habitat type). The cable routes for future projects within the geographic analysis area have not been fully determined but would be emplaced over the next 8 years and beyond. Locations, amounts, and timing of dredging for future offshore wind projects are not known at this time. Assuming the areal extent of sediment deposition and burial impacts is proportional to the length of cable installed (Appendix E), Alternative A (excluding the proposed Project) would result in 374,010 acres of light sedimentation (up to 0.04 inch deep).[20] Increased sediment deposition may occur during multiple years. The area with a greater sediment deposition from simultaneous or sequential activities would be limited, as most of the impacted areas would only be lightly sedimented and would recover naturally in the short term.

Climate change: Finfish, invertebrates, and EFH may be affected by climate change, primarily from increasing ocean surface and bottom temperatures, which has been shown to impact the distribution of fish in the northeast United States, with several species shifting their centers of biomass either northward or to deeper waters (Gaichas et al. 2015; Hare et al. 2016). As a result of climate change, the composition of the fish assemblage in any particular location, and the seasonal dynamics of that assemblage, may change, potentially leading to changes in fishing activity. Warming of ocean waters is expected to influence the migrations of finfish and invertebrates and may influence the frequencies of various diseases (Brothers et al. 2016; Hoegh-Guldberg and Bruno 2010). CO_2 emissions also cause ocean acidification, possibly contributing to reduced growth or the decline of invertebrates that have calcareous shells (PMEL 2020). See Section G.2.1, Air Quality, for details on the expected contribution of offshore wind activities to climate change.

EMF: Biologically significant impacts on finfish, invertebrates, and EFH have not been documented for EMF from AC cables (CSA Ocean Sciences, Inc. and Exponent 2019; Thomsen et al. 2015). In the United States, behavioral impacts have been documented for benthic species (skate and lobster) near operating DC cables (Hutchison et al. 2018, 2020b). The impacts are localized and affect the animals only while they are within the EMF. A recent review concludes that research has demonstrated responses to EMF in various species but not at the EMF strengths involved in marine renewable energy projects (Gill and Desender 2020). Operating cables related to future offshore wind activities other than the proposed Project would produce EMF to some degree. The submarine cable routes for those projects have not been determined at this time. Alternative A would result in up to 6,552 miles of offshore export, inter-array, and inter-link cable added to the geographic analysis area, producing EMF in the immediate vicinity of each submarine cable.

Submarine cables in the geographic analysis area are assumed to be installed with appropriate shielding and/or burial depth to reduce potential EMF to low levels. EMF of any two sources would not overlap (except where cable cross each other) because developers typically allow at least 330-foot spacing between cables (even for multiple cables within a single OECC), EMF strength diminishes rapidly with distance, and potentially significant EMF would likely extend less than 50 feet from each cable. A migrating individual may encounter EMF on multiple occasions, each time potentially experiencing a behavioral impact during the time it is exposed to the EMF. Most exposures are expected to last for

[20] The Sediment Transport Modeling Report for the proposed Project (COP Appendix III-A, Table 20; Epsilon 2023) assumed deposition of up to 0.04 inch of sediment across approximately 2,740 acres for an assumed 48.0-mile export cable, or approximately 57.1 acres per linear mile. For the 6,552 miles of export cable assumed in Alternative A, this equates to approximately 374,010 acres of light sedimentation.

minutes, not hours, and the affected area would represent only a negligible portion of the available habitat for most migratory species, many of which travel several miles in a day (CSA Ocean Sciences, Inc. and Exponent 2019). EMF from high voltage DC cables does not appear to constitute a barrier to migration (Kavet et al. 2016), and there is no evidence to indicate that EMF from submarine AC power cables affects commercially and recreationally important fish species within the southern New England area (CSA Ocean Sciences, Inc. and Exponent 2019). Although the EMF would exist as long as a submarine cable was in operation, impacts on finfish, invertebrates, and EFH would likely be biologically insignificant.

Lighting: Light can attract finfish and invertebrates, potentially affecting distributions in a highly localized area. Light can also disrupt natural cycles such as spawning. Offshore wind development would result in additional light from vessels and offshore structures. Downward-directed deck lighting would have a much greater impact than the navigational lights required on vessels or structures. Vessels would be lit during construction, operations, and decommissioning and would follow BOEM lighting guidelines. The impact of lighting from Alternative A would likely be small relative to non-wind industry activities. In a maximum-case scenario, vessel lights could be active 24 hours per day during construction. This lighting could attract finfish and invertebrates to construction zones, potentially exposing them to greater harm from other IPFs (e.g., noise).

Under Alternative A, up to 3,104 WTGs and ESPs (constructed incrementally from 2023 to 2030 and beyond) would have navigation and/or aviation hazard lights during operations in accordance with BOEM's lighting and marking guidelines. Because navigation and/or aviation hazard lights are not downward-focused lighting, the amount of such light penetrating the sea surface is anticipated to be minimal and is not likely to affect finfish, invertebrates, and EFH.

Noise: Noise from construction, pile driving, G&G survey activities, aircraft, trenching, operations, vessels, and decommissioning could contribute to impacts on finfish, invertebrates, and EFH. Pile-driving noise would have the greatest impact.

Alternative A would include construction of up to 3,104 WTGs and ESPs and would create noise—including pile driving—that affects finfish, invertebrates, and EFH. Noise from pile driving would be temporary, occurring during installation of foundations for offshore structures. This noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or for 4 to 6 hours per day for the installation of two foundations per day. One or more projects may install more than one foundation per day, either sequentially or simultaneously. Construction of offshore wind facilities in the geographic analysis area would likely occur over from 2023 to 2030 and beyond. Noise transmitted through water and/or the seabed can cause injury and/or mortality to finfish (and likely to invertebrates, though research is lacking) in a limited space around each pile and can cause short-term stress and behavioral changes to individuals over a greater space. The extent of these impacts depends on pile size, hammer energy, local acoustic conditions, and attenuation level. Behavioral impacts from pile-driving noise would likely extend radially less than 8.8 miles around each pile and the radius for injury, including potential mortality, is estimated to extend up to 515 feet, given the proposed noise attenuation mitigation measures for a 12-meter (39-foot) monopile (Pyć et al. 2018; COP Volume I, Section 3.3.1.4, Volume III, Section 6.6.2, and Volume III, Appendix M; Epsilon 2023; BOEM 2021a). Based on these findings and the 1-nautical mile (1.9-kilometer, 1.15-mile) grid spacing of WTG and ESP foundations, the radius for potential injury or mortality would not overlap between any two foundations. The radius for behavioral impacts could overlap among two or more foundations if multiple piles are driven simultaneously by one project or multiple projects. With construction of all 3,104 foundations in Alternative A, the risk of injury, including potential mortality, is expected to occur over approximately 9,758 acres. Potentially injurious noise could also be considered as rendering EFH temporarily unavailable or unsuitable for the duration of the noise. The affected areas of seafloor would likely be recolonized in the short term, whereas the water around the foundation would cease to be affected immediately after the noise ceases. Eggs, embryos, and larvae of finfish and invertebrates could also experience developmental abnormalities or mortality resulting from this noise. Popper et al. (2014) identifies 210 decibels referenced to 1 micropascal (dB re 1 µPa) squared second (μPa^2 s) sound exposure level (SEL), or 207 dB re 1 µPa peak sound pressure (Lpk) as the thresholds for mortality for eggs and larvae.

The impact of pile-driving noise on finfish and invertebrates would depend on the time of year it occurs; the impact could be greater if the noise occurs in spawning habitat during a spawning period, particularly for those species that aggregate to spawn (e.g., Atlantic cod), use sound to communicate (e.g., Atlantic cod), or spawn only once during their lifetime (e.g., longfin squid). It is anticipated that most pile-driving activity would occur in the summer months when weather windows are favorable. Thus, species that spawn in the summer, such as longfin squid or bluefish, would be more susceptible to disturbance from pile-driving noise. Therefore, pile-driving noise could cause reduced reproductive success in one or more spawning seasons, which could potentially result in long-term impacts on populations if one or more cohorts suffer suppressed recruitment. Recent studies on the behavioral impacts of pile-driving noise on black sea bass and longfin squid have shown behavioral responses, but behavior returns to a pre-exposure state after the cessation of the noise (Jones et al. 2020; Shelledy et al. 2018). Jones et al. (2021) determined that longfin squid feeding behaviors and ability to capture prey was affected by playbacks of pile-driving noise in a laboratory environment. In the presence of pile-driving noise, there was a reduction in feeding success, and the introduction of pile-driving noise caused the squid to abandon predation attempts. Interestingly, additional work showed that interactions between males, as well as reproductive behaviors between males and females, were unaffected by pile-driving noise, suggesting that the motivation to mate exceeds the potential stress that noise may introduce (Stanley et al. 2023). Wilber et al. (2022) conducted a demersal trawl survey near the Block Island Wind Farm before, during, and after construction and reported the fall and spring biomass of longfin squid to vary synchronously between the wind farm area and regional surveys, suggesting the construction and operations of the wind farm had little to no impact on the local longfin squid populations. Under Alternative A, noise from pile driving could affect the same populations or individuals multiple times in a single year or in sequential years; it is currently unknown whether sequential or concurrent driving of multiple piles would have greater impacts.

Noise from G&G surveys of cable routes, unexploded ordinance (UXO), benthic resource monitoring, and other site characterization surveys for offshore wind facilities could also affect finfish, invertebrates, and EFH (Section 3.7, Marine Mammals, discusses UXO in greater detail). G&G noise would occur intermittently over an assumed construction period beginning in 2023 and extending through 2030 and beyond (Appendix E). G&G noise resulting from offshore wind site characterization surveys is less intense than G&G noise from seismic surveys used in oil and gas exploration; while air gun seismic surveys create high-intensity impulsive noise to penetrate deep into the seabed, offshore wind site characterization surveys typically use sub-bottom profiler technologies that generate the less intense sound waves needed for only shallow seabed penetration. These activities can disturb finfish and invertebrates in the investigation’s immediate vicinity and can cause temporary behavioral changes. Seismic surveys are not expected in the geographic analysis area.

Noise from aircraft, trenching/cable burial, vessels, and WTG operations are expected to occur but would have little impact on finfish, invertebrates, and EFH. Offshore wind projects may use aircraft for crew transport during operations and/or construction; however, very little of the aircraft noise propagates through the water; therefore, there is not likely to be any impact of aircraft noise on finfish, invertebrates, and EFH. Noise from trenching of inter-array and export cables would be temporary, local, and extend only a short distance beyond the emplacement corridor. Impacts of trenching/cable burial noise are typically less prominent than the impacts of the physical disturbances discussed under cable emplacement and maintenance and sediment deposition and burial. Future offshore wind activities would also increase vessel noise. Analysis of vessel noise related to the Cape Wind Energy Project found that noise levels from construction vessels at 10 feet were loud enough to induce avoidance, but not physically harm, finfish and/or invertebrates (MMS 2009). Behavioral impacts would likely be temporary.

While noise associated with operational WTGs may be audible to some finfish and invertebrates, this would only occur at relatively short distances from the WTG foundations, and there is no information to suggest that such noise would affect finfish, invertebrates, and EFH (English et al. 2017). As measured at the Block Island Wind Farm, the low-frequency noise from WTG operation barely exceeds ambient levels at 164 feet from the WTG base (Thomsen et al. 2015; Kraus et al. 2016a). This type of noise would persist for the life of each offshore wind energy project.

Port utilization: Ports throughout the geographic analysis area would likely be upgraded in response to Alternative A (Table G.1-3), increasing the total amount of disturbed habitat. Ports are largely privately owned or managed businesses that are expected to compete against each other to host offshore wind activity. For example, at Vineyard Haven, which has undergone upgrades to host operations activities for offshore wind projects, barrier beach and intertidal habitat would be affected by past and ongoing port upgrades, potentially converting these important fish habitats to developed structure. Increases in port utilization due to offshore wind projects would lead to increased vessel traffic. Port expansions would likely happen over the next 8 years and beyond, and the increase in port utilization would be at its peak during construction activities and would decrease during operations but would increase again during decommissioning. Any port expansion and construction activities related to offshore wind projects would add to the total amount of disturbed habitat. Existing ports already affect finfish, invertebrates, and EFH by temporarily displacing finfish and invertebrates and disturbing habitats, as well as permanently converting habitats. Future port expansions would implement BMPs such as stormwater management and turbidity curtains to minimize impacts (Table G.1-3). Although the degree of impacts on EFH would likely be undetectable outside the immediate vicinity of affected ports, impacts on EFH for certain species and/or life stages may lead to temporary to permanent impacts on finfish and invertebrates beyond the vicinity of the ports.

Presence of structures: The presence of structures such as buoys, met towers, foundations, scour/cable protection, and submarine cable infrastructure could affect finfish, invertebrates, and EFH through entanglement and gear loss/damage, hydrodynamic disturbance, fish aggregation, habitat conversion, and migration disturbances. The potential locations of cable protection for future projects have not been fully determined at this time. Alternative A would include up to 3,104 foundations, 5,414 acres of foundation scour protection, and 1,906 acres of new hard protection atop cables (Appendix E). Projects may also install more buoys and met towers. structures would be added intermittently beginning in 2023 and continuing through 2030 and beyond, and they would remain until decommissioning of each facility is complete (33 years) Alternative A would substantially increase the number of structures, which are presently rare in the geographic analysis area.

The presence of structures may increase private and for-hire recreational fishing effort in areas where there was no effort previously (Section 3.9; Section 3.15, Recreation and Tourism) and increase the risk of gear loss/damage by entanglement with structures, potentially leading to injury or mortality of finfish and invertebrates. Commercial fisheries operating near structures may also experience gear loss, potentially increasing the impacts of ghost fishing and other disturbances on finfish, invertebrates, and EFH. Lost commercial fishing gear moved by currents could disturb habitats and potentially harm individuals. Such impacts at any one location would likely be short term and localized, although the increased risk of occurrence would persist as long as the structures remain.

Human-made structures, especially tall vertical structures such as foundations, alter local water flow at a fine scale. A modeling study by Chen et al. (2016) found that WTG foundations in the southern New England region would not have a significant influence on southward larval transport during storm events, although foundation placement could either increase or decrease larval dispersion and speed, depending on initial location; however, the models never found the foundations to trap or block larval transport. Tank and modeling tests, such as those conducted by Miles et al. (2017) and Cazenave et al. (2016), conclude that mean flows are reduced/disrupted immediately downstream of a monopile foundation but return to background levels within a distance proportional to the pile diameter (recommended eight to ten times the pile diameter). For the piles assumed to be used in Alternative A (i.e., 7-meter [23-foot] monopiles), disruption would occur up to 230 feet from and downstream of each pile. A shelf-scale model of a contiguous 297 WTG, 1.4 GW wind development area in sandy-bottom conditions in the eastern Irish Sea indicated a 5 percent reduction in peak water velocities and found that this reduction may extend up to approximately 0.5 nautical mile (0.58 mile) downstream of a monopile foundation, and impacts varied based on array geometry (Cazenave et al. 2016). In general, modeling studies indicate that water flow typically returns to within 5 percent of background levels within a distance equivalent to 3.5 to 10 times an offshore structure's diameter (Chen et al. 2016; Miles et al. 2017). As a result, the disruption of mean flows is not likely to reach from one WTG or ESP foundation to an adjacent foundation.

Altered hydrodynamics can increase seabed scour and sediment suspension around foundations, resulting in sediment plumes. Sediment plumes around foundations, seen in shallow-water and high-current velocity systems, are not expected in the RI/MA Lease Areas or other wind development areas in the geographic analysis area, due in part to water depths, which reduce the influence of tidal forcing on hydrodynamics. Water depths in wind development areas on the OCS typically range from 59 to 197 feet, whereas early offshore wind projects in the North Sea (which are the subject of many available studies) were installed in water depths between 9.8 and 65.6 feet. While the surface currents in the U.S. wind lease areas are comparable to those at European wind developments, the bottom currents are typically less, due to the greater water depth. Lower bottom currents reduce the potential for scour, the time sediments remain suspended within the water column, and the distance suspended sediments travel. Scour protection measures, such as rock at the base of the foundations, further reduce sediment resuspension due to scour. Thus, impacts on finfish, invertebrates, and EFH from sediment resuspension near foundations are not anticipated to be measurable above existing conditions.

The changes in fluid flow caused by the presence of many structures on the OCS could also influence finfish, invertebrates, and EFH at a broader spatial scale. The existing physical oceanographic conditions in the geographic analysis area for finfish, invertebrates, and EFH, with a particular focus on the southern New England region, are described in Section D-2 of Appendix D. The spatial scale of the potential impacts of many structures on oceanographic conditions is not well known but may be on the order of 0.5 nautical mile (0.58 mile) from each structure (Section D-2).

Although waters on the OCS experience considerable vertical mixing in fall, winter, and spring, an important seasonal feature influencing finfish and invertebrates is the cold pool, a mass of cold bottom water in the MAB overlain and surrounded by warmer water. The presence of the cold pool in the MAB promotes survival of an assemblage of boreal (cold water) species generally found north of Cape Cod. Atlantic sea scallops and Atlantic surf clam are fishery species dependent on cooler waters on the shelf to support their MAB subpopulations. Demersal fishes associated with the cold pool at different stages of their life history include yellowtail flounder, winter flounder, summer flounder, windowpane flounder, witch flounder (*Glyptocephalus cynoglossus*), fourspot flounder (*Hippoglossina oblonga*), black sea bass, tautog, monkfish, spiny dogfish, and skates. The distribution of Atlantic surf clam has changed over the past 20 years in response to northward and offshore shift in cold pool spatial coverage over the same time period (Weinberg 2005; Friedland et al. 2022). Changes in the size and seasonal duration (and inshore extent) of the cold pool over the past 50 years have correlated with shifts in the demersal fish composition of the MAB (Friedland et al 2021).

The cold pool forms in late spring and persists through summer, gradually moving southwest, shrinking, and warming due to vertical mixing and other factors (Chen et al. 2018). During summer, local upwelling and mixing of the cold pool with surface waters provides a source of nutrients, influencing the ecosystem's primary productivity, which in turn influences finfish and invertebrates (Lentz 2017; Matte and Waldhauer 1984). The cold pool is a dynamic feature of the middle to outer portions of the continental shelf, but its nearshore boundary typically lies at depths from 66 to 131 feet (Brown et al. 2015; Chen et al. 2018; Lentz 2017). Offshore wind lease areas are mostly sited within depths less than 197 feet. While offshore wind foundation structures would affect local mixing of cool bottom waters with warm surface waters, the extent to which these local impacts may cumulatively affect the cold pool is not well understood. Given the size of the cold pool—approximately 11,580 square miles (NMFS 2020a)—BOEM does not anticipate that future offshore wind structures, as described in Alternative A, would affect the cold pool, although they could affect local conditions. The presence of many offshore wind structures could affect local oceanographic and atmospheric conditions by reducing wind-forced mixing of surface waters and increasing vertical mixing of water forced by currents flowing around foundations (Carpenter et al. 2016; Cazenave et al. 2016; Schultze et al. 2020a; Daewel et al. 2022). During times of stratification (summer), increased mixing could possibly increase pelagic primary productivity in local areas, possibly resulting in increased biomass of finfish and invertebrates. Changes in primary productivity might not translate into impacts on finfish and commercially important invertebrates if the increased productivity is consumed by filter feeders such as mussels that colonize the structure surfaces (Slavik et al. 2019). Increased mixing may also result in warmer bottom temperatures. Warmer bottom temperatures may increase stress on some shellfish and fishes that are at the southern/inshore extent of their temperature tolerance. Observations and model scenarios of wind wakes associated with wind energy fields have been generated by researchers working in the North Sea (Schultze et al. 2020b; Daewel et al. 2022). There is still uncertainty regarding the applicability of those models to the oceanographic environment of the northeastern U.S. continental shelf (van Berkel et al. 2020; Miles et al. 2021). The impacts on finfish and invertebrates from changes to local oceanographic and atmospheric conditions caused by the presence of offshore structures are expected to be localized and are likely to vary seasonally and regionally.

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

In addition to fish aggregation, the new structures may also provide new hard-structure habitat for structure-oriented and/or hard-bottom species, which may be beneficial (Daigle 2011). Cable protection, scour protection, and foundations would convert habitat from a soft-bottom to hard-structure habitat, although it would differ from the typical hard-bottom habitat in the geographic analysis area for finfish, invertebrates, and EFH, namely, coarse substrates in a sand matrix. This would constitute a modification of the existing soft-bottom or hard-bottom habitat, and it may or may not function similarly to hard-bottom habitat typical in the region (HDR 2019a; Kerckhof et al. 2019). Soft bottom is the dominant habitat type from Cape Hatteras to the Gulf of Maine (over 60 million acres), and species that rely on this habitat would not likely experience population-level impacts (Greene et al. 2010; Guida et al. 2017). The new surfaces could also be colonized by invasive species (e.g., certain tunicate species) found in hard-bottom habitats on Georges Bank (Frady and Mecray 2004). The new structures could create an artificial reef effect, attracting a different community of fish and invertebrates in the immediate vicinity of the structures. Species preferring hard-bottom habitat (e.g., Atlantic cod, American lobster, black sea bass, striped bass, etc.) would gain habitat, while obligate soft-bottom species (e.g., summer flounder, Atlantic surf clam, and longfin squid) would see habitat locally reduced. The attraction of structure-oriented predators (e.g., black sea bass) may affect prey species, including lobster.

The reef effect has been observed around WTGs, leading to local increases in biomass and diversity (Causon and Gill 2018); however, the diversity may decline over time as early colonizers are replaced by successional communities dominated by blue mussels (*Mytilus edulis*) and anemones (Kerckhof et al. 2019). Invertebrate and fish assemblages may develop around these reef-like elements within the first few years after construction (English et al. 2017). Although some studies have noted increased biomass and production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fishes from the surrounding areas (Causon and Gill 2018). Recent observations at the Block Island Wind Farm have reported considerable colonization by mussels (ten Brink and Dalton 2018; HDR 2019a). The potential impacts of offshore wind facilities on offshore ecosystem functioning have been studied using simulations (Raoux et al. 2017; Pezy et al. 2018) and calibrated with field observations (Wang et al. 2019). These studies indicated that the offshore wind facilities can increase bivalve biomass and shift local food webs toward detritivores.[21] They also indicated higher biomass for benthic fish and invertebrates and possibly for pelagic fish, marine mammals, and birds. Overall, omnivorous[22] behavior, energy recycling, and general ecosystem activity were all predicted to increase after offshore wind facility construction (Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019). These changes may not necessarily happen evenly across an entire offshore wind facility but are likely concentrated around the vicinity of each structure. Various attempts to measure the linear extent of the reef effect have reported distances from 52.5 feet (Stanley 1994) to 1,968.5 feet (Kang et al. 2011) from a structure, and Rosemond et al. (2018) have suggested assuming a distance of 98 to 197 feet as a first approximation. These studies indicate that offshore wind facilities can generate beneficial impacts on local ecosystems. The presence of many distinct hard-structure areas could also increase connectivity between geographically distant populations (Folpp et al. 2011; Mora et al. 2003), as the structures may provide patches of attractive habitat, helping structure-oriented species traverse the mostly sandy OCS. Structures, although creating novel habitat and potentially increasing local biodiversity and biomass, may also facilitate spread of invasive species, become predator or ecological traps, or disrupt migratory behavior in some species. Most responses to the conversion of habitat from soft to hard bottom would be species-specific and difficult to predict. The WTGs would attract structure-oriented species, such as black sea bass, which may promote elevated predation risk for newly settled or other small fishes residing at the structures (Leitão et al. 2008).

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

Long-term monitoring studies from Belgium and Denmark broadly show that long-term operational impacts of offshore wind structures on the marine benthic environment (e.g., increased animal abundances, compositional shifts) are evident close to foundations and scour protection (Lefaible et al. 2019), and no impacts have been evident at the scale of an entire facility (Bergström et al. 2014). In Belgium, monitoring conducted at wind facilities between 2005 and 2016 found the number of epibenthic and demersal-benthopelagic fish species remained similar over the years and was not affected by construction of the wind facilities (Degraer et al. 2019). Epibenthic density and biomass showed a similar

[21] A detritivore is an organism that obtains its nutrition by feeding on detritus.
[22] An omnivorous animal is one that has the ability to eat and survive on both plant and animal matter.

trend with an increase in the first 2 years after construction. These higher values, however, leveled off 3 years after construction. As for epibenthos, demersal-benthopelagic fish seemed to show more variance in densities only in the first few years after construction. These results indicate that the soft-sediment ecosystem in between the turbines (at distances greater 656 feet) has not changed substantially 5 to 6 years after construction and that species assemblages within the offshore wind energy facilities seem to be mainly structured by temporal variability at larger spatial scales (e.g., temperature fluctuations, hydrodynamic changes, plankton blooms). Similar to studies in other parts of the North Sea, some species of fish seemed to respond positively to offshore wind structures, but these potentially beneficial impacts cannot be distinguished from the reduction in fishing effort within the wind facility. With the exception of the United Kingdom, European countries have prohibited mobile trawl fishing within offshore wind facilities.

Considering the above information, the impacts of the presence of structures on finfish, invertebrates, and EFH may range from moderate adverse to beneficial. These impacts would be permanent as long as the structures remain.

While primarily an ongoing activity, regulated fishing effort affects finfish, invertebrates, and EFH by modifying the nature, distribution, and intensity of fishing-related impacts (mortality, bottom disturbance). Regulated fishing effort results in the removal of a substantial amount of the annually produced biomass of commercially regulated finfish and invertebrates and can also influence bycatch of non-regulated species. Future offshore wind development other than the proposed Project could affect finfish, invertebrates, and EFH through this IPF by influencing the management measures chosen to support fisheries management goals, which may alter the nature, distribution, and intensity of fishing-related impacts on finfish, invertebrates, and EFH (Section 3.9).

Traffic: Construction, operations, and decommissioning of ongoing and planned activities would generate new vessel traffic. Based on the vessel traffic generated by the proposed Project, it is assumed that construction of each individual offshore wind project (estimated to last 3 years per project) would generate an average of 22 and a maximum of 56 vessels operating in the geographic analysis area for navigation and vessel traffic at any given time. As shown in Table E1 in Appendix E, construction-related vessel traffic in the geographic analysis area would be at its peak in 2026 (Section 3.13, Navigation and Vessel Traffic) when as many as 16 offshore wind projects (other than the proposed Project) could be under construction simultaneously. This vessel activity would be distributed across the entire geographic analysis area, leading to marginal increases in regional vessel traffic above historical baseline averages, which is not expected to result in a significant increase in impacts related to vessel traffic.

Endangered Species Act-Listed Species

The endangered Atlantic salmon, Atlantic sturgeon, shortnose sturgeon, giant manta ray, oceanic whitetip shark, and scalloped hammerhead sharks are the finfish listed under the ESA that may be affected by the proposed Project.

As presented in Section 3.6.1.3, the Atlantic salmon Gulf of Maine DPS is listed as endangered and overlaps the geographic range of the Gulf of Maine DPS. Atlantic salmon within the geographic analysis area would be encountered during vessel transits from ports in Atlantic Canada and potentially Europe. Since the physical components of the proposed Project would be located offshore Massachusetts, the main source of potential adverse impacts on Atlantic salmon would be vessel strikes or discharges from vessel operations. However, the likelihood of vessels encountering Atlantic salmon during regular operations within the geographic analysis area is low, as vessel strikes are not often reported for this species, and most vessel transits related to Alternative A would not disturb any freshwater habitats where spawning occurs. Additionally, given the brief transit encounter periods and the regulatory management of marine debris through adherence to existing state, federal, and international regulations related to the management and accidental discharge of marine debris and pollutants, including the International Convention for the Prevention of Pollution from Ships requirements in the open sea, the USCG and Canadian Coast Guard regulations and the U.S. Environmental Protection Agency (USEPA) under the National Pollutant Discharge Elimination System vessel general permit measures, impacts from proposed offshore vessel discharges would also be extremely low. Therefore, the potential for adverse impacts from Alternative A, such as accidental releases from the construction activities related to the offshore wind industry and general commercial vessels, would not be expected to contribute appreciably to overall impacts on Atlantic salmon Gulf of Maine DPS and is considered negligible.

Atlantic sturgeon subadult and adults occur in marine waters year-round typically within the 50-meter depth contour (NMFS 2023a). For the Atlantic sturgeon, all five DPSs could be affected by Alternative A; the geographic analysis area for this species is its' entire range shown on Figure 3.6-1. The IPFs that could have the most impact on Atlantic sturgeon in relation to Alternative A would be vessel traffic (strikes), noise impacts related to pile driving, EMF related to inter-array and OECC cable power transmission, and gear utilization in regard to commercial fisheries activities and offshore wind monitoring surveys. The remaining IPFs; accidental releases, anchorage, cable emplacement and maintenance, lighting, and presence of structures; are considered to have the same level of negligible to minor impacts on Atlantic sturgeon.

Due to the number of developing offshore wind projects in the region, multiple surveys and monitoring activities will be carried out within the various wind energy areas. Fisheries monitoring surveys generally include the use of trawls surveys and as assessed in the NMFS BA (BOEM 2023b), can have negative impacts related to gear utilization on the Atlantic sturgeon. Capture of Atlantic sturgeon in trawl gear has the potential to result in injury and mortality, reduced fecundity, and delayed or aborted spawning migrations (Moser and Ross 1995; Collins et al. 2000; Moser et al. 2000). However, the use of trawl gear has been employed as a safe and reliable method to capture sturgeon, provided that the tow time is limited (NMFS 2014). Given that trawl surveys from offshore wind projects could lead to potential capture and/or minor injury, impacts cannot be discounted. Since Atlantic sturgeon densities in the offshore environment are widely dispersed, entanglement in demersal trawl gear associated with Alternative A would be considered minor and not result in a population-level impact on Atlantic sturgeon.

Vessel strikes on Atlantic sturgeon are most likely to occur in areas where Atlantic sturgeon populations overlap with abundant boat traffic such as large ports or areas with relatively narrow waterways (ASSRT 2007). While Atlantic sturgeon are known to be struck and killed by vessels in rivers and estuaries, vessel strikes are less likely in the marine environment, likely due to the space between bottom-oriented sturgeon and the propellers and hull of vessels. Atlantic sturgeon are a demersal species and most likely to occur at or near the bottom of the water column in the marine environment. At these depths and in open coastal and marine environments, which would not constrain the distribution or movement of individuals, Atlantic sturgeon are not likely to be struck by proposed Project-related vessels. Therefore, in the offshore areas of the proposed Project area, vessel-related mortalities are not expected.

Noise impacts related to pile driving would most likely result in behavioral avoidance of the construction sites (BOEM 2023b). Atlantic sturgeon could be present in small numbers year-round in the offshore habitat, with a peak presence between November and May. During spawning season, adults travel upstream in the spawning rivers, so the likelihood of being within deeper offshore habitats during spawning periods is lower. Most pile driving is anticipated to occur in the summer, when mature Atlantic sturgeon are more likely to reside in rivers and nearshore waters, thus reducing their risk of exposure to pile-driving noise (Ingram et al. 2019). Elevated noise levels from pile driving could cause Atlantic sturgeon to temporarily vacate the area ensonified above behavioral thresholds (Krebs et al. 2016), resulting in a temporary disruption of feeding, mating, and other essential activities. No long-term avoidance of the proposed Project area or impacts on spawning behavior are expected to occur since spawning occurs in freshwater river habitats. Atlantic sturgeon have a primitive swim bladder, which allows them to detect sound pressure in addition to particle motion (Popper et al. 2014; Popper and Hawkins 2018), but their swim bladder is not involved in their hearing, making them less sensitive to underwater sound pressure levels (SPL) than fish with swim bladders involved in hearing. Several studies have been conducted on the behavioral response of fish to impulsive noise sources. Those that have been published show varying results, ranging from avoidance (moving out of the affected area or into deeper water; Dalen and Knutsen 1987; Slotte et al. 2004) to minor changes in behavior (Wardle et al. 2001; Hassel et al. 2004) or no reaction at all (Peña et al. 2013).

Marine fish have specialized electrosensory organs capable of detecting electrical fields on the order of 0.5 millivolts per meter (Gill et al. 2012; Normandeau et al. 2011). Based on magnetic field strength, the induced electrical field in Atlantic sturgeon in proximity to exposed cable segments is likely to exceed the 0.5 millivolts per meter threshold. This suggests that fish 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 Russian sturgeon (*Acipenser gueldenstaedtii*) have been reported to slow down when crossing beneath overhead high voltage cables and speed up once past them (Gill et al. 2012). This is not a useful comparison, however, because overhead power cables are unshielded and generate relatively powerful induced electrical fields compared to shielded subsea cables. Insufficient information is available to associate exposure with induced electrical fields generated by subsea cables with behavioral or physiological impacts (Gill et al. 2012). However, natural electrical field impacts generated by wave and current actions are on the order of 10 to 100 millivolts per meter, many times stronger than the induced field generated by buried cable segments. Given the range of baseline variability and limited area of detectable impacts relative to available habitat on the OCS, the impacts of exposure to EMF related to offshore wind and other power transmission cables within the geographic analysis area would be non-measurable and negligible on Atlantic sturgeon.

The primary risk to shortnose sturgeon from Alternative A would be vessel strikes and discharges related to vessel traffic in ports located in lower salinity estuarine environments. The only vessel ports that are on rivers with shortnose sturgeon are Saint John, New Brunswick, Canada on the Saint John River, Capital Region ports on the Hudson River, and Paulsboro on the Delaware River (COP Volume I, Section 3.2.2.5; Epsilon 2023). Generally, shortnose sturgeon spawning occurs far upstream in their natal rivers, with individuals moving downriver to the estuaries to feed, rest, and spend most of their time. They are a primarily benthic species that are rarely known to leave their natal freshwater rivers (Kieffer and Kynard 1993; NMFS 2015); therefore, their presence in the marine environment is uncommon (Baker and Howsen 2021). Movement of shortnose sturgeon between rivers is rare, though there have been some reported migrations between the Connecticut and Hudson rivers (Shortnose Sturgeon Status Review Team 2010). Acoustic tagging studies conducted in the Delaware River indicate the existence of an overwintering area in the lower portion of the river, below Wilmington, Delaware (Shortnose Sturgeon Status Review Team 2010). Based on the wide distribution of the shortnose sturgeon within the geographic analysis area, commercial vessel traffic associated offshore wind projects in the region would have a non-measurable, if not negligible, impact on shortnose sturgeon.

Giant manta ray, oceanic whitetip sharks, and scalloped hammerhead sharks are found within New England and MAB mainly from July through September when waters reach 19 to 22 Celsius [°C]). Ongoing activities, future non-wind activities, and future offshore wind activities other than the proposed Project may also affect the giant manta ray, oceanic whitetip, and scalloped hammerhead sharks. The most prominent IPF for each of these species is likely to be noise from pile driving; however, most pile driving is anticipated to occur in the summer, when mature Atlantic sturgeon are more likely to reside in rivers and nearshore waters, thus reducing their risk of exposure to pile-driving noise (Ingram et al. 2019). Pile-driving noise for the giant manta ray, oceanic whitetip, and scalloped hammerhead sharks could result in minor impacts. These three listed species can be present within the deeper water offshore areas within the summer months. This timeframe would coincide with construction and pile-driving activities. These three species are elasmobranchs, have no swim bladder (non-physoclistic), and are less sensitive to sound impacts. The pile-driving activities related to the proposed offshore wind projects could displace these species, disturbing their behavior and potential feeding opportunities. These impacts would likely be short term and localized to the construction site. Each of these species would most likely transit through the proposed Project area following prey species migrations related to upwelling areas for giant manta rays and finfish prey such as herring, mackerel, sardines, and squid for the oceanic whitetip and scalloped hammerhead sharks.

Conclusions

Impacts of Alternative A. Under Alternative A, finfish, invertebrates, and EFH would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under Alternative A, ongoing activities would have continuing temporary to permanent impacts (disturbance, displacement, injury, mortality, reduced reproductive success, habitat degradation, habitat conversion) on finfish, invertebrates, and EFH, primarily through resource exploitation/regulated fishing effort, dredging, bottom trawling, bycatch, G&G survey noise, pile-driving noise, cable emplacement and maintenance, the presence of structures, and climate change. The impacts of ongoing activities, especially fishing, dredging, and climate change, would be **moderate** and **moderate** beneficial due to the reef effect from the presence of structures.

Cumulative Impacts of Alternative A. In addition to ongoing activities, planned activities other than offshore wind may also contribute to impacts on finfish, invertebrates, and EFH. Planned activities other than offshore wind include increased vessel traffic; new submarine cables and pipelines; increasing onshore construction; marine surveys; marine minerals extraction; port expansion; channel-deepening activities; and the installation of new towers, buoys, and piers. The impacts of planned activities other than offshore wind would be minor. The combination of ongoing and planned activities other than offshore wind would result in moderate impacts on finfish, invertebrates, and EFH, primarily through ongoing fishing activities.

Future offshore wind activities in the geographic analysis area combined with ongoing and planned activities would result in **moderate** impacts and could potentially include **moderate** beneficial impacts due to the reef effect from the presence of structures. Future offshore wind activities are expected to contribute considerably to several IPFs, the most prominent being the presence of structures, namely foundations and scour/cable protection. The majority of offshore structures in the geographic analysis area for finfish, invertebrates, and EFH would be attributable to the future offshore wind industry. The future offshore wind industry would also be responsible for the majority of impacts related to new cable emplacement and pile-driving noise. However, ongoing impacts resulting from fishing pressure, especially via dredging and bottom-trawling methods, would continue to be one of the most impactful IPFs in the geographic analysis area for finfish, invertebrates, and EFH.

3.6.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of impacts on finfish, invertebrates, and EFH:

- The total amount of long-term habitat alteration from scour protection for the foundations, inter-array cables, and export cables;
- The total amount of habitat temporarily altered by installation of the export cable in the OECC and inter-array and inter-link cables in the SWDA;
- The number, size, and type of foundations used for the WTGs and ESPs;
- The methods used for cable laying, as well as the types of vessels used;

- The amount of dredging associated with cable laying, if any, and its location; and
- The time of year when construction activities occur in relation to migrations and spawning for fish and invertebrate species.

The potential impacts would have a greater magnitude if construction activities coincided with sensitive life stages for finfish and invertebrate organisms.

3.6.2.3 Impacts of Alternative B – Proposed Action on Finfish, Invertebrates, and Essential Fish Habitat

This section identifies the potential impacts of Alternative B on finfish, invertebrates, and EFH. When analyzing the impacts of Alternative B on finfish, invertebrates, and EFH, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for finfish, invertebrates, and EFH.

Except where otherwise stated, the impacts of Phase 1 decommissioning would be similar to those for Phase 1 construction for all of the IPFs described below.

Impacts of Phase 1

Phase 1 would affect finfish, invertebrates, and EFH through the following primary IPFs during construction, operations, and decommissioning.

Accidental releases: In addition to accidental releases of other materials, accidental releases of invasive species from vessels associated with Phase 1 would have a low risk of resulting in widespread and permanent impacts, as discussed in Section 3.6.2.1. The increase in risk of accidental releases of invasive species attributable to Phase 1 would be negligible. Section 2.3 describes the non-routine activities associated with Phase 1. These activities, if they were to occur, would generally require temporary activity to address emergency conditions, fuel spills, accidental releases of waste material, collisions, and allisions. Non-routine events such as oil or chemical spills can have adverse or lethal impacts on marine life. Spills are expected to occur at the surface, and impacts on the water column would be mostly limited to the surface-mixed layer, or approximately 33 feet. Oils in particular tend to stay at the surface, and other chemicals are predicted to dilute to non-toxic levels before they would reach most finfish, invertebrates, and EFH. Small spills would, therefore, have a negligible impact, while larger spills, which are unlikely, could have a moderate impact on species due to impacts on water quality (Section G.2.2).

The greatest source of risk for accidental releases during operations results from vessel traffic related to maintenance and survey monitoring activities. Phase 1 operations would generate approximately 290 vessel round trips per year (Section 3.13). If an accidental release were to occur, the impacts would be localized and temporary due to the likely limited extent and duration of a release and result in negligible to minor impacts. Mitigation measure such as OSRPs will be in place for immediate response to vessel release resulting in a localized and temporary impact due to the likely limited extent and duration of a release.

Anchoring and gear utilization: Anchoring used in Phase 1 would leave marks on the seabed, increase turbidity levels, and have the potential for physical contact to cause mortality of benthic and demersal species. Impacts on finfish, invertebrates, and EFH from anchoring are greatest for sensitive EFH (e.g., eelgrass, hard bottom) and sessile or slow-moving species (e.g., corals, sponges, and sedentary shellfish). Impacts from anchoring would occur during construction in the SWDA and OECC, but would be limited, with a total expected area of vessel and buoy disturbance totaling 178 acres (COP Appendix III-T, Table 2; Epsilon 2023). All impacts would be localized, turbidity would be temporary, and most impacts from physical contact would be recovered in the short term. Degradation of sensitive EFH, if it occurs, could be long term to permanent. The anticipated impacts on finfish, invertebrates, and EFH from anchoring under Phase 1 would be minor. Monitoring surveys may include video, multibeam bathymetry, ventless trap, fish pot, lobster tagging, and grab sampling, which could entail seafloor disturbances. BOEM assumes that survey procedures would have sufficient mitigation procedures in place to reduce potential impacts such as avoidance of sensitive habitats. Given the short-term, low-intensity, and localized nature of the impacts of gear utilization, impacts would be negligible.

Cable emplacement and maintenance: Cable emplacement impacts would include temporary displacement of mobile benthic species inhabiting the OECC route (i.e., winter flounder, American lobster, monkfish). Impacts on sessile species and life stages (i.e., demersal eggs, squid egg mops, Atlantic surf clam) would include a reduction in fitness or mortality. Impacts related to habitat disturbance in the immediate area of emplacement activities would be unavoidable and temporary to permanent, depending on the type of habitat affected. Localized loss of demersal eggs could lead to reduced fish recruitment; however, this impact would be limited, and BOEM does not anticipate impacts at a population level. For the Cape Wind Energy Project, seabed scars associated with jet plow cable installation were expected to recover in 1 to 38 days (Applied Science Associates 2005), allowing for rapid recolonization from the surrounding area (MMS 2009). Phase 1 would not affect beds or loose aggregations of eelgrass EFH HAPC for juvenile and adult summer flounder because Phase 1 would avoid eelgrass aggregations; however, Phase 1 could affect HAPC for juvenile Atlantic cod. All the hard-bottom habitat within the OECC would be considered HAPC for juvenile Atlantic cod, as would some other habitat types not mapped. Some HAPC for juvenile Atlantic cod in the OECC would be altered by cable installation. The total amount of juvenile Atlantic cod HAPC that could be disturbed by the proposed Project is not known but would not exceed (and would likely be only a fraction of) the total area of disturbance within the OECC, namely 263 acres (COP Appendix III-T, Table 5; Epsilon 2023).

To avoid impacts on the high concentrations of fishing activities and natural resource events (e.g., spawning of squid and other species) in springtime within Nantucket Sound, the applicant would avoid cable installation in Nantucket Sound during springtime. Overall, there would be moderate impacts from the temporary habitat disturbance on finfish, invertebrates, and EFH.

BOEM could require the applicant, as a condition of COP approval, to develop a fisheries monitoring plan for construction, operations, and decommissioning, similar to (or as an extension of) the fisheries monitoring plan implemented for Vineyard Wind 1 (Cadrin et al. 2019). Under such a plan, fisheries monitoring would be conducted before, during, and after construction in the proposed Project area and control areas to support a “beyond before after control impact” analysis (e.g., sampling at multiple control sites at multiple periods before and after impact). Sampling would be conducted four times: pre-construction (to assess existing conditions); during construction; and at two different intervals during operations (i.e., 1 year after construction and in some later year post-construction). Each of these four assessment periods would capture all four seasons of the year. Fisheries survey methodologies include trawl survey for finfish and squid, ventless trap survey, plankton survey, and optical survey (drop-camera) of benthic invertebrates and habitats. All fisheries monitoring plan surveys would be consulted and coordinated among BOEM, NMFS, and the applicant to ensure that impacts from post-construction monitoring activities are mitigated to the level of least practicable adverse impact.

The applicant would implement a benthic monitoring plan (COP Appendix III-U; Epsilon 2023) to document the disturbance to and recovery of marine benthic habitat and communities as a result of construction of different proposed Project components. Post-construction monitoring could reduce later impacts on finfish and invertebrate resources in the region. Information gained via post-construction monitoring by the applicant could be used to inform decommissioning procedures and/or could be used by others planning similar projects in the future to assist in reducing potential impacts.

The COP for the proposed Project m”dels’the potential turbidity resulting from construction activities (Appendix III-A; Epsilon 2023). Impacts associated with turbidity are likely to affect benthic species more than pelagic species because the increased turbidity occurs primarily in the bottom 19.7 feet of the water column (COP Appendix III-A, Section 4.3.4; Epsilon 2023). Turbidity would likely displace mobile juvenile and adult species (i.e., striped bass, alewife [*Alosa pseudoharengus*]), which could expose them to increased predation, temporarily reduce prey availability, and result in higher energetic costs. For sessile organisms unable to escape the suspended sediment plumes, the impacts could range from reduced fitness to mortality (Wilber and Clarke 2001; Berry et al. 2011). Sub-lethal impacts for mollusk eggs occur with an exposure of 200 milligrams per liter for 12 hours; for other life stages, the minimum threshold for sub-lethal impacts would be 100 milligrams per liter for 24 hours (COP Volume III, Section 6.5.2.1.2; Epsilon 2023). Sessile organisms in the SWDA might be affected by turbidity multiple times during construction, potentially compounding impacts and possibly increasing mortality. Based on the modeled concentration of total suspended solids and the estimated time it would remain suspended, there would be minor temporary impacts because any reductions in abundance or fitness of organisms would likely recover naturally. The EFH assessment (BOEM 2023a) and other BOEM studies (2018d, 2019e, 2020) provide additional information on potential impacts on fish, invertebrates, and EFH for Phase 1 activities, based on studies conducted for Vineyard Wind 1.

Water withdrawals are necessary for jet plow cable installation. The COP describes water withdrawal and estimates the quantities withdrawn (Volume III, Section 6.5.2.1.4; Epsilon 2023). Due to the surface-oriented intake for the jet plow, water withdrawal could entrain eggs and larvae of pelagic finfish and invertebrates, resulting in 100 percent mortality (MMS 2009). However, the rate of egg and larval survival to adulthood for many species of marine finfish is very low (MMS 2009), and mortality associated with entrainment would be insignificant at the population level. Jet plowing would impact species with pelagic eggs or larvae, including numerous flatfish species such as windowpane flounder, winter flounder, witch flounder, yellowtail flounder, and summer flounder; important commercial groundfish species such as Atlantic cod, haddock, and pollock; and other recreationally and commercially important species such as monkfish, Atlantic herring, Atlantic mackerel, silver hake, and butterfish. Species with demersal eggs such as longfin squid, Atlantic wolffish, and ocean pout which adhere to bottom substrate, would not be affected by the water withdrawal aspect of jet plowing. Species with demersal eggs but pelagic larvae such as winter flounder and Atlantic sea scallop may still be at risk of entrainment. Most jet plowing would take place during summer and could impact eggs and larvae present at that time (BOEM 2023a). Walsh et al. (2015) recognized at least 15 federally managed species with eggs and larvae present during summer months including silver hake, offshore hake (*Merluccius albidus*), monkfish, bluefish, Atlantic croaker (*Micropogonias undulatus*), Atlantic mackerel, and black sea bass. Based on the limited time of jetting and the overall habitat available for pelagic eggs and larvae in comparison to the volume of water withdrawn, there would be temporary and minor impacts, with affected populations completely recovering after jet plowing activities. The EFH assessment (BOEM 2023a) and the Vineyard Wind 1 BA and Biological Opinion (BO) provide additional information on potential impacts on fish, invertebrates, and EFH for Phase 1 activities (BOEM 2019d, 2019e; NMFS 2020b).

There would be negligible impacts on finfish, invertebrates, and EFH at the landfall site because the HDD would traverse under the seafloor and beach at either Covell’s Beach or Craigville Beach. Due to summer construction restrictions on Cape Cod (unless authorized by the Town of Barnstable), the applicant would not make the landfall transition from June through September.

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

Dredging for cable installation in the OECC would cause localized and short-term impacts (habitat alteration, change in complexity) on finfish, invertebrates, and EFH through seabed profile alterations, as well as sediment deposition. The dredging potentially involved in Phase 1 could affect up to 52 acres, resulting in temporary seabed profile alterations. Much of the offshore proposed Project area is characterized as unconsolidated soft sediment arranged in waves, megaripples, and ripples, with some isolated patches of mud and gravel. These features would temporarily be disturbed by pre-construction grapnel runs; seabed preparation; possible sand wave dredging; foundation placement; scour protection installation; anchoring, clearing, and trenching for offshore export and inter-array cable installation; and cable protection activities. Sand ripples and waves disturbed by offshore export and inter-array cable installation would naturally reform within days to weeks under the influence of the same tidal and wind-forced bottom currents that formed them initially (Kraus and Carter 2018). In addition, mechanical trenching, used in more resistant sediments (e.g., gravel, cobble), causes seabed profile alterations during use, although the seabed is typically restored to its original profile after utility line installation in the trench. These bathymetric changes would create narrow troughs or flats in fields of sand waves, changing the character of the seafloor as finfish and invertebrate habitat, but are expected to recover without mitigation. The corresponding impacts on finfish, invertebrates, and EFH would be minor and would dissipate over time as mobile sand waves fill in the altered seabed profile.

In areas where cable is installed via a jet or mechanical plow, impacts would be localized and temporary and would recover completely without mitigation. In areas where seabed conditions might not allow for cable burial to the desired depth, other methods of cable protection would be employed, such as rock armoring, gabion rock bags, or concrete mattresses, which would permanently alter the seabed profile. At locations with large sand waves, dredging may be necessary to allow the offshore export cable to be buried in stable seabed. If needed, a TSHD would remove sediment using suction, store the sediment in a hopper, and dump the sediment in piles on the seafloor at a different place within the OECC, several hundred yards away from the dredged area. If use of a TSHD is required during export cable installation, the applicant may be required to obtain a Marine Protection, Research, and Sanctuaries Act Section 103 permit from USACE to identify specific dumping locations for dredge material and the potential impacts of disposing dredge material in those locations. Under Section 103 of the Marine Protection, Research, and Sanctuaries Act, USACE regulates the transportation of dredged material for purposes of dumping it into ocean water. At this time, the potential for use of a TSHD is low, and the applicant is not currently pursuing a Section 103 permit. Should the applicant determine the definitive need for the use of a TSHD during export cable installation, the applicant will coordinate with USACE regarding Section 103 permitting and supplemental NEPA review, as applicable, prior to conducting dredging activities as part of export cable installation. Overall, impacts on finfish, invertebrates, and EFH from seabed profile alterations under Phase 1 would be minor.

Dredged material disposal during construction would cause temporary, localized turbidity increases and long-term sedimentation or burial at the immediate disposal site. Sediment deposition and burial could also occur as a result of cable installation methods. Phase 1 construction could affect finfish, invertebrates, and EFH by covering habitat, smothering sessile organisms or life stages, and habitat avoidance or abandonment by mobile species. Mobile species of finfish and invertebrates (e.g., flatfish) would likely avoid or abandon deposition areas. Slow-moving but mobile species (e.g., Jonah crabs, Atlantic horseshoe crabs, whelks, Atlantic sea scallops) may not be able to escape the affected area but would likely be able to uncover themselves during and after sedimentation. Sessile species are often capable of handling some degree of sediment deposition because turbidity and sedimentation occur naturally in soft-bottom habitats (e.g., during storm events; Wilber et al. 2005). Sediment deposition could bury demersal eggs and newly settled bivalve spat (i.e., American oyster [*Crassostrea virginica*] spat, longfin squid egg mops, Atlantic wolffish eggs, whelk egg cases and hatchlings), leading to sub-lethal impacts or mortality. Wilber and Clarke (2001) found reduced feeding and respiratory rates in oysters when exposed to deposition from dredging. Mortality can occur to sessile shellfish in sedimentation levels greater than 0.8 inch (Wilber and Clarke 2001; COP Volume III, Section 6.5.2.1.3; Epsilon 2023). Benthic eggs and larvae (e.g., whelks, winter flounder, longfin squid egg mops) are more susceptible to increased mortality rates in depositions over 0.04 inch (Wilber and Clarke 2001; Berry et al. 2011). Sediment thickness and deposition modeling for Phase 1 indicates that only 2.5 acres would experience of deposition greater than 0.2 inch, with potential impacts on demersal eggs and species of similar sensitivity within the SWDA (COP Volume III, Section 6.5.2.1.3; Epsilon 2023). Shellfish and organisms of similar sensitivity are not expected to be affected by sediment deposition from cable installation in the SWDA. Sediment deposition covering hard-bottom habitat along the OECC could temporarily impact juvenile Atlantic cod HAPC (BOEM 2019e) and impact the settlement of bivalve larvae (Wilber and Clarke 2001). Based on the limited distribution of sediment depositions exceeding 0.04 inch along the OECC and the overall minimal amount of soft-bottom habitat affected by Phase 1, there would be temporary and minor impacts, with affected populations completely recovering following construction activities (BOEM 2023a, 2019e; NMFS 2020a).

As described above, the individual activities associated with Phase 1 cable emplacement and maintenance during construction (i.e., habitat disturbance, sediment deposition, dredging, and seabed profile alteration) would have negligible to minor impacts on finfish, invertebrates, and EFH. Impacts would be measurable, but the affected species and habitats would return to normal (pre-construction) without mitigation and would, thus, have an overall impact rating of minor.

Section 2.3 describes the non-routine activities associated with Phase 1; similar non-routine activities could occur for other future offshore wind activities. These activities, if they were to occur, would generally require temporary activity to address emergency conditions. The offshore export cables and inter-array cables would be monitored through distributed temperature sensing equipment. The distributed temperature sensing system would be able to provide real-time monitoring of temperature along the OECC, alerting the applicant should the temperature change, which could be the result of scouring of material and cable exposure. If cable repairs are needed, support vessels such as a jack-up vessel may be used. As such, only cable repairs (if required) would temporarily impact benthic finfish life stages and demersal and sessile invertebrates and only in a localized area immediately adjacent to the repair. Impacts from occasional non-routine activities to repair segments of cables would be similar to those temporary habitat disturbances involved in installation. Generally, the disturbance to finfish, invertebrates, and EFH would be temporary and localized, with an abundance of similar foraging habitat and prey available in adjacent areas. Assuming repairs would be infrequent and affecting only small sections of the cables, impacts on finfish, invertebrates, and EFH from cable repairs would be unmeasurable and, therefore, negligible.

Climate change: Finfish, invertebrates, and EFH may be affected by climate change, primarily from increasing ocean surface and bottom temperatures, which has been shown to impact the distribution of fishes in the northeast United States, with several species shifting their centers of biomass either northward or to deeper waters (Gaichas et al. 2015; Hare et al. 2016). Several sub-IPFs related to climate change, including ocean acidification, warming/sea level rise, altered habitat or ecology, altered migration patterns, and increased disease frequency, have the potential to result in long-term, potentially high-consequence risks to finfish, invertebrates, and EFH. Ocean acidification affects the settlement and survival of shellfish (PMEL 2020) and would contribute to the reduced growth or decline of invertebrates that have calcareous shells. These impacts could lead to changes in prey abundance and distribution, changes in migratory patterns, and timing of migrations for finfish and invertebrates. The impacts through this IPF from Phase 1 would be the same as those under Alternative A. The intensity of impacts resulting from climate change are uncertain but are anticipated to qualify as minor to moderate.

EMF: Biologically significant impacts on finfish, invertebrates, and EFH have not been documented for EMF from AC cables (CSA Ocean Sciences, Inc. and Exponent 2019; Thomsen et al. 2015); however, many marine and diadromous species can sense electric and/or magnetic fields, and EMF from submarine cables may affect their ability to navigate and detect predators/prey or could cause physiological and developmental impacts (Gill and Desender 2020; Taormina et al. 2018). In the United States, behavioral impacts have been documented for benthic species (skate and lobster) near operating DC cables (Hutchison et al. 2018, 2020b). Buried submarine cables reduce, but do not entirely eliminate, EMF (Taormina et al. 2018). To minimize EMF generated by cables, all cabling would be contained in grounded metallic shielding to prevent detectable electric fields. The applicant would also bury cables to a target burial depth of 5 to 8 feet below the surface or use cable protection, which would diminish the impact of EMF so that it would likely impact only demersal species. The closer the cable is to the sediment-water interface, the stronger the exposure to magnetic fields.

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

Atlantic sturgeon have both electro and magneto sensitivity that can affect feeding, predator detection, and navigation (BOEM 2012a), although research suggests marine species may be less likely to detect EMF from AC cables (BOEM 2012a). Although some species-specific avoidance behavior has been observed, no evidence of population-scale impacts or physiological impacts have been reported, and studies of EMF impacts on invertebrates are scarce (Taormina et al. 2018; Gill and Desender 2020). American lobster held in cages displayed behavioral differences when exposed to EMF, but the research did not indicate a barrier to movement (Hutchison et al. 2018, 2020b). The same studies found that little skate, an electrosensitive elasmobranch, was even more sensitive to the EMF, which led to movement patterns that could be interpreted as increased foraging behavior; again, the EMF did not constitute a barrier to movement. Although a study by Scott et al. (2018) found that the edible crab (*Cancer pagurus*) is attracted to EMF, the impacts were seen only at laboratory strengths greater than 150 times the field strength expected directly over Phase 1's cables (Epsilon 2018). Currently, there is no evidence that EMF would result in population-scale impacts on fishes or invertebrates (Taormina et al. 2018; Hutchison et al. 2018, 2020b; Gill and Desender 2020). A field survey found that an AC cable design comparable to that proposed by the applicant produced a much weaker magnetic field than expected (Hutchison et al. 2018); field strength was insignificant approximately 33 feet from the cable. Therefore, impacts on pelagic species would likely be negligible. By burying cables and containing them in grounded metallic shielding (Normandeau et al. 2011), the impacts of EMF should be minor on finfish, invertebrates, and EFH. See the EFH assessment for additional discussion of EMF impacts on other fishes or invertebrates with EFH in the SWDA and OECC (BOEM 2023a). NMFS's BO for Vineyard Wind 1 concluded that EMF from the proposed Project would be extremely unlikely to affect the Atlantic sturgeon (NMFS 2020a).

As discussed in Section 3.6.2.1, EMF production during the operations of power transmission cables can be detected by some finfish and invertebrate species but does not appear to present a barrier to movement. EMF impacts would be minimized by burying cables to the target depth of 5 to 8 feet below the seafloor. The impacts on finfish, invertebrates, and EFH from EMF would be negligible to minor during operations.

Lighting: Light can attract finfish and invertebrates, potentially affecting distributions in a highly localized area. Light can also disrupt natural cycles such as spawning. Phase 1 would allow nighttime work only on an as-needed basis and would not allow pile driving to begin at night. As a result, light from

Phase 1 vessels is not anticipated to result in biologically significant impacts on finfish, invertebrates, and EFH. Up to 64 WTGs and ESPs would have aviation hazard navigation lights, but no downward-focused lighting. Each WTG would be lit in accordance with USCG, FAA, and BOEM requirements, and only a small fraction of the emitted light would enter the water (BOEM 2021a; COP Volume III, Section 2.2.1; Epsilon 2023). Therefore, lighting from Phase 1 would be minimal and lead to a negligible impact, if any, on finfish, invertebrates, and EFH.

Vessel generated lighting would be greatly reduced during the operational stage of the proposed Project. Service vessels and tenders would mainly be supporting operations during daylight hours greatly reducing the need for artificial sources of light within the SWDA. Lighting impacts would only slightly increase, but not significantly, during decommissioning operations if WTG were to be removed. Lighting during Phase 1 operations and decommissioning would have a negligible impact on finfish and invertebrates

Noise: Phase 1 construction activities would result in noise from vessel activity, G&G surveys, vibratory pile setting and impact pile driving for WTG and ESP installations, UXO detonations, and cable burial or trenching. These activities would result in short-term increases in underwater noise from Phase 1 construction. Underwater sounds would include repetitive, impulsive sounds produced by impact pile driving and UXO detonations, and non-impulsive sounds produced by vibratory pile setting, vessel traffic, and cable jetting installation methods. The intensity of these sounds would vary, with some sounds being louder than ambient noise. Ambient noise within the SWDA averaged between 76.4 and 78.3 dB re 1 µPa (COP Appendix II-A, Attachment E; Epsilon 2023). Ambient noise can influence how fish detect other sounds because fish have localized noise filters that separate background noise and other sounds simultaneously (Popper and Fay 1993). A description of the characteristics of these noise sources is provided in Appendix B.

The Intensity and magnitude of impact pile driving during foundation installation under Phase 1 could result in injury and/or mortality to finfish and invertebrates in a localized area around each pile and short-term stress and behavioral changes to individuals over a greater area. Eggs, embryos, and larvae of finfish and invertebrates could also experience developmental abnormalities or mortality resulting from this noise. Popper et al. (2014) identifies 210 dB re 1 μPa^2 s SEL, or 207 dB re 1 µPa Lpk as the thresholds for mortality for eggs and larvae. Potentially injurious noise could also be considered as rendering EFH temporarily unavailable or unsuitable during pile-driving activities. The extent of pile-driving acoustic impacts depends on pile size, hammer energy, and local acoustic conditions. Noise from pile driving during Phase 1 construction would occur during installation of monopile and jacket pilings for WTGs and ESPs. Each of the piles would require an estimated 2 to 3 hours per pile or 4 to 6 hours per day over the 2-year period, increasing the risk of injury to finfish and invertebrates in a limited radius around each pile and short-term stress and behavioral changes to individuals over a broader area.

Potential impacts on finfish and invertebrates, as described in Section 3.6.2.1, could include mortality, injury, and behavioral disturbances. Noise impacts would predominantly affect fishes that have swim bladders connected to the ear (otoliths) and some invertebrates such as squid that have lateral lines and statocysts that detect particle motion (i.e., water movement) (Mooney et al. 2016; Solé et al. 2018). Noise impacts could also affect fish and invertebrates that spawn during the summer months when-pile driving activities occur. This is of particular concern for species that also spawn once in a lifetime, such as longfin squid, which could result in a reduction of reproductive success over one or more spawning seasons. While limited available research suggests longfin squid are susceptible to behavioral responses from pile driving (Jones et al. 2020; Jones et al. 2021). In the presence of pile-driving noise, there was a reduction in feeding success, and the introduction of pile-driving noise caused the squid to abandon predation attempts. Interestingly, additional work showed that interactions between males, as well as reproductive behaviors between males and females, were unaffected by pile-driving noise, suggesting that the motivation to mate exceeds the potential stress that noise may introduce (Stanley et al.

2023). Additionally, fisheries data collected before, during, and after a recent wind energy development showed no significant impact on demersal fish and invertebrate presence during operations (Wilber et al. 2022), indicating that any avoidance of the SWDA during foundation installation activities would be temporary. To assess the potential impacts of anthropogenic sound on fish, Popper et al. (2014) classified fishes into three groups: fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes (e.g., tuna or Atlantic salmon); fishes whose hearing involves a swim bladder or other gas volume (e.g., Atlantic cod or herring); and fishes without a swim bladder (e.g., sharks) that can sink and settle on the substrate when inactive (Carroll et al. 2017; Popper et al. 2014). The most sensitive species are those with swim bladders connected or close to the inner ear. These species can experience both recoverable and mortal injuries at lower sound levels than other species (Popper et al. 2014; Thomsen et al. 2006).

Acoustic modeling for proposed Project pile driving estimated the radial distance to sound thresholds from the center of 12-meter (39.4-foot) and 13-meter (42.7-foot) monopiles and the center of a jacket foundation consisting of four, 4-meter (13.1-foot) piles (COP Appendix III-M; Epsilon 2023). Phase 1 would include 4-meter (13-foot) monopiles to support ESPs and 12-meter (39-foot) monopiles to support WTGs. The acoustic model simulations used a range of pile-driving hammer energies (3,500 kilojoule [kJ] and 6,000 kJ for the pin pile and monopile foundations, respectively) and broadband noise attenuation 10 dB. Tables 3.6-2 and 3.6-3. present the ranges to the acoustic thresholds for fish during foundation installation using impact pile driving only, as well as foundation installation using vibratory pile setting followed by impact pile driving.

Table 3.6-2: Summary of Proposed Action 9^{5t}h Percentile Acoustic Ranges to Acoustic Thresholds for Atlantic Sturgeon for Foundation Installation using Impact Pile Driving Only with 10 Decibel Noise Mitigation

	Two 12-Meter Monopiles per Day, 6,000 kJ Hammer			Two 13-Meter Monopiles per Day, 5,000 kJ Hammer			Four 4-Meter Pin Piles per Day, 3,500 kJ Hammer		
Fish Group	**Injury (Lpk)**	**Injury (SEL_{24h})**	**Behavior (SPL)**	**Injury (Lpk)**	**Injury (SEL_{24h})**	**Behavior (SPL)**	**Injury (Lpk)**	**Injury (SEL_{24h})**	**Behavior (SPL)**
Fish <2 grams	108	6,295	10,789	126	7,103	11,431	128	10,251	8,656
Fish ≥2 grams	108	4,704	10,789	126	5,362	11,431	128	8,200	8,656

Source: COP Appendix III-M, Epsilon 2023

kJ = kilojoule; Lpk = peak sound pressure (dB re 1 μPa); SEL_{24h} = sound exposure level over 24 hours (dB re 1 μPa^2 s[squared second]); SPL = root mean square sound pressure (dB re 1 μPa)

Table 3.6-3: Summary of Proposed Action 9^{5t}h Percentile Acoustic Ranges to Acoustic Thresholds for Atlantic Sturgeon for Foundation Installation using Vibratory Pile Setting Followed by Impact Pile Driving with 10 Decibel Noise Mitigation

	Two 12-Meter Monopiles per Day, 6,000 kJ Hammer			Two 13-Meter Monopiles per Day, 5,000 kJ Hammer			Four 4-Meter Pin Piles per Day, 3,500 kJ Hammer		
Fish Group	**Injury (Lpk)**	**Injury (SEL_{24h})**	**Behavior (SPL)**	**Injury (Lpk)**	**Injury (SEL_{24h})**	**Behavior (SPL)**	**Injury (Lpk)**	**Injury (SEL_{24h})**	**Behavior (SPL)**
Fish <2 grams	108	7,441	3,693	126	8,280	4,491	128	12,021	5,358
Fish ≥2 grams	108	5,613	3,693	126	6,283	4,491	128	9,268	5,358

Source: COP Appendix III-M, Epsilon 2023

kJ = kilojoule; Lpk = peak sound pressure (dB re 1 μPa); SEL_{24h} = sound exposure level over 24 hours (dB re 1 μPa^2 s[squared second]); SPL = root mean square sound pressure (dB re 1 μPa)

The acoustic thresholds for injury (both the Lpk and SEL_{24h} metrics) used in the COP modeling (Appendix III-M, Epsilon 2023) were largely based on data from the mortality of fishes exposed to explosives and other surrogate sources as recommended by NMFS (2023b). As shown in Table 3.6-2, acoustic ranges to the injury threshold for fish during foundation installation using impact pile driving alone ranged from 4.7 and 10.3 kilometers (2.9 and 6.4 miles) based on the SEL_{24h} metric with 10 dB noise attenuation; and acoustic ranges to the injury threshold for fish during foundation installation using vibratory pile setting followed by impact pile driving (Table 3.6-3) ranged from 3.5 to 7.5 miles (5.6 to 12.0 kilometers) based on the SEL_{24h} metric with 10 dB noise attenuation.

The standard acoustic behavioral threshold is 150 dB re 1 μPa for all fishes (Andersson et al. 2007; Mueller-Blenke et al. 2010; Purser and Radford 2011; Wysocki et al. 2007). As shown in Table 3.6-3, acoustic ranges to potential behavioral disturbance for fish during foundation installation using vibratory pile setting followed by impact pile driving ranged from 2.3 to 3.4 miles (3.7 to 5.4 kilometers) with 10 dB noise attenuation.

During Phase 1, only one pile would be driven at a time, and no more than two piles would be installed per day during the 2- to 3-year construction period. Once construction is complete and installation activities have ceased, impacts would dissipate. Although foundation installation noise would propagate across a considerable area, the primary impacts on finfish and invertebrates would be temporary displacement from the affected area, recoverable injury, and temporary threshold shift. Individuals displaced by foundation installation noise would be expected to return to the affected area once the noise had ceased, and foundation installation noise would not likely have any measurable impact on populations of species subject to mortality from pile-driving noise. Therefore, there would be minor impacts on fish populations from foundation installation because this activity would occur sporadically, the actual area of impact would be small in relation to the overall habitat and spatial distribution of fish populations in the region, and foundation installation noise would only occur over a relatively short period of time (i.e., approximately 2 to 3 hours per foundation or up to 6 hours per day).

A possible impact of foundation installation noise could be a change in the presence of HMS near the SWDA. If common fishes and invertebrates that constitute the main prey sources for tuna, sharks, and other HMS were driven away from the SWDA by noise, this could cause HMS to also abandon the area. Because the prey items would likely return once the noise has ceased, HMS would also be likely to return to their original behaviors and distributions. Due to their sensitive life history traits, invertebrates such as longfin squid that spawn once in a lifetime may be susceptible to a reduction in reproductive success and behavioral responses; however, the limited research available suggests pile-driving noise has little to no impact on their ability to sustain viable populations (Jones et al. 2021; Wilber et al. 2022). Therefore, impacts would be minor on finfish, invertebrates, and EFH as only temporary, localized impacts are expected.

Acoustic modeling was not conducted for potential UXO detonation impacts on fish; however, modeling results are available for sea turtles for Revolution Wind, which is also located offshore Rhode Island and Massachusetts and would, therefore, have comparable seafloor and oceanographic conditions applicable for underwater acoustic modeling. Preliminary survey data for the Project area indicate there is a risk of UXOs that cannot be avoided or removed through non-explosive methods. The analysis in the LOA application (JASCO 2023) estimated up to ten UXO may be detonated over a 2-year period during construction. Underwater detonations of UXO present the risk of mortality and potential mortal injury and behavioral disturbances (Popper et al. 2014). A quantitative analysis of ranges to physiological injury ranges was not included for fish (JASCO 2022); however, based on the thresholds modeled for Revolution Wind (Hannay and Zykov 2022), a qualitative assessment of potential impacts can be conducted for fish. Modeling conducted by Hannay and Zykov (2022) estimated a maximum range to the injury and mortality threshold for fish of 951 feet during detonation of a 1,000-pound charge in 148-foot water depths. The applicant is not planning to monitor for fish prior to detonations but has committed to the implementation of a noise mitigation systems during all detonation events, though the exact system has not yet been selected. This; coupled with the unlikely occurrence of high order detonation of UXO due to the preference for non-detonation removal methods (JASCO 2023), the conservative approach to modeling distances, the low number of potential detonations required under Alternative B (estimated to be no more than ten), and the commitment to a noise mitigation system with 10 dB attenuation, further reduces the potential for exposure for fish and invertebrates. The full extent of the potential for injuries is not known, and if they occur, they could result in physiological impacts that lead to injury or mortality of small numbers of fish if they are present within the detonation area, particularly for species with a swim bladder, which make them more susceptible to barotrauma from underwater noise (Popper et al. 2014). When a fish with a swim bladder is exposed to a sound wave, gas in their swim bladder expands and contracts more than the surrounding tissue during the periods of under pressure and overpressure, respectively. This can cause the swim bladder to oscillate, resulting in tissue damage and possible rupture. Therefore, physical injuries in fish with swim bladders present in the SWDA during detonations could occur resulting in long-term, moderate impacts. Given the low number of UXO detonations expected, this would only affect individuals and would not be expected to result in population-level impacts.

Phase 1 trenching activities and burial methods are known to emit noise, comparable to those produced by use of vessels with DP thrusters. These disturbances are temporary, local, and extend only a short distance beyond the cable lay corridor. Impacts of this noise source are typically less prominent than the impacts arising from physical disturbance and subsequent sediment suspension. Noise due to trenching and burial would have negligible impacts on finfish, invertebrates, and EFH.

All other noise-producing activities under Phase 1 (i.e., G&G survey activity, vessel activity, WTG operations, cable trenching) would not be expected to exceed the impacts expected under Alternative A, as described in Section 3.6.2.1, and would, therefore, have negligible impacts.

Cable maintenance operations would be infrequent over the life of the proposed offshore wind sites; related noise impacts would be temporary, local, and extend only a short distance beyond the cable corridor, resulting in negligible impacts that are temporary, short, and spatially localized to the trenching/burial operations.

Noise associated with operations vessels would impact fish, invertebrates, and EFH in a similar way to construction vessel traffic (COP Appendix III-M, Section 1.4.1; Epsilon 2023). However, the impacts would be smaller than construction because operations would generate fewer vessel trips, and many of the vessels used (i.e., crew transport vessels) would be smaller and used for shorter time periods. Mobile species/life stages within range of vessel noise capable of initiating physiological stress or noise-related impacts would likely move away from the source and not result in population-level consequences. BOEM (2018b) determined there would not likely be an impact from noise generated by vessel transit and operations, including noise generated by vessel engines and thrusters.

WTGs would also produce noise throughout operations, although sound levels are typically low (Madsen et al. 2006). Measurements of the Block Island Wind Farm operational noise registered at less than 100 dB re 1 μPa at 164 feet from the turbine, whereas background noise levels under calm conditions were up to 110 dB re 1 μPa at 164 feet from the turbine and 107 dB re 1 μPa at 18.6 miles from the turbine (HDR 2019a). According to the few available audiograms indicating fish thresholds for behavioral responses, this sound intensity would be barely detectable (Miller and Potty 2017). SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 μPa at 46 and 65.6 feet, respectively (Tougaard and Henrikson 2009), which is only slightly higher than the ambient noise levels recorded at the RI/MA Lease Areas from 2011 to 2015 (95 to greater than 104 dB re μPa) (Kraus et al. 2016a).When operational, WTGs would produce noise that can cause masking impacts, but thus far, noise related to operational WTGs have not been found to have an impact on finfish (English et al. 2017). The NMFS interim criterion for behavior impacts on fishes is 150 dB. In regard to invertebrates and sound, sensitivity thresholds for sound exposure have been established for few species. Mooney et al. (2016) reported evidence of behavioral responses and habituation to sound by longfin squid, and Przeslawski et al. (2018) assessed noise impacts on scallops. While no clear evidence of scallop mortality associated with seismic survey sound was found, the possibility of sub-lethal impacts was not assessed (Przeslawski et al. 2018). The lack of a swim bladder or any other gas bubble structure associated with hearing suggests that the ability of scallops to hear may be most similar to fish without swim bladders (Normandeau 2012). Eggs and larvae of fish are also sensitive to noise (Popper et al. 2014; Pyć et al. 2018).

Detection distance from noise generated by WTGs depends on several variables (i.e., hearing capability of fish, depth, size and spacing of WTGs, wind speed) and does not create a level of noise capable of injury (Wahlberg and Westerberg 2005). No study has shown any behavioral impact of sound during the operational phase of wind energy facilities. However, due to the lower sound emissions during operations, measurements and research remain a low priority in comparison with pile-driving sound (Thomsen et al. 2015). In light of reports of abundant finfish and invertebrates near WTG foundations (Causon and Gill 2018; English et al. 2017; ten Brink and Dalton 2018), it appears that noise from operating WTGs does not result in finfish and invertebrates avoiding WTGs or failing to thrive near them. Results from a study at the Block Island Wind Farm indicate a correlation between underwater sound levels and increasing wind speed, but this is not clearly influenced by turbine machinery; it may be the natural effects that wind and sea state have on underwater sound (Elliott et al. 2019; Urick 1983). A recent compilation of operational noise from several wind energy facilities with turbines up to 6.15 MW in nameplate capacity showed that operational noise generally attenuates rapidly with distance from the turbines, falling below normal ocean ambient noise within approximately 1 kilometer (0.6 mile) from the source. That compilation found that the combined noise levels from multiple turbines is lower or comparable to that generated by a small cargo ship (Tougaard et al. 2020). Based on the Tougaard et al. (2020) dataset, operational noise from jacket foundations could be louder than from monopiles due to the jacket foundation's larger surface area interacting with the water. Additional data are needed to fully understand the impact of size, foundation type, and drive type on the amount of sound produced during turbine operation. Based on this and the above impacts associated with WTG and vessel noise, the noise impacts from Phase 1 would be minor.

The impacts of Phase 1 decommissioning would be similar to those described for construction, except for the absence of pile-driving noise. Complex habitat that may have developed around cable protection and WTG and ESP scour protection would be removed, resulting in a conversion of habitat type back to soft sediment. Structure-dependent finfish and invertebrate species would be the most affected by the decommissioning and removal of hard substrate (Claisse et al. 2014; Smith et al. 2016). The proposed decommissioning activities would reverse the artificial reef effect, converting approximately 109 acres (74 acres of WTG and ESP scour and 35 acres cable protection) from hard-bottom habitat back to soft-bottom habitat. However, remnants of the previous epifaunal hard-bottom organisms shell hash and other biogenic detritus accumulated over the 33 years of artificial reef development would remain on the seabed after decommissioning activities. The presence of these biogenic components would alter the characteristics of the seafloor under the removed wind energy facilities. This modification in benthic habitat resources would result in a long-term change from the existing conditions. The modification would be a primarily localized alteration of sediment characteristics in portions of the Phase 1 footprint that previously had hard protection. This change in sediment would not likely affect the ability of benthic habitat to support the biological community within the proposed Project area. Therefore, the impacts on finfish, invertebrates and EFH from Phase 1 decommissioning would be negligible to moderate.

Port utilization: Phase 1 construction would use existing east coast port facilities, some of which would be upgraded to support the offshore wind industry as a whole (Section 3.6.2.1). No ports would specifically be expanded to support Phase 1 construction, and Phase 1 port utilization would not increase overall port utilization beyond the levels described for Alternative A. As a result, port utilization for Phase 1 construction would have negligible impacts on finfish, invertebrates, and EFH.

Operations and decommissioning are not anticipated to cause any port expansion or otherwise affect finfish, invertebrates, and EFH that are present near ports to be used under Alternative B, and impacts would be negligible.

Presence of structures: The presence of structures could affect finfish, invertebrates, and EFH through entanglement and gear loss/damage, hydrodynamic disturbance, fish aggregation, habitat conversion, and migration disturbances, as detailed in Section 3.6.2.1. Long-term habitat alteration would occur in the form of installation of the foundations, scour protection around the WTG and ESP foundations, and cable protection for the inter-array and export cables. Temporary habitat alteration would occur from activities associated with WTG and ESP construction of the inter-array and export cable. The total area of alteration within the SWDA due to Phase 1 foundation and scour protection installation, jack-up vessel use, inter-array and inter-link cable installation, and potential cable protection installation for Phase 1 is 502 acres, which is 0.4 percent of the SWDA (COP Appendix III-T, Table 2; Epsilon 2023). The amount of bottom habitat altered within the OECC by cable protection would be approximately 22 acres or less. The total area of soft-bottom habitat impacted by Phase 1 is less than 0.00002 percent of available soft-bottom habitat in the geographic analysis area for finfish, invertebrates, and EFH. As discussed in Section 3.4, Benthic Resources, and Section 3.5, Coastal Habitats and Fauna, portions of the areas of hard-bottom habitat along the OECC could be converted to soft-bottom habitat during cable installation. The OECC installation and sand wave dredging along the route would result in a temporary disturbance of up to 263 acres, which includes 52 acres of dredging.

Replacement of soft-bottom habitat with hard-bottom habitat would benefit some species (i.e., American lobster, Atlantic cod) while reducing habitat for others (i.e., winter flounder, American sand lance [*Ammodytes americanus*]). The installation of foundations and scour protection would cause some displacement of mobile finfish and invertebrate species that prefer soft-bottom habitat (i.e., flatfish). Sessile species (i.e., shellfish, demersal eggs) in the immediate area would likely be subject to mortality. Conversely, species preferring hard-bottom habitat (i.e., Atlantic cod, American lobster) would have increased habitat availability from scour protection around foundations. This could alter the distribution of species. However, temperature is expected to be a bigger driver of habitat occupation and species movement through the SWDA as a whole (Secor et al. 2018). Although the vertical surfaces on WTG and ESP monopiles would also introduce a source of new hard substrate, the dominant community after several years of succession is not anticipated to be highly diverse, based upon the almost singular colonization of foundations by blue mussels observed at the Block Island Wind Farm (HDR 2019a) and the dominance of blue mussels and/or sea anemones observed at wind energy facilities in the Belgian part of the North Sea (Kerckhof et al. 2019). New hard surfaces might provide a favorable substrate for exotic invasive species (Langhamer 2012), potentially leading to the spread of non-native species through the stepping-stone effect. Studies from the North Sea of Scotland found that WTGs provided new hard substrate and facilitated the spread of non-native species, confirming that the stepping-stone effect can occur in offshore environments if non-native species are present and introduced (De Mesel et al. 2015). There would be moderate impacts from the long-term conversion of habitat, although this could be beneficial for fishes and invertebrates that prefer hard-bottom communities. Impacts associated with long-term habitat alteration are an unavoidable consequence of construction. Because the long-term habitat alteration from soft to hard-bottom habitat would encompass a proportionally small area relative to the SWDA as a whole, these impacts are unlikely to have substantial impacts on populations in the SWDA, as displaced species would have large areas of preferred habitat available nearby (Guida et al. 2017; COP Volume II-A, Section 2.1.2.1 and Appendix II-I, Chart 2; Epsilon 2023).

WTG and ESP foundations could affect pelagic species and life stages. A modeling study by Chen et al. (2016) found that WTGs in the region would not have a significant influence on southward larval transport during storm events, although foundation placement could either increase or decrease larval dispersion and speed, depending on initial location; however, the models never found the foundations to trap or block larvae. Using tank tests, Miles et al. (2017) recorded mean current flows reduced immediately downstream of an offshore wind monopile foundation but return to background levels within a distance proportional to the pile diameter. In a current-only regime, mean flows returned to within 5 percent of background levels within a radius of approximately 8.3 times the pile diameter. In a combined current and wave regime, flow returned to background levels within a radius of 3.5 times the pile diameter. The authors suggested that downstream impacts have a length scale of 8 to 10 times the pile diameter (Miles et al. 2017). Applied to Phase 1, this ratio suggests that background conditions would exist approximately 328 feet from each monopile foundation.

A recent study completed by BOEM assessed the ‘mesoscale’ effects of offshore wind energy facilities on coastal and oceanic environmental conditions and habitat by examining how oceanic hydrodynamics change after turbines are installed, particularly with regard to turbulent mixing, bed shear stress, and larval transport (Johnson et al. 2021). This study focused on the Massachusetts-Rhode Island marine areas, where proposed wind energy lease areas are in the licensing review process. Four post-installation scenarios were assessed, and two species of finfish (silver hake and summer flounder) and one invertebrate (Atlantic sea scallop) were selected as the focal species. Results indicated recordable changes to local hydrodynamics, including changes to temperature stratification due to increased mixing, increased flow resistance, and decreased current magnitude and wave height. 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 impacts are unlikely to be biologically significant at population levels for species like hake and scallops that spawn over broad areas across 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 impacts.

Similar to Johnson et al. (2021), a model was recently completed to assess the wake-related wind speed deficits that occur in the lee of a wind farm (Christiansen et al. 2022). The study focused on the sea surface interference of single wake effects due to the recent upsurge in offshore wind energy production and resulting larger-scale disturbances in hydro- and thermodynamics in the southern and central North Sea. The results of the modeling effort indicated a reduction in sea surface currents and potentially a reduction in the temperature and salinity distribution and stratification within areas of wind farm operations, potentially extending miles from offshore wind developments. Changing wind directions were shown to inhibit severe local impact surrounding individual wind farms, but a potential cascading impact could occur in areas with clustered wind farms as proposed for the southern New England subregion. The potential change in surface water mixing could result in changes to biological productivity of the southern New England region. However, Christiansen et al. (2022) did not identify an overwhelming impact on the biological productivity of the German Bight. In comparison, other studies have concluded that wind farms could also increase the mixing of surface waters and deepen the thermocline, possibly increasing pelagic productivity in local areas (English et al. 2017; Daewel et al. 2022). Daewel et al. (2022) found that the depth of the mixed layer is predicted to be 1 or 2 meters shallower around the turbines and that the residual current past the turbine was reduced by 15 percent. Net primary productivity both decreased and increased depending on the spatial layout considered, with an overall change in the phytoplankton biomass of less than one percent (Daewel et al. 2022). Christiansen et al. (2022) showed that even though variability occurred in temperature and salinity, the changes were indistinguishable from interannual variability. European wind farm facilities differ, as they are in shallower waters with weak seasonal stratification, in sheltered areas along the coasts, and are arranged with tight spacing of turbines (Lentz 2017; Hogan et al. 2023). Therefore, caution should be taken when making direct comparisons of the potential impacts of hydrodynamic changes to the waters within the lease area. A field survey of a Dutch wind energy facility found no impact of the wind energy facility on bivalve recruitment (Bergman et al. 2010). Considering that potential impacts on the pelagic environment are likely to be non-measurable and localized, impacts of pelagic changes would be negligible.

Cable protection and scour protection around WTG and ESP foundations could create an artificial reef effect, attract a different community of fishes and invertebrates, and shift the habitat from a benthic soft-bottom to hard-bottom habitat, although this new habitat may or may not function similarly to naturally occurring hard-bottom habitat typical in the region (Kerckhof et al. 2019; HDR 2019a). Species preferring hard-bottom habitat (i.e., Atlantic cod, American lobster) would gain habitat, while soft-bottom species (summer flounder, Atlantic surf clam) would see habitat locally reduced. The reef effect has been observed around WTGs, leading to local increases in biomass and diversity (Causon and Gill 2018). Invertebrate and fish assemblages may develop around these reef-like elements within the first few years after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (Causon and Gill 2018). For the Cape Wind Energy Project, the MMS did not anticipate the vertical monopile structures to provide a true artificial reef due to the material and low quantity of interstitial spaces available, in contrast to the rocky scour protection (MMS 2009); however, recent observations at the Block Island Wind Farm have reported considerable colonization by mussels (ten Brink and Dalton 2018). Similar to scour protection, the offshore export cable could require protection (e.g., rock or concrete mattresses) in places where it is not buried to the minimum target burial depth of 5 feet. However, the applicant has committed to prioritizing cable burial.

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

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

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

While primarily an ongoing activity, regulated fishing effort can affect finfish, invertebrates, and EFH by modifying the nature, distribution, and intensity of fishing-related impacts (mortality, bottom disturbance). Phase 1 and other future offshore wind development could influence this IPF (Section 3.9), possibly influencing when, where, and to what degree fishing activities affect finfish, invertebrates, and EFH. The intensity of impacts on finfish, invertebrates, and EFH under future fishing regulations is uncertain but would likely be similar to or less than under the status quo and would likely be moderate. To the degree that offshore wind development results in regulatory exclusion of some currently fished areas from future fishing, Phase 1 would have moderate beneficial impacts on finfish, invertebrate, and EFH resources in those areas.

Traffic: As discussed in Section 3.13, Phase 1 construction would generate an average of 30 and a maximum of 60 vessels operating in the geographic analysis area at one time. Although Phase 1 would result in an increase in regional vessel traffic above historical baseline averages, this is not expected to result in a significant increase in impacts related to vessel traffic. The impacts from vessel presence related to operations, monitoring surveys, and decommissioning activities on finfish, invertebrates, and EFH species would be short-term, localized, and minor.

Endangered Species Act-Listed Species

As discussed in Section 3.6.2.1, the only IPF that may affect the Atlantic salmon (Gulf of Maine DPS) would be potential for vessel strikes and impacts from marine debris encountered during vessel transits from ports in Atlantic Canada and potentially Europe (BOEM 2023b). The likelihood of proposed Project vessels encountering Atlantic salmon during transits is low, as vessel strikes are not often reported for this species, and vessel transits would not disturb any freshwater habitats where spawning occurs (BOEM 2023b). Given the extreme low probability and brief instance of a vessel encounter and the marine debris and pollution abatement measures that would be established by BOEM as a mitigation measure, impacts from the proposed Project vessel discharges would also be extremely rare. Impacts on Atlantic salmon would be unmeasurable and considered negligible.

Atlantic sturgeon subadults and adults occur in marine waters year-round. For the Atlantic sturgeon, all five DPSs could be affected by the proposed Project. The IPFs that could impact Atlantic sturgeon the most would be vessel strikes through port utilization and pile driving resulting most likely in behavioral avoidance of the construction sites (BOEM 2023b). As mentioned in Section 3.6.2.1, Atlantic sturgeon may be present in small numbers year-round in the proposed Project area, with a peak presence between November and May. Most pile driving is anticipated to occur in the summer, when mature Atlantic sturgeon are more likely to reside in rivers and nearshore waters, thus reducing their risk of exposure to pile-driving noise (Ingram et al. 2019). No preferred foraging areas or aggregation areas have been identified in the proposed Project area; therefore, no pile-driving activities would occur in any designated critical habitat. Atlantic sturgeon could be exposed to noises above behavioral threshold and may avoid the proposed Project area; however, avoidance of preferred foraging areas and accessing of spawning or overwintering areas would not occur, and only cessation of opportunistic foraging areas during migration period is expected. Soft-start procedures would also facilitate a gradual increase of equipment energy to allow marine life to leave the area prior to the start of operations at full energy that could result in injury, further reducing the risk of physiological injury. Should an exposure occur, it would be temporary with impacts dissipating once the activity had ceased or the individual had left the area. Potential impacts would be brief (e.g., Atlantic sturgeon may approach the noisy area and divert away from it). Any impacts from this brief exposure would be so small that they could not be measured, detected, or evaluated and considered negligible.

Impacts of Phase 2

As described in this section, impact levels for Phase 2 are expected to be similar to those described for Phase 1 due to the use of similar construction and decommissioning techniques.

Phase 1 and Phase 2 would each result in a similar number of vessels performing similar operations, construction methods, and component infrastructure. Phase 2 would include up to 89 structures (up to 3 of which could be ESPs, with the remainder for WTGs) that would potentially use of bottom-frame foundations for WTGs and ESPs (COP Volume I, Section 4.2.1; Epsilon 2023). As shown in Table C-3 in Appendix C, each bottom frame foundation would require up to 1.7 acres of scour protection, compared to 1.2 acres for monopiles and 1.6 acres for each jacket foundation. As a result, the impacts of Phase 2 would be marginally larger than, but substantively similar to, those described for Phase 1. Specifically, Phase 2 would have negligible to minor impacts on finfish, invertebrates, and EFH due to EMF; negligible impacts from IPFs for accidental releases, lighting, port utilization; minor impacts from anchoring and gear utilization and noise; and moderate impacts from cable emplacement and maintenance, presence of structures, and climate change. Phase 2 construction would have moderate beneficial impacts on finfish, invertebrates, and EFH from the presence of structures and changes in regulated fishing effort.

If the applicant selects the SCV as part of the final Phase 2 design, some or all of the impacts on finfish, invertebrates, and EFH from the Phase 2 OECC through Muskeget Channel may not occur, while impacts along the SCV route would occur. The SCV would disturb up to 329 acres of seafloor, including approximately 41 acres of offshore export cable protection, but impacts would be localized, short term, and temporary. Based on available information, the impacts of SCV construction on finfish, invertebrates, and EFH would be similar to those for the Phase 2 OECC and range from negligible to moderate; impacts would be highest if EFH cannot be avoided. BOEM will provide a more detailed analysis of the SCV impacts on finfish, invertebrates, and EFH in a supplemental NEPA analysis, if the SCV is selected.

Phase 2 operations would be similar to (and likely be combined with) Phase 1 operations and would, thus, result in negligible to minor impacts on finfish, invertebrates, and EFH. The negligible to minor impact of Phase 2 operations would not increase the impacts beyond that of Alternative A. Phase 2 decommissioning impacts are expected to be similar to those described for Phase 1 decommissioning and would range from negligible to moderate.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-3 would contribute to impacts on finfish, invertebrates, and EFH through the primary IPFs of cable maintenance and emplacement, climate change, noise (especially pile driving), and the presence of structures. These impacts would primarily occur through seafloor disturbance, sedimentation, and dredging. Cumulative impacts would be similar to the impacts described for Alternative B but distributed across the entire geographic analysis area—especially in wind development areas. Overall, the cumulative impacts on finfish, invertebrates, and EFH would be **moderate** and **moderate** beneficial from reef effect associated with the presence of structures.

Conclusions

Impacts of Alternative B. Alternative B would have **moderate** impacts and **moderate** beneficial impacts on finfish, invertebrates, and EFH within the geographic analysis area based on all IPFs. Impacts from

Alternative B would include temporary and long-term consequences resulting from habitat alteration, increased turbidity, sediment deposition, entrainment, increased noise, vessel strike, and EMF. Other impacts associated with Alternative B may occur as a consequence of routine activities after the applicant completes construction, although the impact of routine post-construction activities on fish, invertebrates, and EFH is likely to be negligible, based on the small fraction of the habitat within the SWDA and OECC that would be affected.

The impacts from Alternative B would range from negligible to moderate, including the presence of structures, which may also result in moderate beneficial impacts. The impact conclusions for ongoing and future non-offshore wind activities are presented in Section 3.6.2.1. The most prominent IPFs of Alternative B are expected to be cable emplacement and maintenance, presence of structures, noise (specifically from pile driving), and climate change. In general, the impacts are likely to be local and not alter the overall character of finfish, invertebrate, and EFH resources in the geographic analysis area. Despite mortality and temporary or permanent habitat alteration, the long-term impact on finfish, invertebrates, and EFH from construction of Alternative B would be moderate, as the impacts could be measurable on a site-level scale but not within the entire proposed Project area, and the resources would likely recover naturally over time. The applicant may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

The endangered Atlantic sturgeon, giant manta ray, and oceanic whitetip shark are the only finfish or invertebrate listed under the ESA that may be affected by the proposed Project. BOEM does not anticipate that any Atlantic sturgeon, giant manta rays, and oceanic whitetip sharks would be seriously injured or killed as a result of exposure to any IPF. Additionally, giant manta rays and oceanic whitetip sharks are considered rare within the geographic analysis area, so they would not be expected to be present at densities that would result in substantial impacts on either species. Atlantic sturgeon, giant manta rays, and oceanic whitetip shark may experience impacts of ongoing and planned activities. The most significant IPF for these listed species is likely to be noise from pile driving. Since the Atlantic sturgeon adults and subadults would most likely not be within the SWDA or OCEE during summer, when offshore construction is most likely to occur, impacts on individual Atlantic sturgeon if present offshore are expected to be limited to temporary behavioral disturbance.

Cumulative Impacts of Alternative B. The cumulative impacts of all IPFs from ongoing and planned activities, including Alternative B, would be **moderate** with a **moderate** beneficial impact from the presence of structures and their associated reef effect until decommissioning. Alternative B combined with ongoing and planned activities are not anticipated to result in population consequences for listed finfish and invertebrate species.

3.6.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Finfish, Invertebrates, and Essential Fish Habitat

When analyzing the impacts of Alternative C on finfish, invertebrates, and EFH, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for finfish, invertebrates, and EFH. Alternatives C-1 and C-2, summarized below, would limit the number of export cables installed in the Eastern Muskeget route or Western Muskeget Variant but would not affect the number or placement of WTGs or ESPs for the proposed Project, compared to Alternative B. All other proposed Project components, including construction, operations, and decommissioning, would align with Alternative B:

- Alternative C-1 would avoid impacts on complex habitats in the Western Muskeget Variant by removing that route as an option for Phase 2. Under this alternative, all three Phase 2 export cables would be installed in the Eastern Muskeget route, as well as two cables for Phase 1.

- Alternative C-2 would limit the number of export cables installed in the Eastern Muskeget route to three (both Phase 1 cables and one Phase 2 cable) and would include installation of up to two cables in the Western Muskeget Variant. This would reduce impacts on complex habitats in the Eastern Muskeget route.

Alternatives C-1 and C-2 would reduce or avoid some impacts on finfish, invertebrates, and EFH during construction, operations, and decommissioning in either the Western Muskeget Variant or Eastern Muskeget route due to a decrease in the extent of cable installation in complex habitat areas, including the avoidance of cod habitat in the area avoided. This would reduce the impacts from IPFs for accidental releases, anchoring and gear utilization, EMF, lighting, cable emplacement and maintenance, noise, and presence of structures (i.e., scour protection and foundations) in the specific area avoided.

The Western Muskeget Variant would affect less seafloor acreage than the Eastern Muskeget route; however, the Western Muskeget Variant is comprised of complex seafloor only, while the Eastern Muskeget route is comprised of complex seafloor, hard coarse deposits, and soft bottom (Table 3.4-1). Because of the rare habitats provided by complex and hard coarse deposit seafloor types, avoidance of disturbance to these habitats would also result in lower impacts on finfish, invertebrates, and EFH (additional discussion is provided in Section 3.4).

Alternative C-1 would use only the Eastern Muskeget route, which would eliminate the impacts on finfish, invertebrates, and EFH in the Western Muskeget Variant. The Eastern Muskeget route contains more types of habitat than the Western Muskeget Variant, but less of the habitat is complex seafloor. Using only the Eastern Muskeget route in Alternative C-1 would, therefore, affect more habitat types and a wider variety of finfish and invertebrate species inhabiting these habitats (as well as EFH, where present) than if the Western Muskeget Variant alone were used. However, Alternative C-1 would affect less of the complex habitat compared to Alternative B (which includes the potential use of the Western Muskeget Variant).

Alternative C-2 could use both the Eastern Muskeget route and the Western Muskeget Variant and would, therefore, affect finfish, invertebrates, and EFH in complex seafloor, hard coarse deposits, and soft-bottom habitats across a larger area than Alternative C-1. Under Alternative C-2, dredging for Phase 2 cable installation could impact up to 73 acres and could include up to 274,800 cubic yards of dredged material (compared to 67 acres and 235,400 cubic yards for Alternative B and Alternative C-1). The impacts of Alternative C-2 on finfish, invertebrates, and EFH in the Eastern Muskeget route would be less than those under Alternative C-1, and potentially less than those of Alternative B because Alternative C-2 would involve installation of fewer cables in the Eastern Muskeget route. The impacts of Alternative C-2 on finfish, invertebrates, and EFH in the Western Muskeget Variant would be greater than those of Alternative C-1, due to the installation of up to two cables in that corridor (where no such cables would be installed under Alternative B or Alternative C-1). Overall, Alternative C-2 would have greater impacts than Alternative C-1 on finfish and invertebrates that use complex seafloor habitats and on EFH in those habitats due to impacts within both the Eastern and Western Muskeget.

Overall, the impacts of Alternatives C-1 and C-2 on finfish, invertebrates, and EFH would remain **moderate**, with **moderate** beneficial from the reef effect associated with the presence of structures. Although Alternative C-1 would result in a slightly shorter cable route due to use of the Eastern Muskeget route only, compared to cable placement in both the Eastern Muskeget route and the Western Muskeget Variant, the differences in route length are not anticipated to be enough to reduce the potential impacts on finfish, invertebrates, and EFH, although the specific species and EFH affected would differ slightly due to the different habitat types present in each route.

Alternatives C-1 and C-2 would occur within the same overall environment (e.g., ongoing and future actions). Therefore, impacts would only vary if the alternatives' incremental contributions differ (i.e., significant reduction), although incremental impacts from Alternatives C-1 and C-2 are expected to be similar to those of Alternative B. Therefore, the cumulative impacts of Alternatives C-1 and C-2, when combined with previous, ongoing, and future actions, would be **moderate** and **moderate** beneficial, the same as impact rating as Alternative B.

The impact levels for ESA-listed species under Alternative C-1 and C-2 are also expected to be the same as those described for Alternative B (Section 3.6.2.3) due to the use of similar construction and decommissioning techniques. Alternatives C-1 and C-2 would not increase impacts and are not anticipated to result in population consequences for ESA-listed species.

3.6.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Finfish, Invertebrates, and Essential Fish Habitat with the Western Muskeget Variant Contingency Option

Impacts on finfish, invertebrates, and EFH from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B (Scenario 2 for Phase 2). While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WT or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce the potential impacts on fish, invertebrates, and EFH by a negligible increment for both Phase 1 (3.2 acres[23] if a foundation is eliminated or 3.9 acres[23] if a ESP foundation is eliminated) and Phase 2 (4.5 acres[23] if a WTG foundation is eliminated or 7.6 acres[23] if a ESP foundation is eliminated) as a result of one less foundation and associated scour protection and required construction vessel impacts (COP Volume III, Appendix III-T; Epsilon 2023). Additionally, the impacts would be slightly less, as less pile driving would be required.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on finfish, invertebrates, and EFH relative to those of Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **moderate** impacts on finfish, invertebrates, and EFH within the geographic analysis area, as well as **moderate** beneficial impacts from the reef effect associated with the presence of structures. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **moderate** and **moderate** beneficial.

[23] This acreage assumes that the foundation and associated scour protection, as well as seafloor disturbance, as a result of construction vessel impacts would not occur at a single position.

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3.7 Marine Mammals

This section discusses marine mammal resources in the geographic analysis area, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.7-1. Specifically, this includes Scotian Shelf, Northeast Shelf, and Southeast Shelf LMEs. This broad geographic area includes the proposed Project area (defined as the area encompassing the SWDA and OECC) and is likely to capture the majority of the movement range for most species that could be affected by the proposed Project. It is also inclusive of all areas that could be affected by the proposed Project's activities, including Nantucket Sound, areas south of Martha's Vineyard and Nantucket, and the RI/MA Lease Areas. Appendix D provides a detailed summary of existing conditions, while Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor (or Lower) Impacts, describes anticipated impacts based on assessed IPFs of ongoing and future offshore activities other than offshore wind.

3.7.1 Description of the Affected Environment for Marine Mammals

Marine mammals are highly mobile animals that typically use the waters of the geographic analysis area for a range of life-sustaining activities, including migration, foraging, mating, and giving birth. Some individuals occur in all seasons, while others are seasonally present in the proposed Project area. The spatial distributions of marine mammal species in the geographic analysis area are not uniform; some species are pelagic and occur farther offshore, some are coastal and found nearshore, and others occur in both near and offshore areas. Additionally, some species prefer waters of the OCS and shelf edge (defined as a region that straddles the continental shelf break [656-foot depth contour]), either seasonally or while feeding due to changes in the abundance and locations of their prey species; however, at other times of the year, these same species can occur in shallower depths closer to shore. Regarding terminology used to describe types of marine mammals herein, "pinnipeds" refers to seals; "odontocetes" refers to toothed whales, dolphins, and porpoises; "mysticetes" refers to baleen whales; and "cetaceans" is inclusive of odontocetes and mysticetes.

Forty marine mammal species are known to occur year-round, seasonally, and/or incidentally on the geographic analysis area (Table 3.7-1). This includes 6 mysticete whales; 29 odontocete whales, dolphins, and porpoise; 4 seals; and 1 manatee species. Current species abundance estimates for the 38 marine mammal species in the Atlantic under the jurisdiction of NMFS can be found in NMFS' marine mammal stock assessment reports for the U.S. Atlantic (Hayes et al. 2019, 2020, 2021, 2022, 2023); beluga whale (*Delphinapterus leucas)* information can be found in the Committee on the Status of Endangered Wildlife in Canada status reports for Canadian designatable units of beluga whale (COSEWIC 2014, 2020); and manatee information can be found in the U.S. Fish and Wildlife Service stock assessment report for the West Indian manatee (USFWS 2023). For these reports, data collection, analysis, and interpretation are conducted through marine mammal research programs at NOAA Fisheries Science Centers and by other researchers. For the endangered North Atlantic right whale (NARW; *Eubalaena glacialis*) stock assessment report, the right whale catalog and sightings database, which use data from a photo-identification recapture database for individual NARWs, is used with available records through November 2020 (Hayes et al. 2023).

Descriptions of marine mammals found in the geographic analysis area are summarized in the COP for the proposed Project (Volume III, Section 6.7; Epsilon 2023), which incorporates existing published literature, gray literature, and public reports. Abundance and density data maps are accessible from Duke University's Marine Geospatial Ecology Lab (MGEL 2022; Roberts et al. 2016b, 2023). These data also document a generally patchy and seasonally variable marine mammal species presence and population density in the geographic analysis area.

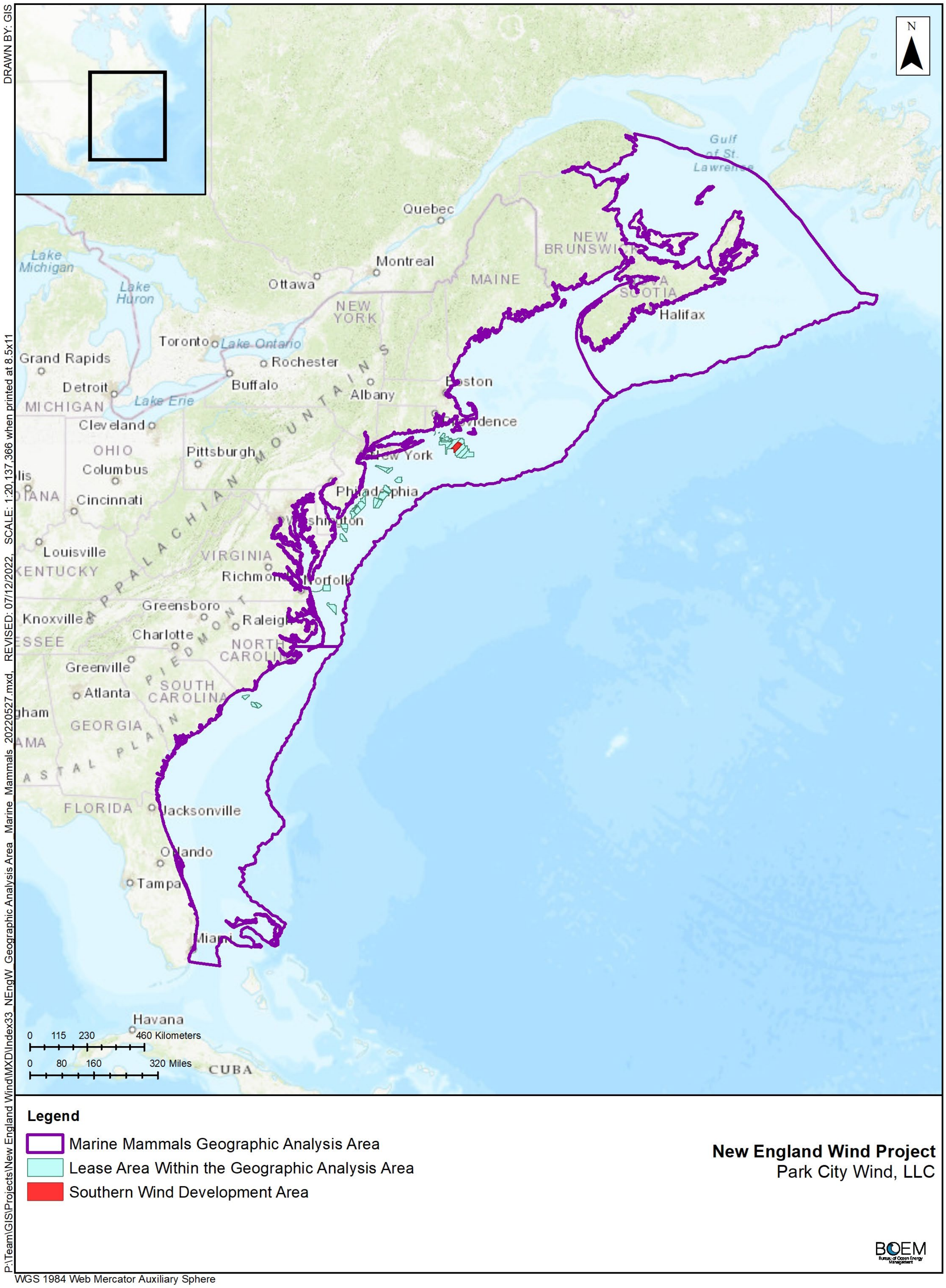

Figure 3.7-1: Geographic Analysis Area for Marine Mammals

Table 3.7-1 summarizes the presence, distribution, and population status of marine mammal species known to occur in and around the geographic analysis area. Table 3.7-2 presents average monthly and annual average marine mammal densities for the SWDA with a 10-kilometer (6-mile) buffer as described in the acoustic modeling report (COP Appendix III-M; Epsilon 2023; JASCO 2023; 88 Fed. Reg. 37606 [June 8, 2023]) using the most recent density data from Roberts et al. (2023).

This section focuses on 16 of the 40 marine mammal species potentially present in the proposed Project area (Table 3.7-1). Specifically, this includes species that would likely have regular, common, or uncommon occurrences in the proposed Project area based on the previously referenced abundance and density data (Roberts et al. 2016b, 2023) and published literature such as Kenney and Vigness-Raposa (2010), Kraus et al. (2016b), and Palka et al. (2017, 2021) that reference vessel, aerial, and acoustic survey methods. The time of year; level of activity; and duration of construction, operations, and decommissioning activities were important factors in determining which marine mammal species would likely be present at the time and place of the various activities associated with offshore wind development in the geographic analysis area. Furthermore, species occurrence and density data were used to identify the subset of marine mammals for consideration and to estimate the distributions of those species. Among marine mammal species that may occur in this area, five are listed as endangered: NARW, blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). The humpback whale (*Megaptera novaeangliae*) was previously federally listed as endangered. However, in 2016, NOAA revised the ESA listing for the humpback whale to identify 14 DPS; the DPS of humpback whales that occurs along the east coast of the United States (West Indies DPS) is not listed as endangered or threatened (81 Fed. Reg. 62259 [October 11, 2016]).

The proposed Project's MMPA LOA application requests a small amount of take for blue whale, beluga whale, and beaked whale species, all of which would be considered rare in the geographic analysis area. Rare species are typically not carried forward in the analysis; however, due to take requests in the proposed Project's LOA, they are considered in the assessment. Blue whales in the North Atlantic appear to target high-latitude feeding areas and may also use deep-ocean features such as sea mounts outside the feeding season (Pike et al. 2009; Lesage et al. 2017, 2018). Given their reported occurrence and habitat preferences, their presence in the geographic analysis area is uncommon (Waring et al. 2007, 2009, 2012, 2013). Additionally, sightings and strandings data indicate that blue whales occur along the U.S. East Coast continental shelf rarely, typically exhibiting a more pelagic distribution (NMFS 1998; Kraus et al. 2016b; Lesage et al. 2017). Beluga whales are primarily found in subarctic and arctic waters and can be found in the area of Labrador Current and along the coasts of Newfoundland and Greenland. However, this species was detected in the bays and inlets of Rhode Island and Massachusetts in 2014 (Swaintek 2014). Beaked whales can occur in relatively high numbers in the in the geographic analysis area; however, this occurrence is usually offshore near the continental shelf edge (BOEM 2014c) outside of the proposed Project area. These species are included in Table 3-7.1. The impact of the IPFs on these species is expected to be similar for other marine mammals of their group and are considered as such in this document.

Details (e.g., biology, population status, life history, habitats, habitat use, the threats they face, distribution, and conservation efforts) for the species that may be impacted by offshore wind development in the geographic analysis area can be found in the proposed Project's COP (Volume III, Table 6.7-1; Epsilon 2023), in Appendix B, Supplemental Information and Additional Figures and Tables, and through the following resources:

- NMFS Find a Species website (https://www.fisheries.noaa.gov/find-species)
- The Northeast Ocean Data Portal (https://www.northeastoceandata.org/data-explorer/?mammals-turtles)
- Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations species profiles (http://seamap.env.duke.edu/)

- Habitat-based Marine Mammal Density Models for the U.S. Atlantic (https://seamap.env.duke.edu/models/Duke/EC/)
- Stock assessment reports and species overview website for the West Indian manatee available from USFWS (2019, 2023)
- COSEWIC status reports for Canadian designatable units of beluga whale (COSEWIC 2014, 2020)

Table 3.7-1: Occurrence, Seasonality, and Population Status of Marine Mammal Species

Common Name (Family)	Scientific Name	Stock	Estimated Abundance[a]	Federal Regulatory Status[b]	Relative Occurrence in the SWDA[c]	Seasonal Occurrence in the SWDA[d]
Baleen whales (Mysticeti)						
Blue whale	*Balaenoptera musculus*	Western North Atlantic	402[e]	MMPA–strategic; ESA endangered	Rare	—
Fin whale	*Balaenoptera physalus*	Western North Atlantic	6,802	MMPA–strategic; ESA endangered	Common	Year-round, heightened abundance spring-summer
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine (West Indies DPS)	1,396	MMPA–non-strategic[f]	Common	Year-round, heightened abundance spring-fall
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast	21,968	MMPA–non-strategic	Common	Year-round, heightened abundance spring-fall
NARW	*Eubalaena glacialis*	Western North Atlantic	338	MMPA–strategic; ESA endangered	Common	Year-round, heightened abundance winter-spring
Sei whale	*Balaenoptera borealis*	Nova Scotia	6,292	MMPA–strategic; ESA endangered	Regular	Year-round, heightened abundance spring-summer
Toothed whales (Odontoceti)						
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	39,921	MMPA–non-strategic	Uncommon	Year-round, heightened abundance spring-summer
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	93,233	MMPA–non-strategic	Common	Year-round, heightened abundance spring-fall
Beluga whale	*Delphinapterus leucas*	Canadian Atlantic Arctic[g]	131,450[g]	MMPA–non-strategic	Rare	—
Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic, Offshore[h]	62,851	MMPA–non-strategic	Common	Year-round
		Western North Atlantic, Northern Migratory Coastal	6,639	MMPA–strategic	Rare	—
Clymene dolphin	*Stenella clymene*	Western North Atlantic	4,237	MMPA–non-strategic	Rare	—
False killer whale	*Pseudorca crassidens*	Western North Atlantic	1,791	MMPA–non-strategic	Rare	—
Fraser's dolphin	*Lagenodelphis hosei*	Western North Atlantic	Unknown	MMPA–non-strategic	Rare	—
Killer whale	*Orcinus orca*	Western North Atlantic	Unknown	MMPA–non-strategic	Rare	—

Common Name (Family)	Scientific Name	Stock	Estimated Abundance[a]	Federal Regulatory Status[b]	Relative Occurrence in the SWDA[c]	Seasonal Occurrence in the SWDA[d]
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	39,215	MMPA–non-strategic	Uncommon	Year-round
Melon-headed whale	*Peponocephala electra*	Western North Atlantic	Unknown	MMPA–non-strategic	Rare	—
Pan-tropical spotted dolphin	*Stenella attenuata*	Western North Atlantic	6,593	MMPA–non-strategic	Rare	—
Pygmy killer whale	*Feresa attenuata*	Western North Atlantic	Unknown	MMPA–non-strategic	Rare	—
Risso's dolphin	*Grampus griseus*	Western North Atlantic	35,215	MMPA–non-strategic	Uncommon	Year-round
Rough-toothed dolphin	*Steno bredanensis*	Western North Atlantic	136	MMPA–non-strategic	Rare	—
Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic	172,974	MMPA–non-strategic	Common	Year-round, heightened abundance summer-fall
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	28,924	MMPA–non-strategic	Rare	—
Sperm whale	*Physeter macrocephalus*	North Atlantic	4,349	MMPA–strategic; ESA endangered	Uncommon	Year-round, heightened abundance summer-fall
Spinner dolphin	*Stenella longirostris*	Western North Atlantic	4,102	MMPA–non-strategic	Rare	—
Striped dolphin	*Stenella coeruleoalba*	Western North Atlantic	67,036	MMPA–non-strategic	Rare	—
White-beaked dolphin	*Lagenorhynchus albirostris*	Western North Atlantic	536,016	MMPA–non-strategic	Rare	—
Beaked whales (Ziphiidae)						
Cuvier's beaked whale	*Ziphius cavirostris*	Western North Atlantic	5,744	MMPA–non-strategic	Rare	—
Blainville's beaked whale	*Mesoplodon densirostris*	Western North Atlantic	10,107[i]	MMPA–non-strategic	Rare	—
Gervais' beaked whale	*Mesoplodon europaeus*	Western North Atlantic	10,107[i]	MMPA–non-strategic	Rare	—
Sowerby's beaked whale	*Mesoplodon bidens*	Western North Atlantic	10,107[i]	MMPA–non-strategic	Rare	—
True's beaked whale	*Mesoplodon mirus*	Western North Atlantic	10,107[i]	MMPA–non-strategic	Rare	—
Northern bottlenose whale	*Hyperoodon ampullatus*	Western North Atlantic	Unknown	MMPA–non-strategic	Rare	—
Dwarf and pygmy sperm whales (Kogiidae)						
Dwarf sperm whale	*Kogia sima*	Western North Atlantic	7,750[j]	MMPA–non-strategic	Rare	—
Pygmy sperm whale	*Kogia breviceps*	Western North Atlantic	7,750[j]	MMPA–non-strategic	Rare	—
Porpoises (Phocoenidae)						

Common Name (Family)	Scientific Name	Stock	Estimated Abundance[a]	Federal Regulatory Status[b]	Relative Occurrence in the SWDA[c]	Seasonal Occurrence in the SWDA[d]
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine, Bay of Fundy	95,543	MMPA–non-strategic	Common	Year-round, heightened abundance fall-spring
Earless seals (Phocidae)						
Gray seal	*Halichoerus grypus*	Western North Atlantic	27,300[k]	MMPA–non-strategic	Common	Year-round
Harbor seal	*Phoca vitulina*	Western North Atlantic	61,336	MMPA–non-strategic	Common	Year-round
Harp seal	*Pagophilus groenlandicus*	Western North Atlantic	Unknown[l]	MMPA–non-strategic	Uncommon	Winter
Hooded seal	*Cystophora cristata*	Western North Atlantic	Unknown	MMPA–non-strategic	Rare	—
Sea cows (Sirenia)						
West Indian manatee (Florida subspecies)	*Trichechus manatus latirostris*	Florida	8,810[m]	MMPA–strategic; ESA threatened[c,n]	Rare	—

DPS = distinct population segment; ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; NARW = North Atlantic right whale; NMFS = National Marine Fisheries Service; PBR = potential biological removal; SWDA = Southern Wind Development Area; USEPA = U.S. Environmental Protection Agency

— = Species are expected to be rare in the SWDA and are, therefore, not discussed further in this assessment.

[a] Unless otherwise noted, best available abundance estimates are from NMFS stock assessment reports (Hayes et al. 2019, 2020, 2021, 2022, 2023)

[b] This denotes the highest federal regulatory classification. A strategic stock is defined as any marine mammal stock:

[1] for which the level of direct human-caused mortality exceeds the PBR level;
[2] that is declining and likely to be listed as threatened under the ESA; or
[3] that is listed as threatened or endangered under the ESA or as depleted under the MMPA (NMFS 2021e).

[c] Relative occurrence, as defined in COP Section 6.7.1.1 (Volume III; Epsilon 2023), was derived using NMFS stock assessment reports (Hayes et al. 2019, 2020, 2021, 2022, 2023); published literature such as Kenney and Vigness-Raposa (2010), Kraus et al. (2016b), Palka et al. (2017, 2021) O'Brien et al. (2021a, 2021b, 2022a); and density estimates (Roberts et al. 2016b, 2023), and is categorized as follows:

Common: the species occurs consistently in moderate to large numbers.
Regular: the species occurs in low to moderate numbers on a regular basis or seasonally.
Uncommon: the species occurs in low numbers or on an irregular basis.
Rare: there are limited species records for some years; range includes the SWDA but due to habitat preferences and distribution information, species are not expected of occur in the SWDA. Records may exist for adjacent waters.

[d] Seasonal occurrence is defined as follows:

Winter: December, January, February
Spring: March, April, May
Summer: June, July, August
Fall: September, October, November

[d] This indicates species that would be likely to have regular or common occurrences in the proposed Project area.

[e] No best population estimate exists for the blue whale; the minimum population estimate is presented in this table (Hayes et al. 2021).

[f] The humpback whale was previously federally listed as endangered; however, based on the revised listing completed by NMFS in 2016 (81 Fed. Reg. 62259 [October 11, 2016]), the DPS of humpback whales that occurs along the U.S. East Coast, the West Indies DPS, is no longer considered endangered or threatened.

[g] Eight distinct beluga whale designatable units exist in the Canadian Atlantic and Arctic regions (COSEWIC 2014, 2020). Since the extralimital range of individuals from multiple designatable units may overlap, the population estimate provided is inclusive of all Canadian designatable units.

[h] Bottlenose dolphins occurring in the SWDA likely belong to the Western North Atlantic Offshore stock (Hayes et al. 2021).

[i] This estimate includes all undifferentiated Mesoplodon spp. beaked whales in the Atlantic (Hayes et al. 2021).
[j] This estimate includes both dwarf and pygmy sperm whales (Hayes et al. 2021).
[k] This is an estimate of gray seal population in U.S. waters. Data are derived from pup production estimates; Hayes et al. (2019, 2020, 2021) note that uncertainty about the relationship between whelping areas along with a lack of reproductive and mortality data make it difficult to reliably assess the population trend.
[l] Hayes et al. (2021) report insufficient data to estimate the population size of harp seals in U.S. waters; the best estimate for the whole population is 7.4 million.
[m] A best population estimate is provided for the West Indian manatee (Florida subspecies; USFWS 2023). The current range-wide population estimate for the West Indian manatee (all subspecies) is 13,000 (USFWS 2019).
[n] The West Indian manatee, including the Florida manatee subspecies, was previously federally listed as endangered; however, based on the revised listing completed by the USEPA in 2017 (82 Fed. Reg. 16668 [May 5, 2017]), the West Indian manatee, including all its subspecies, was reclassified as threatened and is no longer considered endangered under the ESA.

Table 3.7-2: Average Monthly and Annual Average Marine Mammal Densities for May to December in the Southern Wind Development Area and a 10-Kilometer Buffer[a]

Common Name	Scientific Name	Monthly Average Densities (Individuals/100 km^2)[b]												Annual Mean Density
		January	February	March	April	May	June	July	August	September	October	November	December	(Individuals per km^2)
Mysticetes														
Fin whale[b]	*Balaenoptera physalus*	0.215	0.166	0.107	0.164	0.272	0.256	0.438	0.366	0.227	0.057	0.051	0.141	0.205
Humpback whale	*Megaptera novaeangliae*	0.031	0.023	0.043	0.149	0.294	0.307	0.172	0.120	0.167	0.236	0.190	0.030	0.147
Minke whale	*Balaenoptera acutorostrata*	0.113	0.137	0.136	0.806	1.728	1.637	0.700	0.471	0.516	0.465	0.052	0.077	0.570
NARW[b]	*Eubalaena glacialis*	0.387	0.461	0.456	0.478	0.295	0.050	0.022	0.018	0.028	0.052	0.068	0.197	0.209
Sei whale[b]	*Balaenoptera borealis*	0.039	0.021	0.044	0.112	0.192	0.052	0.013	0.011	0.019	0.036	0.079	0.065	0.057
Odontocetes														
Atlantic spotted dolphin	*Stenella frontalis*	0.001	<0.001	<0.001	0.003	0.018	0.025	0.031	0.054	0.273	0.431	0.179	0.018	0.086
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	2.049	1.230	0.850	1.313	3.322	3.003	1.392	0.730	1.654	2.431	1.791	2.440	1.850
Common bottlenose dolphin (offshore)	*Tursiops truncatus*	0.495	0.111	0.059	0.156	0.814	1.358	1.479	1.659	1.483	1.337	1.255	1.101	0.942
Short-beaked common dolphin	*Delphinus delphis*	7.130	2.455	1.884	3.258	6.254	13.905	10.533	14.446	25.703	22.676	11.103	10.774	10.844
Harbor porpoise	*Phocoena phocoena*	10.007	10.784	10.277	8.914	6.741	0.960	0.880	0.848	0.988	1.271	1.418	5.812	4.908
Long-finned pilot whale[c]	*Globicephala melas*	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
Short-finned pilot whale[c]	*Globicephala macrorhynchus*	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
Risso's dolphin	*Grampus griseus*	0.043	0.004	0.002	0.018	0.096	0.048	0.068	0.128	0.158	0.087	0.120	0.179	0.079
Sperm whale[b]	*Physeter macrocephalus*	0.031	0.011	0.013	0.003	0.014	0.028	0.038	0.107	0.070	0.057	0.031	0.020	0.035
Pinnipeds														
Gray seal[d]	*Halichoerus grypus*	5.395	5.603	4.176	3.203	4.716	0.806	0.088	0.094	0.226	0.500	1.768	4.534	2.592
Harbor seal[d]	*Phoca vitulina*	8.093	8.404	6.265	4.804	7.074	1.209	0.132	0.140	0.339	0.750	2.652	6.802	3.889
Harp seal[d]	*Pagophilus groenlandicus*	5.781	6.003	4.475	3.432	5.053	0.864	0.094	0.100	0.242	0.535	1.894	4.858	2.778

Source: JASCO 2023
ESA = Endangered Species Act; km^2 = square kilometers; SWDA = Southern Wind Development Area
[a] The 10-kilometer (31-mile) buffer surrounding the SWDA is intended to be inclusive of the full potential area of ensonification for noise-producing proposed Project activities, as described in the underwater acoustic modeling report (COP Appendix III-M; Epsilon 2023).
[b] This denotes an ESA-listed species.
[c] Long- and short-finned pilot whale densities are the annual pilot whale guild density scaled by their relative abundances.
[d] Gray and harbor seal densities are the seals guild density scaled by their relative abundances; gray seals are used as a surrogate for harp seals.

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Current population trends, as well as calculated potential biological removal (PBR)[24] and observed mortality and serious injury (M/SI) for marine mammal species that commonly occur within the proposed Project area are presented in Table 3.7-3. Marine mammal stock assessment reports for 2020 (Hayes et al. 2021), 2021 (Hayes et al. 2022), and 2022 (Hayes et al. 2023) indicate that statistically significant data to determine population trends for most marine mammal species regularly found in the geographic analysis area are lacking; only the NARW and humpback whale have sufficient data to support a population trend analysis. The Gulf of Maine humpback whale stock continues to experience a positive trend in abundance (Hayes et al. 2020). However, data show the population of the endangered NARW declined in abundance from 2011 to 2020 (Hayes et al. 2023). Recruitment of new individuals from births remains low, with mortalities exceeding births by 3:2 during the 2017 to 2020 timeframe (Pettis et al. 2021). Researchers have identified 17 calves for the 2024 calving season as of February 1, 2024 (NMFS 2024a). However, one of the calves was observed with severe injuries consistent with a vessel strike off Amelia Island, Florida in January 2024 (NMFS 2024a). In comparison, 12 calves were observed during the 2023 calving season (defined as calves born between mid-November 2022 and mid-April 2023), which was down from 15 during the 2022 season and 20 during the 2021 season (NMFS 2024a). Despite the optimistic calving numbers so far for 2024, mortalities continue to exceed the species' calculated PBR (Hayes et al. 2023; Pettis et al. 2021, 2022). The current PBR for NARWs is 0.7 individuals, whereas the total annual observed M/SI is 8.1 individuals (Hayes et al. 2023), as shown in Table 3.7-3. Not all mortalities are detected (Hayes et al. 2023), and overall mortality is likely higher than estimated (Pace 2021). The very low NARW PBR value relative to much higher M/SI values continue to indicate substantial population decline; the current population estimate for NARWs is at its lowest point in nearly 20 years, with a best-estimated 338 individuals remaining (Hayes et al. 2023).

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

Table 3.7-3: Potential Biological Removal, Total Observed Annual Human-Caused Mortality and Serious Injury, and Population Trends for Marine Mammal Species that Commonly Occur within the Offshore Export Cable Corridor and Southern Wind Development Area

Common Name (Family)	Scientific Name	Stock	Estimated Abundance[a]	PBR[b]	Total Observed Annual Human-Caused M/SI[c]	Current Population Trend[d]
Baleen whales (Mysticeti)						
Fin whale[e]	*Balaenoptera physalus*	Western North Atlantic	6,802	11	1.8	NC
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	1,396	22	12.15[f]	2.8% increase per year from 2000 to 2016[g]
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast	21,968	170	10.6	NC
NARW[e]	*Eubalaena glacialis*	Western North Atlantic	338	0.7	8.1[f]	29.7% decline from 2011 to 2020[h]
Sei whale[e]	*Balaenoptera borealis*	Nova Scotia	6,292	6.2	0.8	NC
Toothed whales (Odontoceti)						
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	93,233	544	227	NC
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	39,921	320	0	NC
Common bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic, Offshore	62,851	519	28	NC
Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic	172,974	1,452	390	NC
Risso's dolphin	*Grampus griseus*	Western North Atlantic	35,215	301	34	NC
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	39,215	306	9	NC
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	28,924	236	136	NC
Sperm whale	*Physeter macrocephalus*	North Atlantic	4,349	3.9	0	NC
Porpoises (Phocoenidae)						
Harbor porpoise	*Phocoena*	Gulf of Maine, Bay of Fundy	95,543	851	164	NC
Earless seals (Phocidae)						
Gray seal	*Halichoerus grypus*	Western North Atlantic	27,300	1,389	4,453[f]	NC
Harbor seal	*Phoca vitulina*	Western North Atlantic	61,336	1,729	339[f]	NC

M/SI = mortality and serious injury; NARW = North Atlantic right whale; NC = not conclusive; NMFS = National Marine Fisheries Service; PBR = potential biological removal; UME = unusual mortality event

[a] Best available abundance estimates are from NMFS stock assessment reports (Hayes et al. 2019, 2020, 2021, 2022, 2023).

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

[c] The total observed annual M/SI is the sum of detected human-caused mortalities and serious injuries resulting from interactions with fisheries (i.e., entanglements) and vessel strikes, averaged over a 4-year period. Total annual M/SI rates are negatively biased and likely an underestimate, as not all mortalities are detected and reported.
[d] Based on NMFS stock assessment reports (Hayes et al. 2019, 2020, 2021, 2022; Pace 2021), current data are unable to support a statistically significant population trend analysis for species listed with “NC,” therefore, an assessment of “increasing,” “decreasing,” and/or “stable” is not supported at this time for these species.
[e] This indicates an ESA-listed species.
[f] This indicates an ongoing and active or recently closed UME (NMFS 2024b). Information on active and closed UMEs can be found on NMFS’ website (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events).
[g] Abundance increased 2.8 percent from the years 1990–2011, followed by a significant decrease in mean survival rates beginning in 2010, which correlated with a considerable change in habitat use by humpback whales (Hayes et al. 2023; Pace 2021).
[h] Derived from 2011 and 2020 median abundance estimates for NARW (Hayes et al. 2023).

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

The habitat within the geographic analysis area may play a role in the reproductive cycle for multiple species (Leiter et al. 2017; Stone et al. 2017). Stone et al. (2017) documented 27 sightings of cetaceans with their young, including NARWs, humpback whales, fin whales, sei whales, minke whales (*Balaenoptera acutorostrata*), pilot whales (*Globicephala* spp.), common bottlenose dolphins, and short-beaked common dolphins (*Delphinus delphis*) within the study area encompassing the RI/MA Lease Areas during a 3.5-year study period between October 2011 and June 2015. Humpback whales had the highest number of sightings with calves present (Stone et al. 2017).

Waters off the northeast United States, including southern New England and the SWDA, represent important feeding habitats for several species of baleen whales, such as NARW, humpback, fin, and minke whales (Hayes et al. 2019, 2023). These species undertake yearly migrations between their winter breeding grounds in southern latitudes and summer feeding grounds in northern latitudes, though not all individuals of a population migrate every year. The primary prey source for baleen whales is generally zooplankton and small schooling fish. Seasonal trends in overall zooplankton abundance have been detected over the shelf waters of southern New England, ranging from relatively low densities (12 to 23 cubic centimeters per 100 cubic meters) in January through February to relatively high densities (greater than 55 cubic centimeters per 100 cubic meters) during May through August (NEFSC 2018b). These trends are also present in one of the most abundant and widespread zooplankton species on the Northeast U.S. Shelf, *Calanus finmarchicus*, which is an important food source for many fish species and for NARWs. On average, *C. finmarchicus* has been the most abundant during the spring and summer (March through August), with the peak density in May through June along the Northeast U.S. Shelf (NEFSC 2018b). Zooplankton from the *Pseudocalanus* complex were also detected at relatively high levels with the *C. finmarchicus*, which are also known to be an important food source for NARW (NEFSC 2018b; Hudak et al. 2023). *Centropages* spp., which are also a preferred prey species for NARW (Hudak et al. 2023), showed very low densities relative to the *C. finmarchicus* and *Pseudocalanus* complex in the sample collected by NEFSC (2018b). Levels of zooplankton biovolume have been remarkably consistent over the past 20 years with some interannual variability. However, mean total density for *C. finmarchicus* along the Northeast U.S. Shelf varied greatly from year to year, commonly halving or doubling from one year to the next (NEFSC 2018b; Grieve et al. 2017; Hudak et al. 2023).

The Atlantic Marine Assessment Program for Protected Species is a comprehensive multi-agency research program in the U.S. Atlantic Ocean, from Maine to the Florida Keys. Its aims to assess the abundance, distribution, ecology, and behavior of marine mammals, sea turtles, and seabirds throughout the U.S. Atlantic. The Atlantic Marine Assessment Program for Protected Species has been collecting data generated from aerial and shipboard surveys along the U.S. Coast, including in the RI/MA Lease Areas since 2010. Higher abundance estimates were modeled for late spring through early summer for humpback whale, sei whales, minke whales, sperm whales, Atlantic white-sided dolphins (*Lagenorhynchus acutus*), and short-beaked common dolphins, whereas relatively consistent seasonal abundance was demonstrated for fin whales, long-finned pilot whales (*Globicephala melaena*), short-finned pilot whales (*Globicephala macrorhynchus*), and Atlantic spotted dolphins (*Stenella frontalis*); higher late-summer abundances were evident for Risso's dolphins (*Grampus griseus*) and harbor porpoises (*Phocoena phocoena*) (Palka et al. 2017, 2021). Atlantic Marine Assessment Program for Protected Species survey data results likewise indicate a preference for deeper offshore waters for pygmy and dwarf sperm whales (*Kogia breviceps* and *Kogia sima*), beaked whales, and striped dolphins (*Stenella coeruleoalba*) (Palka et al. 2017, 2021).

NARWs have the potential to occur in the geographic analysis area year-round. The relative abundance and density of NARWs is highest in the winter and spring within the RI/MA Lease Areas, with individuals typically arriving in December and departing around May (Kenney and Vigness-Raposa 2010; Kraus et al. 2016b; Leiter et al. 2017; Quintana-Rizzo et al. 2021). The species is less commonly observed in the proposed Project area during July, August, and September when they are at more northern feeding grounds such as the Gulf of Maine/Bay of Fundy and Gulf of St. Lawrence (Pendleton et al. 2012; Kraus et al. 2016b; Leiter et al. 2017; Crowe et al. 2021). A recent increase in habitat use and year-round presence of the southern New England region, including Nantucket Shoals, indicates that the area is an increasingly important NARW habitat (O'Brien et al 2022b). Surveys indicate that there are several areas where NARWs congregate seasonally, which include OCS waters adjacent and northeast of the proposed Project area. NARWs have been documented feeding and socializing south of Martha's Vineyard and Nantucket Islands, within and adjacent to the proposed Project. Sighting rates are highest between December and May, but individuals my occur during summer months (e.g., August 2019) (Leiter et al. 2017; Stone et al. 2017; Quintana-Rizzo et al. 2021; O'Brien et al. 2022a), Almost 50 percent of reproductive females used southern New England waters (Quintana-Rizzo et al. 2021). New England waters are important feeding habitats for NARW that must locate and exploit dense patches of zooplankton to feed efficiently and meet biological and energetic requirements (Fortune et al. 2013). These dense zooplankton patches, dominated by *Calanus finmarchicus*, *Pseudocalanus* complex, and *Centropages* spp., are a primary driver in NARW distribution and habitat use within their northern latitude foraging grounds (Kenney et al. 1986; Pendleton et al. 2012; Pershing et al. 2009; Hudak et al. 2023). Southern New England waters, most notably Nantucket Shoals, support these dense aggregations of preferred prey, and this area is identified as the only known winter foraging area for NARW (Quintana-Rizzo et al. 2021; O'Brien et al. 2022a). The tidal front along the western edge of Nantucket Shoals, generally associated with the 98-foot isobath, is a well-mixed, productive region associated with NARW foraging aggregations (Quintana-Rizzo et al. 2021). From 2011-2015 survey data, NARW sightings increased in the northern parts of the wind energy areas in spring and shifted generally westward, but their specific locations and extents varied with time (Quintana-Rizzo et al. 2021). Sei whales are also often sighted foraging in conjunction with NARW during the spring when they target the same zooplankton prey species as NARW (Davis et al. 2020). Additional stressors in this area, such as increased vessel traffic, habitat modifications, and underwater noise; may potentially exacerbate existing stressors on NARWs.

Fin whales are common in continental shelf waters of the geographic analysis area north of Cape Hatteras, North Carolina, and can occur year-round in the vicinity of the proposed Project area, though seasonal densities are highest in the spring through summer (Kenney and Vigness-Raposa 2010; Hayes et al. 2022). Sei whales have been sighted in the summer in continental shelf waters of the northeastern United States, with irregular movements that appear to be associated with oceanic fronts, sea surface temperatures, and specific bathymetric features (Olsen et al. 2009; Hayes et al. 2022). Humpback whales can be found in New England waters throughout the year, but their numbers decrease in winter when most animals migrate to their more southerly calving and breeding grounds (Hayes et al. 2020). Sperm whales have been observed during scientific surveys conducted in summer over the continental shelf edge, over the continental slope, and into mid-ocean regions but are not common in shelf waters in or near the proposed Project area (Hayes et al. 2020).

Multiple dolphin species, such as the Atlantic white-sided dolphin, common bottlenose dolphin (*Tursiops truncates*), and short-beaked common dolphin, are common in waters in and around the proposed Project area; short-beaked common dolphins were the most frequently observed dolphin species in aerial surveys conducted from 2011 to 2015 in the RI/MA Lease Areas (Kraus et al. 2016b). The offshore morphotype[25] of common bottlenose dolphin is distributed primarily along the OCS and continental slope in the northwest Atlantic Ocean, including the proposed Project area, and is the only type expected to be encountered in the proposed Project area (Hayes et al. 2020). Risso's dolphins and long-finned pilot whales are present in in the geographic analysis area but typically in association with unique bathymetric features such as the shelf edge and George's Bank. The harbor porpoise is abundant throughout the coastal waters of the U.S. East Coast and are most likely to be encountered from spring through fall in nearshore waters of the proposed Project area (Hayes et al. 2022). Two seal species, the harbor seal and gray seal, are also commonly present in nearshore waters of the proposed Project area, though harp seals (*Pagophilus groenlandicus*) may also be encountered seasonally (Hayes et al. 2022).

There have been elevated numbers of NARW mortalities and injuries reported since 2017, which prompted NMFS to designate an unusual mortality event (UME) for NARWs (NMFS 2024c). These elevated mortalities and injuries have continued into 2024, totaling 36 mortalities, 35 serious injuries, and 51 sublethal injuries or illness as of February 1, 2024 (NMFS 2024c). Entanglement in fishing gear and vessel strikes are the preliminary cause of mortality, serious injury, and morbidity (sublethal injury and illness) in most of these whales during the ongoing UME. In addition to this recent UME, the reproductive output for the species has declined by 40 percent since 2010 (Kraus et al. 2016b). Recent evidence suggests that the proportion of NARW mortality attributed to fishing gear entanglement, and overall mortality is likely higher than previously estimated (Pace 2021). The species continues to be in severe decline, which prompted the International Union for Conservation of Nature to update the species' red list status in July 2020 from endangered to critically endangered, noting its high risk for global extinction. Additional information about the current population status for NARWs is provided in Hayes et al. (2023). Overall, NARWs exhibit poor body condition, potentially suppressing growth, survival, age of sexual maturation, and calving rates (Christiansen et al. 2020).

Active UMEs ongoing within the geographic analysis area have also been designated for humpback whales (NMFS 2024d) and the Florida manatee (*Trichechus manatus latirostris;* NMFS 2024d). Since 2016, a total of 212 humpback whale mortality have been reported along the Atlantic coast from Maine to Florida (NMFS 2024d). Partial or full necropsies were performed on approximately half the whales, and of those examined, 40 percent should signs of human interaction such as vessel strikes or entanglement (NMFS 2024d). The UME for the Florida manatee was first designated in 2021 for manatees occurring along the Atlantic Coast of Florida, attributed to malnutrition and poor environmental conditions in the Indian River Lagoon leading to poor body condition for this population (NMFS 2024e). A 2018–2022 Northeast pinniped UME was also established for harbor seal (*Phoca vitulina),*gray seal (*Halichoerus grypus),* harp seals, and hooded seals (*Cystophora cristata*) along the southern and central coast of Maine; a UME involving harbor seals and gray seals was declared in June 2022. Strandings were attributed to a spillover event of the highly pathogenic avian influenza H5N1 virus from infected birds to harbor and gray seals (NMFS 2024e). This UME was closed in January 2024 (NMFS 2024e). A currently non-active (i.e., closure pending) UME was also declared for the minke whale in January 2017, attributed to suspected human interactions (e.g., vessel strikes, entanglement), as well as evidence of infectious diseases (NMFS 2024f).

NMFS has designated two critical habitat areas in U.S. waters for the NARW under the ESA: the Gulf of Maine/Georges Bank region and the southeast calving grounds from North Carolina to Florida (81 Fed. Reg. 4837), both of which are included in the geographic analysis area. Two critical habitat areas for NARWs are also defined in Canadian waters (Brown et al. 2009). Critical habitat is designated for the West Indian manatee (*Trichechus manatus latirostris*) (42 Fed. Reg. 47840); however, no manatee critical

[25] A morphotype is any of a group of different types of individuals of the same species in a population.

habitat is located within the geographic analysis area. The offshore waters of southern New England, including waters in and near the geographic analysis area, are used as a migration corridor for NARWs and are considered a biologically important area for migrations between their feeding grounds off the northeast United States and calving grounds off the Southeast United States (LaBrecque et al. 2015). Further, a biologically important area for fin whale feeding has been identified for the area east of Montauk Point, New York, to the west boundary of the RI/MA Lease Areas between the 49-foot and 164-foot depth contour from March to October; a biologically important area for sei whale feeding has been identified from the 82-foot depth contour off coastal Maine and Massachusetts west to the 656-foot depth contour in the central Gulf of Maine, including the northern shelf break area of Georges Bank; and a biologically important area for minke whale feeding has been identified in waters less than 656 feet in the southern and southwestern section of the Gulf of Maine, including Georges Bank, the Great South Channel, Cape Cod Bay and Massachusetts Bay, Stellwagen Bank, Cape Anne, and Jeffreys Ledge (LaBrecque et al. 2015).

3.7.2 Impact Level Definitions for Marine Mammals

Definitions of potential impact levels for adverse effects are provided in Table 3.7-4. Definitions for duration are provided in Section 3.3, Definition of Impact Levels. Beneficial impacts are also described, as applicable, for each IPF. Beneficial impacts are those that result in a positive effect on marine mammals. Impact levels are intended to serve NEPA purposes only and they are not intended to incorporate similar terms of art used in other statutory or regulatory reviews. For example, the term "negligible" is used for NEPA purposes as defined here and is not necessarily intended to indicate a negligible impact or effect under the MMPA. Similarly, the use of "detectable" or "measurable" in the NEPA significance criteria is not necessarily intended to indicate whether an effect is "insignificant" or "adverse" for purposes of ESA Section 7 consultation.

Table 3.7-4: Impact Level Definitions for Marine Mammals

Impact Level	Impact Type	Definition
Negligible	Adverse	The impacts on individual marine mammals or their habitat, if any, would be at the lowest levels of detection and barely measurable, with no perceptible consequences to individuals or the population.
	Beneficial	Impacts on species or habitat would be beneficial but so small as to be unmeasurable.
Minor	Adverse	Impacts on individual marine mammals or their habitat would be detectable and measurable; however, they would be of low intensity, short term, and localized. Impacts on individuals or their habitat would not lead to population-level effects.
	Beneficial	If beneficial impacts occur, they may result in a benefit to some individuals and would be temporary to short term in nature.
Moderate	Adverse	Impacts on individual marine mammals or their habitat would be detectable and measurable; they would be of medium intensity, can be short term or long term, and can be localized or extensive. Impacts on individuals or their habitat could have population-level effects, but the population can sufficiently recover from the impacts or enough habitat remains functional to maintain the viability of the species both locally and throughout their range.
	Beneficial	Beneficial impacts on species would not result in population-level effects. Beneficial impacts on habitat may be short term, long term, or permanent but would not result in population-level benefits to species that rely on them.
Major	Adverse	Impacts on individual marine mammals or their habitat would be detectable and measurable; they would be of severe intensity, can be long lasting or permanent, and would be extensive. Impacts on individuals and their habitat would have severe population-level effects and compromise the viability of the species.
	Beneficial	Beneficial impacts would promote the viability of the affected population or increase population resiliency. Beneficial impacts on habitats would result in population-level benefits to species that rely on them.

3.7.3 Environmental Consequences

3.7.3.1 Impacts of Alternative A – No Action Alternative on Marine Mammals

When analyzing the impacts of Alternative A on marine mammals, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for marine mammals. The cumulative impacts of the Alternative A considered the impacts of the Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, the existing conditions for marine mammals would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Marine mammals in the geographic analysis area are currently subject to a variety of ongoing human-caused IPFs associated with both non-offshore wind and offshore wind projects. The main known contributors to mortality events include collisions with vessel traffic resulting in ship strikes and gear utilization resulting in entanglement with fishing gear and fisheries bycatch. Other important IPFs considered include underwater noise from anthropogenic sources such as offshore construction, G&G surveys, military training and testing activities, vessel noise, aircraft noise, and dredging; accidental releases; cable emplacement and maintenance; EMF; lighting; port utilization; presence of structures; and climate change. IPFs may result in a range of impacts, from mortality to minor disturbance, and typically fall across a scale of risk depending on the activities and susceptibility of the species to impacts. These ongoing impacts on marine mammals are expected to continue regardless of the offshore wind industry. IPFs with the potential to affect marine mammals within the geographic analysis area are briefly discussed in the paragraphs that follow.

The following ongoing offshore wind activities[26] within the geographic analysis area would contribute to impacts on marine mammals:

- Continued operations of the Block Island Wind Farm (5 WTGs) installed in state waters and South Fork Wind (12 WTGs and 1 ESP) in OCS-A 0517;
- Continued operations of the Coastal Virginia Offshore Wind-Pilot Project (2 WTGs) installed in OCS-A 0497;
- Ongoing construction and eventual operations of Vineyard Wind 1 (62 WTGs and 1 ESP) in OCS-A 0501, Revolution Wind (100 WTG and 2 ESP) in OCS-A 0486, Empire Wind (147 WTG and 1 ESP) in OCS-A 0512, and Coastal Virginia Offshore Wind-Commercial Project (176 WTG and 3 ESP) in OCS-A 0483; and
- Ongoing site assessment and site characterization surveys (e.g., G&G surveys, habitat monitoring surveys, fisheries monitoring surveys).

[26] Construction of the Revolution Wind and Empire Wind projects that is expected to occur at the time of publication of this Final EIS are limited to onshore and nearshore project components (BOEM 2023c, 2023d), whereas offshore construction in their respective Lease Areas is assumed to have begun and is ongoing for the Vineyard Wind 1 and Coastal Virginia Offshore Wind-Commercial projects at the time of publication (BOEM 2021b, 2023d). Construction of the Ocean Wind 1 (98 WTG and 3 ESP) Project in OCS-A 0498 that was proposed at the time of publication of this Final EIS was supposed to include construction of onshore components, HRG surveys, and UXO detonations, if required; however, the developer announced that this project was cancelled, and so construction of this Project is not considered under ongoing offshore wind activities, and is instead considered under the planned activities scenario in Section 3.7.3.1.

Ongoing offshore wind activities may affect marine mammals through the primary IPFs of traffic (vessel), noise, and presence of structures. Other IPFs that would affect marine mammals due to ongoing offshore wind activities include accidental releases; anchoring and gear utilization; cable emplacement and maintenance; EMF; lighting; and port utilization. Ongoing offshore wind activities would have the same type of impacts from these IPFs as described in detail in Section 3.7.3.2 for planned offshore wind activities, but the impacts would be of lower intensity as there are fewer ongoing offshore wind projects relative to the planned projects (Appendix E).

Accidental releases: Ongoing vessel activities in the geographic analysis area would pose a risk of accidental releases of fuels, fluids, hazardous material, and trash and debris. Additionally, the 81 WTGs and two ESP installed in associated with ongoing offshore wind projects would also pose a risk of accidental releases. Marine mammals are particularly susceptible to the effects of contaminants from pollution and discharges as they accumulate through the food chain or are ingested with garbage. Polychlorinated biphenyls and chlorinated pesticides (e.g., dichlorodiphenyltrichloroethane, dieldrin) are of most concern and can cause long-term chronic impacts. These contaminants can lead to issues in reproduction and survivorship, and other health concerns (Jepson et al. 2016; Pierce et al. 2008). However, the population-level effects of these and other contaminants are unknown as research on contaminant levels for many marine mammal species is lacking. Some information has been gathered from necropsies from bycatch captures, which therefore focus on smaller cetaceans and seals. Weisbrod et al. (2000) examined polychlorinated biphenyls and chlorinated pesticide concentrations in bycaught and stranded pilot whales in the western North Atlantic. Contaminant levels were similar to or lower than levels found in other toothed whales in the western North Atlantic; the authors theorized that this was due to their feeding further offshore than other species (Weisbrod et al. 2000). High levels of toxic metals (e.g., mercury, lead, cadmium) and selenium were also measured in pilot whales harvested in the Faroe Islands drive fishery (Nielsen et al. 2000).

Marine mammal exposure to aquatic contaminants and inhalation of fumes from oil spills can result in mortality or sublethal impacts on the individual fitness, including adrenal impacts, hematological impacts, liver impacts, lung disease, poor body condition, skin lesions, and several other health impacts attributed to oil exposure (Kellar et al. 2017; Mazet et al. 2001; Mohr et al. 2008; Smith et al. 2017; Sullivan et al. 2019; Takeshita et al. 2017). Additionally, accidental releases may result in impacts on marine mammals due to impacts on prey species. The best available modeling assessing the potential releases specific to offshore wind projects infrastructure is from Bejarano et al. (2013). According to BOEM's modeling (Bejarano et al. 2013), a release of 128,000 gallons, which represents all available oils and fluids from 132 WTGs and ESPs, is likely to occur no more often than once per 1,000 years, and a release of 2,000 gallons or less is likely to occur every 5 to 20 years. The likelihood of a spill occurring from multiple WTGs and ESPs at the same time is very low; therefore, the potential impacts from a spill larger than 2,000 gallons are largely discountable. Based on the volumes potentially involved, the likely number of additional releases associated with offshore wind development would fall within the range of accidental releases that already occur on an ongoing basis from non-offshore wind activities.

Trash and debris may be released by vessels or ports operations throughout the geographic analysis area. Worldwide, 62 of 123 (about 50 percent) marine mammal species have been documented ingesting marine litter (Werner et al. 2016). The global stranding data indicate potential debris induced mortality rates of 0 to 22 percent. Mortality has been documented in cases of debris interactions, as well as blockage of the digestive track, disease, injury, and malnutrition (Baulch and Perry 2014). However, it is difficult to link physiological impacts on individuals to population-level impacts (Browne et al. 2015). While federal regulations are in place to prevent accidental releases, it is possible that some debris could be lost overboard during ongoing offshore wind and non-offshore wind activities.

Another potential impact related to vessels and vessel traffic is the accidental release ballast water and bilge water discharges from marine vessels. Vessels are required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR § 151.2025) and USEPA National Pollutant Discharge Elimination System Vessel General Permit standards, both of which regulate discharge of ballast or bilge water.

Though exposure to accidental releases could result in more severe impacts, BMPs and precautions that all industries follow would reduce the likelihood, and the extent of potential impacts would be localized to the area around each activity. Therefore, impacts from accidental releases and discharges from ongoing activities would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds and are unlikely to result in population-level effects, although consequences to individuals would be detectable and measurable.

Anchoring and gear utilization: Commercial fisheries occurring in the southeastern New England region include bottom trawl, mid-water trawl, dredge, gillnet, longline, and pots and traps (COP Volume III; Epsilon 2023). Targeted fisheries species include monkfish, scallop, surf clam/hard clam, squid, mackerel, Atlantic herring, and lobster, among others. Entanglement in fishing gear is a substantial ongoing threat to marine mammals and may also be responsible for high mortality rates in other large whale species (Hayes et al. 2021; Read et al. 2006). Marine mammals can ingest or become entangled in marine debris (e.g., ropes, plastic) that is lost from fishing vessels and other offshore activities. Most recorded marine megafauna entanglements are directly or indirectly attributable to ropes and lines associated with fishing gear (Benjamins et al. 2014). Theoretically, any line in the water column, including line resting on or floating above the seafloor set in areas where whales occur, could entangle a marine mammal (Hamilton et al. 2019; Johnson et al. 2005). Entanglements may involve the head, flippers, fluke, or multiple body parts; effects range from no apparent injury to death. Existing conditions for commercial fisheries, which contribute the greatest entanglement risk to marine mammals, is discussed and analyzed in Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing. Anchors associated with vessels and met buoys do not pose a direct risk of entanglement or entrapment for any marine mammal species, and the relatively limited extent of seafloor disturbances due to anchoring would result in negligible impacts for mysticetes (including NARWs), odontocetes, and pinnipeds.

Fisheries interactions are likely to have demographic impacts on marine mammal species, with estimated global mortality exceeding hundreds of thousands of individuals each year (Read et al. 2006; Reeves et al. 2013). In the Atlantic, bycatch occurs in various gillnet and trawl fisheries in New England and the Mid-Atlantic Coast, with hotspots driven by marine mammal density and fishing intensity (Benaka et al. 2019; Lewison et al. 2014). Entanglement is listed as a threat to NARWs, humpback whales, blue whales, fin whales, sei whales, common bottlenose dolphins, and gray seals (Hayes et al. 2020, 2021, 2023), though large mysticetes are at greatest risk due to their large body size and slow maneuverability. While entanglement data for blue, fin, sei, and minke whales is limited, evidence of fishery interactions causing injury or mortality has been noted for each of these species in the Greater Atlantic Regional Fisheries Office/NMFS entanglement/stranding database (Hayes et al. 2021). Of the available information, there are considerable data on the potential for entanglement of humpback whales and NARWs. A study of 134 individual humpback whales in the Gulf of Maine suggested that between 48 and 65 percent of the whales experienced entanglements (Robbins and Mattila 2001) and that 12 to 16 percent encounter gear annually (Robbins and Mattila 2001). Along with vessel collisions (discussed below), entanglement of humpback whales could be limiting the recovery of the population (Hayes et al. 2020). Limited information is available for sperm whale entanglement mortalities. However, from 1993 to 1998 there were two documented sperm whale entanglements in the North Atlantic, and three additional mortalities from 2009 through 2010 (Waring et al. 2015). There are no documented reports of fishery-related mortality or serious injury to this stock in the U.S. exclusive economic zone during 2013 through 2017 (Hayes et al. 2020).

Entanglement in fishing gear has been identified as one of the leading causes of mortality in NARW and may be a limiting factor in the species recovery (Hayes et al. 2023; Moore et al. 2021; Knowlton et al. 2012). NMFS estimates that over 85 percent of individuals have been entangled in fishing gear at least once (Hayes et al. 2023) and 60 percent of individuals show evidence of multiple fishing gear entanglements, with rates increasing over the past 30 years (King et al. 2021; Knowlton et al. 2012). Of documented NARW entanglements in which gear was recovered, 80 percent was attributed to non-mobile fishing gear (i.e., lobster and gillnet gear) (Knowlton et al. 2012). Additionally, recent literature indicates that the proportion of NARW mortality attributed to fishing gear entanglement is likely higher than previously estimated from recovered carcasses (Pace 2021).

Pinnipeds, including harbor seals and gray seals, are also at risk for entanglements (Hayes et al. 2020, 2021). Drowning or asphyxiation in gear, chronic secondary complications of injuries, and feeding impairment are all associated with entanglement mortalities in seals (Moore et al. 2013). A 2014 unoccupied aerial system survey of large populations of gray and harbor seals was used to assess the prevalence of entanglement within haul-out locations in the North Atlantic. The mean prevalence of entanglement within the haul-outs varied between 0.83 percent and 3.70 percent (Waring et al. 2015). However, observed serious injury rates are lower than would be expected from the anecdotally observed numbers of gray seals living with ongoing entanglements, as gray seals entangled in netting are common at haul-out sites in the Gulf of Maine and southeastern Massachusetts. This may be because the majority of observed animals are dead when they come aboard the vessel at bycatch (Josephson et al. 2021); therefore, rates do not reflect the number of live animals that may have broken free of the gear and are living with entanglements. Martins et al. (2019) estimated the mean prevalence of live entangled gray seals at haul-out sites in Massachusetts and Isle of Shoals to be between 1 and 4 percent.

Bycatch occurs in various commercial, recreational, and subsistence fisheries with hotspots driven by marine mammal density and fishing intensity (Lewison et al. 2014). Small odontocetes and pinnipeds are at most risk of being caught as bycatch due to their small body size that allows them to be taken up in fishing gear. Of the species considered in this assessment, Risso's dolphins, short-beaked common dolphins, short-finned pilot whales, harbor porpoises, white-sided dolphins, harbor seals, harp seals, gray seals, and hooded seals have been documented in several fisheries' bycatch data (Hayes et al. 2020, 2021, 2023). Several commercial fisheries have documented bycatch. The ones that most commonly report bycatch are pelagic longlining, bottom trawling, and sink gillnetting (Hayes et al. 2020, 2021). Purse seine fisheries, Atlantic blue crab trap/pot, North Carolina roe mullet stop net, and hook and line (rod and reel) have also noted instances of marine mammal bycatch (Hayes et al. 2020, 2021).

Stranding data indicate that other marine mammal species may be affected by entanglements or bycatch; however, the contribution of fishery-related mortalities and serious injuries to these strandings is often difficult to determine. This is because not all of the marine mammals that die or are seriously injured wash ashore, and not all will show signs of entanglement or other fishery interaction (Hayes et al. 2020, 2021). As a result, the contribution of fisheries interactions to the annual mortality and injury of marine animal species in the geographic analysis area and beyond is likely underestimated (Hayes et al. 2020, 2021).

BOEM does not anticipate that mysticete, odontocete, or pinniped entanglement with gear used for biological monitoring for ongoing offshore wind projects would occur. There are no documented cases associated with biological monitoring for the Block Island Wind Farm, Coastal Virginia Offshore Wind-Commercial Project, and Vineyard Wind 1. There are 13 documented seal deaths from South Fork Wind Farm biological monitoring; however, these occurred during gillnet surveys and South Fork Wind Farm has since ceased gillnet surveys. All of the monitoring work associated with ongoing offshore wind projects requires coordination and/or permitting with the appropriate federal agencies and adherence to the recommendations set forth in the Guidelines for Providing Information on Fisheries for Renewable Energy Development on the Atlantic Outer Continental Shelf (BOEM 2019f; NMFS 2016a). For fisheries-associated monitoring using trawls, the slow speed of mobile gear and the short tow times further reduce the potential for entanglements or other interactions for all mammals. Observations during mobile gear use have shown that entanglement or capture of large whale species is extremely rare and unlikely (NMFS 2016b). Although the trawl methods analyzed in commercial fisheries are comparable to the fishery monitoring methods proposed, the proposed trawl effort and tow times (20 minutes) for the proposed fisheries monitoring surveys are less than that previously considered by NMFS for commercial trawling activities. Consequently, the likelihood of interactions with listed species of marine mammals is much lower than commercial fishing activities.

In summary, impacts from anchoring and gear utilization for ongoing non-offshore wind and ongoing offshore wind activities are expected to be moderate for mysticetes (except NARW) due to entanglement and bycatch associated with ongoing commercial and recreational fishing as impacts would be detectable and measurable, of medium intensity, and potential long-term if the interaction leads to an injury. For NARWs, impacts would be major because entanglements in fishing gear from ongoing commercial and recreational fishing has been identified as a leading cause for mortality, and given the vulnerability of this population, the loss of even on individual would compromise the viability of this species. For odontocetes and pinnipeds, impacts from entanglement and bycatch associated with ongoing commercial and recreational fishing would be minor as the impacts are detectable and measurable, but because the documented risk of this IPF on these species is lower the risk of injury is also lower and no population-level effects are expected. Fisheries monitoring surveys for ongoing offshore wind activities are not expected to contribute appreciably to the above-described entanglement or entrapment risk for marine mammals due to the implementation of project-specific monitoring and mitigation measures and the methods employed for these surveys. The potential for impacts on NARWs, mysticetes, and large odontocetes is anticipated to be negligible, while the potential for impacts on small odontocetes and pinnipeds is negligible to minor.

Cable emplacement and maintenance: Emplacement and maintenance of submarine cables and pipelines associated with non-offshore wind activities and ongoing offshore wind projects would disturb bottom sediments, causing temporary increases in suspended sediment; these disturbances would be localized and generally limited to the water column in the vicinity of the emplacement corridor. However, water depth, local hydrological conditions, and benthic substrate composition influence the extent, magnitude, and persistence of the resulting turbidity plume.

Data are not available regarding marine mammal avoidance of localized turbidity plumes; however, Todd et al. (2015) suggest that because some marine mammals often live in turbid waters and some species of mysticetes employ feeding methods that create sediment plumes, some species of marine mammals have a tolerance for increased turbidity. If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any impacts would also be temporary and short term. In addition, turbidity associated with increased sedimentation may result in temporary, short-term impacts on marine mammal prey species. Since sediment resuspension during cable and pipeline emplacement and maintenance would be short term and localized, individual marine mammals, if present, would be expected to successfully forage in nearby areas not affected by increased turbidity. Based on available data, impacts from emplacement and maintenance of submarine cables and pipelines are anticipated to be negligible for mysticetes (including NARWs), odontocetes, and pinnipeds.

EMF: In the geographic analysis area, there are 12 in-service trans-Atlantic cable systems (TeleGeography 2024) that would continue to operate and generate EMF effects under Alternative A. While the type and capacity of all these cables is not specified, the associated baseline EMF effects can be inferred from available literature. Additionally, offshore export and inter-array cables associated with ongoing offshore wind projects are also present within the geographic analysis area and, for those that are operational, generate EMF. Fiber optic communications cables with optical repeaters would not produce EMF effects.

Recent reviews by Bilinski (2021) of EMF effects on marine organisms concluded that measurable, though minimal, effects can occur for some species but not at the relatively low EMF intensities representative of offshore renewable energy projects. Exponent Engineering, P.C. (2018) modeled EMF levels that could be generated by the South Fork Wind Farm export cable and inter-array cable. The model estimated induced magnetic field levels ranging from 13.7 to 76.6 milligauss on the bed surface above the buried and exposed South Fork Wind Farm export 3-215 cable and 9.1 to 65.3 milligauss above the inter-array cable, respectively. Induced field strength would decrease effectively to 0 milligauss within 25 feet (7.6 meters) of each cable. By comparison, Earth's natural magnetic field produces more than five times the maximum potential EMF effect (Exponent Engineering, P.C. 2018). Background magnetic field conditions would fluctuate by 1 to 10 milligauss from the natural field effects produced by waves and currents. The maximum induced electrical field experienced by any organism close to the exposed cable would be no greater than 0.48 millivolt per meter (Exponent Engineering, P.C. 2018). Electrical telecommunications cables are likely to induce a weak EMF on the order of 1 to 6.3 microvolts per meter within 3.3 feet (1 meter) of the cable path (Gill et al. 2005), and fiber optic communications cables with optical repeaters would not produce EMF effects. Transmission cables using high-voltage AC emit 10 times less magnetic field than high-voltage DC (Taormina et al. 2018).

EMF effects on marine mammals from offshore wind activities would vary in extent and magnitude depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., high-voltage DC or AC cables, transmission voltage). There is a potential for animals to react to local variations of the geomagnetic field caused by power cable EMF, including a temporary change in swim direction following exposure to EMF (Gill et al. 2005). These effects are more likely with exposure to high-voltage DC cables versus high-voltage AC cables (Normandeau et al. 2011). However, measurable EMF effects are generally limited to within tens of feet of cable corridors. BOEM would require these future submarine cables to have appropriate shielding and burial depth to minimize potential EMF effects from cable operation. Additionally, impacts on marine mammal prey species are extremely unlikely to occur given the limited distance into the water column that any magnetic field associated with the cables is detectable. There is no evidence to indicate that EMF from undersea AC power cables adversely affect marine mammal forage fish prey species (CSA Ocean Sciences, Inc. and Exponent 2019; Gill et al. 2005). A more recent review by Gill and Desender (2020) supports these findings, where fish were found to be affected by EMF at high intensity for a small number of individual finfish species; however, response in these species was not found to occur at the EMF intensities associated with marine renewable energy projects.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. As a result, heat from submarine high-voltage cables is not expected to affect marine mammals

Impacts from EMF and cable heat from the ongoing offshore wind and non-offshore wind projects are anticipated to be negligible for mysticetes, odontocetes, and pinnipeds due to estimate low EMF levels, the localized nature of EMF along the cables near the seafloor, and appropriate shielding and burial depth. These impacts would be of the lowest level of detection, and barely measurable, with no perceptible consequences to individuals or the population.

Lighting: Artificial lighting associated with ongoing offshore wind and non-offshore wind projects would primarily originate from offshore vessel traffic. Orr et al. (2013) concluded that the operational lighting effects from wind farm facilities on marine mammal distribution, behavior, and habitat use were uncertain but likely negligible if recommended design and operating practices are implemented. BOEM requires wind farm developers to comply with the current design guidance for avoiding and minimizing artificial lighting effects; however, artificial light could aggregate prey species at night. Impacts due to lighting from ongoing activities would likely be negligible for mysticetes, odontocetes, and pinnipeds and are likely to be of the lowest level of detection and barely measurable, with no perceptible consequences to individuals or the population.

Noise: In the geographic analysis area, several anthropogenic noise sources are present and may affect marine mammals in a variety of ways. Vessel traffic, pile-driving noise, and active naval sonars are the main anthropogenic contributors to low and mid-frequency noises in oceanic waters (NMFS 2018), with vessel traffic being the dominant contributor to ambient sound levels in frequencies below 200 Hz (Veirs et al. 2016). In the marine mammal geographic analysis area, underwater noise is generated from ongoing non-offshore wind and ongoing offshore wind activities including impulsive (e.g., impact pile driving, military training and testing activities, G&G surveys) and non-impulsive (e.g., vibratory pile driving, military training and testing activities, vessels, G&G surveys, aircraft, dredging) sources. The long-term effects of multiple anthropogenic underwater noise stressors on marine mammals across their large geographical range are difficult to determine particularly given potential interaction with other stressors. The potential for noise within the geographic analysis area to have population-level consequences varies by species, among individuals, across situational contexts, and by geographic and temporal scales (Southall et al. 2021).

Impulsive sources such as impact pile driving, and certain military training and testing activities can lead to auditory injury (i.e., permanent threshold shift [PTS], temporary threshold shift [TTS]) effects in marine mammals; in addition, military training and testing activities that result in underwater detonations can also lead to non-auditory injury (i.e., physical injuries such as hemorrhage or damage to the lungs, liver, brain, ears, or gastrointestinal tract) in marine mammals.

G&G surveys in the geographic analysis area may utilize both impulsive and non-impulsive sources, however, the risk of PTS occurring is extremely low due to the characteristics of these sources and how they are operated, as detailed below. Non-impulsive noise sources ongoing in the marine mammal geographic analysis area include vibratory pile driving, certain military training and testing activities, vessels, aircraft, and dredging activities, which are not expected to result in PTS for any marine mammal species given the non-impulsive nature of these sources (see Appendix B for a more detailed description of the characteristics of underwater sound sources).

The potential for underwater noise to result in adverse impacts on marine mammals depends on the received sound level, source type, frequency content of the sound relative to the hearing ability of the animal, and the context of the noise exposure event. The siting, construction, operations, maintenance, and decommissioning of other offshore wind farms is expected to introduce underwater sound with a variety of characteristics into the marine environment. Physical descriptions of sounds associated with these activities can be found in Appendix B. The expected impacts of each of these sources on marine mammals is discussed below.

Offshore wind activities may negatively affect marine mammals if the sound frequencies produced overlap with the functional hearing range of the animal exposed (NSF and USGS 2011). To account for differences in hearing among species, Southall et al. (2007) grouped marine mammals into five generalized hearing groups (low-frequency cetaceans [LFC], mid-frequency cetaceans [MFC], high-frequency cetaceans [HFC], phocid pinnipeds in water [PPW], and otariid pinnipeds in water), which have been adopted by NMFS for the purposes of assessing the potential for hearing impairment from underwater noise. No species from the otariid pinnipeds in water hearing group (i.e., eared seals) are expected in the proposed Project area, and these species are not discussed further. A summary of estimated hearing ranges for marine mammal hearing groups from NMFS (2018) is provided in Table 3.7-5.

Table 3.7-5: Estimated Hearing Ranges for Marine Mammal Hearing Groups

Marine Mammal Hearing Group	Estimated Hearing Range	Representative Species
LFC	7 Hz to 35 kHz	Baleen whales (e.g., fin whale [*Balaenoptera physalus*], sei whale [*Balaenoptera borealis*], NARW [*Eubalaena glacialis*], minke whale [*Balaenoptera acutorostrata*], humpback whale [*Megaptera novaeangliae*])
MFC	150 Hz to 160 kHz	Dolphins (e.g., Atlantic spotted dolphin [*Stenella frontalis*], Atlantic white-sided dolphin [*Lagenorhynchus acutus*], short-beaked common dolphin [*Delphinus delphis*], Risso's dolphin [*Grampus griseus*], common bottlenose dolphin [*Tursiops truncatus*]) and toothed whales (e.g., sperm whale [*Physeter macrocephalus*], long-finned pilot whale [*Globicephala melas*])
HFC	275 Hz to 160 kHz	True porpoises (e.g., harbor porpoise [*Phocoena phocoena*])
PPW	50 Hz to 86 kHz	True seals (e.g., harbor seal [*Phoca vitulina*], gray seal [*Halichoerus grypus*])

Source: NMFS 2018

HFC = high-frequency cetacean; Hz: hertz; kHz: kilohertz; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PPW = phocid pinnipeds in water

Noise exposure can cause responses ranging from low-level behavioral effects like temporary avoidance, moderate behavioral effects (such as interference with communication, foraging, mating, predator avoidance, and navigation [Madsen et al. 2006; Southall et al. 2019]) to auditory fatigue (TTS) or auditory injury (PTS) (Southall et al. 2019). The potential for noise to affect marine mammals would depend on the noise source type, spectral and propagation properties of the noise, the noise level to which an animal is exposed, the duration of the exposure, and the context (e.g., life stage, activity, ambient conditions, previous exposures) of the animal at time of exposure. Sources of anthropogenic noise can generally be categorized in two ways: impulsive noise, which is characterized by an instantaneous and rapid increase in sound pressure over a short period of time, and non-impulsive noise, which does not have the characteristic rapid rise in sound pressure seen in impulsive sources. Noise can also be characterized as intermittent or continuous depending on how often noise is generated over time. Both types of noise may be produced by activities related to planned offshore wind projects. Acoustic thresholds, which represent the minimal sound level at which the onset of a particular effect may occur, are available for both impulsive and non-impulsive noise and each marine mammal hearing group from NMFS (2018), as provided in Table 3.7-6. Animals are less likely to respond to sound levels when distant from a source, even when those levels elicit responses at closer ranges; therefore, both proximity and received levels are important factors when evaluating animal responses (Dunlop et al. 2017).

Table 3.7-6: Acoustic Thresholds[a] for Marine Mammal Hearing Groups

Marine Mammal Hearing Group	Impulsive Noise Sources		Non-Impulsive Noise Sources	
	PTS	Behavioral Disturbance (SPL)	PTS (SEL_{24h})	Behavioral Disturbance
LFC	SEL_{24h}: 183 dB re 1 μPa^2 s Lpk: 219 dB re 1 μPa	160 dB re 1 μPa	199 dB re 1 μPa^2 s	Intermittent sources: SPL 160 dB re 1 μPa Continuous sources: SPL 120 dB re 1 μPa
MFC	SEL_{24h}: 185 dB re 1 μPa^2 s Lpk: 230 dB re 1 μPa	160 dB re 1 μPa	198 dB re 1 μPa^2 s	Intermittent sources: SPL 160 dB re 1 μPa Continuous sources: SPL 120 dB re 1 μPa

Marine Mammal Hearing Group	Impulsive Noise Sources		Non-Impulsive Noise Sources	
	PTS	Behavioral Disturbance (SPL)	PTS (SEL_{24h})	Behavioral Disturbance
HFC	SEL_{24h}: 155 dB re 1 µPa² s Lpk: 202 dB re 1 µPa	160 dB re 1 µPa	173 dB re 1 µPa² s	Intermittent sources: SPL 160 dB re 1 µPa Continuous sources: SPL 120 dB re 1 µPa
PPW	SEL_{24h}: 185 dB re 1 µPa² s Lpk: 218 dB re 1 µPa	160 dB re 1 µPa	201 dB re 1 µPa² s	Intermittent sources: SPL 160 dB re 1 µPa Continuous sources: SPL 120 dB re 1 µPa

Source: NMFS 2018; 70 Fed. Reg. 7 (January 11, 2005)

dB re 1 µPa = decibels referenced to 1 micropascal; dB re 1 µPa² s = decibels referenced to 1 micropascal squared second; HFC = high-frequency cetaceans; LFC = low-frequency cetacean; Lpk = peak sound pressure; MFC = mid-frequency cetacean; PPW = phocid pinnipeds in water; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours; SPL = sound pressure level

[a] SEL_{24h} thresholds are frequency weighted based on the marine mammal hearing group, while the Lpk and SPL thresholds are not frequency weighted.

Impact Pile Driving

The only project activities that would require pile driving in the offshore environment that would potentially affect marine mammals are foundation installations associated with offshore wind projects. However, as discussed previously, the Revolution Wind and Empire Wind projects will not have started installation of their foundations at the time of publication of this Final EIS, and foundation installation activities for South Fork Wind have been completed as of November 2023 when their construction incidental harassment authorization (IHA) expired (NMFS 2022b). It is anticipated foundation installation activities for Vineyard Wind 1 will continue through May 2024 based on the expiration date of in their IHA application, though actual pile-driving activities may end sooner based on the estimated 8-month pile-driving duration included in their IHA (NMFS 2023c). The indicative schedule in the Coastal Virginia Offshore Wind-Commercial COP indicates monopile installation using impact pile driving could begin starting in the second quarter of 2024, so installation activities may be starting at the time of publication of this Final EIS. Level A takes (i.e., PTS exposures) were authorized for Vineyard Wind 1 for all marine mammal species except NARW and sperm whales (NMFS 2023c), whereas Level A takes were only authorized for Coastal Virginia Offshore Wind-Commercial for fin whales, humpback whales, minke whales, sei whales, harbor porpoise, gray seals, and harbor seals (NMFS 2024g). For all species except NARW, the risk of Level A take for species for which it was authorized is based on the exposure modeling conducted by the developers, which assess the potential for risk based on the species hearing sensitivity, behavior, and local densities (NMFS 2023c, 2024g). For NARW, no Level A take was authorized based on the extensive mitigation that both projects will implement for this species. Given the critical status of this population, PTS being realized for even one individual would likely have population-level impacts so the proposed Project mitigation plans were developed such that no Level A take of NARW will occur. However, the mitigation applied to NARW will not be applicable for all other marine mammal species, and though mitigation is applied for other species to reduce the risk of exposures, these measures cannot fully eliminate the risk of PTS for all other species for which Level A take was authorized. Given this information, impacts from impact pile driving are expected to be short term and moderate for NARW as they would be of medium intensity but only temporary behavioral disturbances are expected; and moderate for all other marine mammal species given the risk of PTS occurring.

Vibratory Pile Driving

Vibratory pile-driving activities are anticipated only for offshore wind projects during cable installation or to support foundation installation. No vibratory piling of the foundations was proposed for the Vineyard Wind 1 project (NMFS 2023c), but it was proposed for the Coastal Virginia Offshore Wind-Commercial Project (NMFS 2024g). Additionally, all ongoing offshore wind projects may be conducting construction activities to support nearshore cable installation, which may require vibratory pile driving. Vibratory pile driving is a non-impulsive sound source and the hammer produces sound continuously. Due to the proposed mitigation measures for all ongoing offshore wind projects, including clearance and shutdown zones, coupled with the relatively small ranges over which PTS occurs (compared to impact pile driving), vibratory pile driving is unlikely to result in PTS for any marine mammal species. Vibratory pile-driving noise may exceed the behavioral disturbance threshold for continuous noise sources of 120 decibels referenced to 1 micropascal (dB re 1 μPa) (Table 3.7-6) hundreds of feet from the source for nearshore pile driving projects (Illingworth and Rodkin 2017) but these events are expected to be short term and limited to shallow water habitats, which limits the marine mammals potentially present during construction. Vibratory pile driving for the foundations in deeper waters may exceed the behavioral disturbance threshold thousands of meters from the source (NMFS 2024g); however, based on the information from Coastal Virginia Offshore Wind-Commercial (NMFS 2024g), vibratory pile driving would only occur over an approximate 90-minute period per foundation, and the proposed mitigation measures would similarly help reduce the severity of potential impacts. Therefore, while behavioral responses are likely to result from vibratory pile-driving noise, they would be short term and low intensity; thus, impacts would be minor for all marine mammal species.

Unexploded Ordnance Detonations for Ongoing Offshore Wind Projects

UXOs on the seafloor may be encountered in offshore wind lease areas or along export cable routes. If found, UXO may be left alone, moved, or removed by controlled explosive detonation or low-order deflagration. Further information on UXO detonations can be found in Appendix B. Underwater explosions generate shock waves, or a nearly instantaneous wave characterized by extreme changes in pressure, both positive and negative. This shock wave can cause injury and mortality to a marine mammal, depending on how close an animal is to the blast. The physical range at which injury or mortality could occur will vary based on the amount of explosive material in the UXO, size of the animal, and the location of the animal relative to the explosive. Injuries may include hemorrhages or damage to the lungs, liver, gastrointestinal tract, brain, or ears, as well as auditory impairment such as PTS and TTS (Ketten 2004). Smaller animals are generally at a higher risk of blast injuries. While developers may only use detonation as a last resort, the Revolution Wind Project has proposed detonation of up to 13 UXO within its project area offshore Rhode Island as necessary (BOEM 2023c). All other ongoing offshore wind projects (Vineyard Wind 1, Empire Wind, Coastal Virginia Offshore Wind-Commercial) do not proposed UXO detonations as part of their projects (BOEM 2021b, 2023d, 2023f).

Blast injuries have been documented in close association with explosive detonations, including after 42 British ground mines (MK 1-7) were cleared in the Baltic Sea in 2019 (Siebert et al. 2022). Within 1 week and in the 2 months following, a total of 24 harbor porpoises were found dead in the general area, 8 of which had clear signs of blast injury as the primary cause of death (i.e., dislocated ear bones, bleeding in the acoustic fat and melon), and several more had blast injury in addition to other signs of potential mortal stressors (i.e., found as bycatch, blunt force trauma). As the precise timing of the injuries was not known, it is not clear whether the observed injuries were due to this blast event or an unrelated event. In 2011, an underwater detonation (8.75 pound) at the U.S. Navy Silver Strand Training Complex in San Diego, California, resulted in blast injury and death to at least three long-beaked common dolphins (*Delphinus capensis*) that had entered the 2,100-foot mitigation zone minutes before the detonation (Danil and St. Ledger 2011).

To predict the potential impacts of UXOs on marine species, several models have been developed. Goertner (1982) developed a model for physical injuries to cetaceans at a range of depths, and a modified version of this model is recommended by NMFS for predicting injury impacts on marine mammals (NMFS 2023b). In 2022, Hannay and Zykov focused on auditory injury rather than physical injury. They modeled the distance to NMFS auditory exceedance thresholds (Appendix B) for five species groups (LFC, MFC, and HFC; PPW; otariid pinnipeds/sea turtles) exposed to UXO detonations of various charge masses at four sites in the Revolution Wind Project area. While exposure ranges will vary among lease areas based on environmental conditions and other factors, the results provide an example of predicted exposure ranges in U.S. waters. The largest impact ranges were predicted for HFC exposed to a 1,000-pound detonation (the largest charge mass modeled) at 5 kilometers (3 miles) (peak sound pressure [Lpk]) and 7 miles (sound exposure level over 24 hours [SEL_{24h}]) for PTS and 15 miles for TTS (SEL_{24h}; used by NMFS for the behavioral threshold for a single detonation) (Hannay and Zykov 2022). The distances to auditory injury were always greater than the predicted ranges for non-auditory injury associated with the blast impulse. When UXOs are detonated they do not always fully detonate, meaning the explosion may not be as large as predicted by the charge mass. The modeling studies presented previously are based on the assumption that the charge fully detonates.

Behavioral impacts are also possible out to farther ranges, but because the explosion is nearly instantaneous, behavioral impacts are expected to be short term, challenging to observe, and of less concern compared to potential injury and mortality effects. Todd et al. (1996) observed humpback whales near underwater explosions and did not note any overt behavioral changes (e.g., changing course, abrupt dive behavior) within 1.1 miles from the blast, with received Lpk of 123 dB re 1 μPa. They saw no overall trend in humpback whale movements during the course of the month when intermittent blasting was taking place.

The number, charge mass, and location of UXOs that may need controlled detonation for other projects are relatively unknown until a site assessment is performed. Additionally, not all offshore wind projects will require controlled detonations as avoidance, or non-explosive methods of disposing with UXOs will be effective. Therefore, it is difficult to predict the potential likelihood and frequency of impacts of UXO detonation from other projects in the geographic analysis area. However, while the likelihood of encountering this stressor is unknown, the impacts are well documented. At close ranges, UXO detonations can be injurious or lethal. Measures for handling UXOs are likely to be required to decrease the chance that a marine mammal will be severely injured or killed from an explosion. For example, seasonal and time-of-day restrictions can be put in place to avoid times when marine mammals may be present, noise mitigation devices (e.g., double bubble curtain) can be applied to reduce noise beyond a certain radius of the detonation, and visual and passive acoustic monitoring (PAM) of clearance zones can be used to reduce the number of marine mammals present within the predicted distance from a UXO that could cause injury or death. In addition, lower order detonation methods, such as deflagration, are in development and could substantially decrease the energy released into the environment, therefore decreasing the effect ranges (Robinson et al. 2020). With measures in place, the intensity of this IPF is expected to be reduced. The likelihood of UXO detonation associated with planned offshore wind projects is unknown; but is expected to be low given the preferred, non-detonation options available. Due to the permitting and required monitoring and mitigation for all potential UXO clearance activities, PTS is not expected to result for NARW. Because marine mammals could receive PTS exposures during high order detonations but no mortalities or non-auditory injury are expected to occur, and no population-level impacts are expected; impacts on mysticetes (including the NARW), odontocetes, and pinnipeds from UXO detonations would be moderate.

Military Munitions Training

Under Alternative A, the U.S. Navy will conduct ongoing military training and testing activities within the Atlantic Fleet Training and Testing study area, which includes the western Atlantic Ocean along the

U.S. East Coast, the Gulf of Mexico, and portions of the Caribbean Sea, a large portion of which is included in the marine mammal geographic analysis area ongoing. As described in the Final EIS/Overseas EIS (U.S. Navy 2018), activities that could result in noise impacts marine mammals include use of anti-submarine warfare sonar and other transducers; airguns; impact and vibratory pile driving; aircraft noise; weapons noise; and underwater explosions. The Final EIS/Overseas EIS (U.S. Navy 2018) includes an evaluation of the potential impacts on marine mammals due to the acoustic and explosive activities proposed for the Atlantic Fleet Training and Testing program. In summary, these impacts range from mortality to behavioral disturbance depending on the activity. The only activities that was predicted to result in mortality of marine mammals was underwater explosions associated with ship shock trials in the Atlantic Fleet Training and Testing study area (U.S. Navy 2018). It is worth noting that mortalities resulting from vessel strikes were also predicted by the U.S. Navy (2018), but as this is not an underwater noise IPF, it is discussed as part of the ongoing traffic (vessel strikes) IPF below. Non-auditory effects were also predicted to result from underwater explosions, and auditory effects (i.e., PTS, TTS) were predicted to result from anti-submarine warfare sonar use, underwater explosions, and weapons noise; all other noise-producing activities included in the Final EIS/Overseas EIS were only expected to result in behavioral disturbances for marine mammals (U.S. Navy 2018).

Use of anti-submarine warfare sonar activities associated with military training and testing have been linked to stranding events (Fernández et al. 2005; Cox et al. 2006; Balcomb and Claridge 2001; Jepson et al. 2003; Wang and Yang 2006; Parsons et al. 2008; D'Amico et al. 2009; Dolman et al. 2010). Strandings linked to military sonar are reported to predominantly affect deep-diving species (e.g., beaked whales) which strand due to rapid changes in dive behavior in response to the sonar that causes disorientation or physiological effects like the bends that cause them to strand (Fernández et al. 2005; Cox et al. 2006; Balcomb and Claridge 2001; Jepson et al. 2003; Wang and Yang 2006; Parsons et al. 2008; D'Amico et al. 2009; Dolman et al. 2010). Strandings linked to sonar have been reported primarily for beaked whale species, but also include long-finned pilot whales, pygmy killer whales, Risso's dolphins, Atlantic spotted dolphins, and minke whales (Fernández et al. 2005; Cox et al. 2006; Balcomb and Claridge 2001; Jepson et al. 2003; Wang and Yang 2006; Parsons et al. 2008; D'Amico et al. 2009; Dolman et al. 2010). Though the U.S. Navy (2018) does not anticipate marine mammal strandings resulting from use of anti-submarine warfare sonar in the Atlantic Fleet Training and Testing study area with the proposed mitigation and no mortalities associated with this activity were predicted (U.S. Navy 2018), the available data linking marine mammal strandings to sonar use suggest the risk cannot be entirely eliminated.

Based on this information, impacts are expected to be moderate for marine mammals given the risk of mortality, non-auditory injury, and/or PTS for all species except NARW. No mortality, non-auditory injury, or PTS was predicted (U.S. Navy 2018) or authorized (50 CFR Part 218) for NARW with the proposed mitigation. Given the critical status of this population, mortality, non-auditory injury, or PTS being realized for even one individual would have long-term population-level impacts, so the U.S. Navy (2018) included a comprehensive mitigation and monitoring plan such that none of these impacts will occur for NARW. Additionally, as discussed previously, species who face the greatest risk of stranding following exposure to anti-submarine warfare sonar are predominantly deep-diving species and odontocete species, so the likelihood of NARW strandings in response to this sonar is extremely low. For all other species except NARW, Atlantic Fleet Training and Testing activities could result in long-term, medium to severe intensity impacts that are therefore considered moderate. For NARW, impacts would also be moderate, but would be limited to short-term, medium-intensity impacts.

Geological and Geophysical Surveys

G&G surveys in the geographic analysis area would be limited to near shore bathymetric or sand source surveys and the site assessment surveys associated with ongoing offshore wind projects. Bathymetric and sand source surveys would be conducted for storm assessments, dredging depth certification and deposition monitoring, and sand source identification primarily using side scan sonar and multibeam echosounder, which are not expected to have any acoustic impacts on marine mammals, and no takes are requested or authorized for these intermittent activities. There are currently 13 active IHAs for site assessment surveys that have been issued by NMFS for the U.S. Atlantic (NMFS 2024h). No Level A take has been requested or issued under any of these active IHA applications.

For the purposes of ongoing offshore wind projects, G&G surveys use active acoustic sources to evaluate the feasibility of turbine installation and identify potential hazards. Recently, BOEM and the U.S. Geological Survey characterized underwater sounds produced by HRG sources and their potential to affect marine mammals (Ruppel et al. 2022). Although some geophysical sources can be detected by marine mammals, most HRG sources are unlikely to result in substantial behavioral disturbance of marine mammals, even without mitigation (Ruppel et al. 2022). This finding is supported empirically by Kates Varghese et al. (2020), who found no change in beaked whale foraging behavior during two deepwater mapping surveys using a 12-kilohertz (kHz) multibeam echosounder. There was an increase in the number of foraging events during one of the mapping surveys, but this trend continued after the survey ended, suggesting that the change was more likely in response to another factor, such as the prey field of the beaked whales, than to the mapping survey. During both multibeam mapping surveys, foraging continued in the survey area and the animals did not leave the area (Kates Varghese et al. 2020, 2021). Vires (2011) found no change in Blainville’s beaked whale (*Mesoplodon densirostris*) click durations before, during, and after a scientific survey with a 38 kHz EK-60 echosounder, while Cholewiak et al. (2017) found a decrease in beaked whale echolocation click detections during use of an EK-60 echosounder, and Quick et al. (2017) found that short-finned pilot whales did not change foraging behavior but did increase their heading variance during use of an EK-60 echosounder. For some of the higher-amplitude sources such as some boomers and sparkers, behavioral disturbance is possible but unlikely with mitigation measures such as clearance and shutdown zones and the use of protected species observers (PSO) required by BOEM and NMFS. Impacts from ongoing and planned offshore wind projects, therefore, would be limited to short-term behavioral disturbances with no population-level impacts expected and would be minor for all marine mammal species.

Vessel Noise

The most widespread noise source is from vessels in the geographical area of analysis. Large commercial and recreational vessels associated with ongoing offshore wind and non-offshore wind emit various levels of noise, which are present throughout the geographic analysis area. A description of the physical qualities of vessel noise can be found in Appendix B.

A comprehensive review of the literature on marine mammals and vessel noise (Erbe et al. 2019; Richardson et al. 1995) revealed that changes in behavior vary widely across species. These responses have ranged from longer dives in beluga whales (Finley 1990) to disruption of resting behavior in harbor seals (Mikkelsen et al. (2019) to increases in swim velocities in belugas (Finley 1990), humpbacks (Sprogis et al. 2020) and narwhals (Williams et al. 2022). Dolphins have shown longer inter-breath intervals (Nowacek and Wells 2001) and dolphin pods have shown increased breathing synchrony (Hastie et al. 2003). A playback study of humpback whale mother-calf pairs exposed to varying levels of vessel noise revealed that the mother’s respiration rates doubled and swim speeds increased by 37 percent in the high noise conditions (low-frequency weighted received sound pressure level [SPL] at 100 meters was 133 dB re 1 µPa) compared to control and low-noise conditions (104 dB re 1 µPa and 112 dB re 1 µPa, respectively [Sprogis et al. 2020]). Changes to foraging behavior, which can have a direct effect on an animal’s fitness, have been observed in porpoises (Wisniewska et al. 2018) and killer whales (Holt et al. 2021) in response to vessel noise. Thus far, one study has demonstrated a potential correlation between low-frequency anthropogenic noise and physiological stress in baleen whales. Rolland et al. (2012) showed that fecal cortisol levels in NARWs decreased following the 9-11 terrorist attacks, when vessel activity was significantly reduced. Interestingly, NARWs do not seem to avoid vessel noise nor vessel presence

(Nowacek et al. 2004), yet they may incur physiological effects as demonstrated by Rolland et al. (2012). This lack of observable response, despite a physiological response, makes it challenging to assess the biological consequences of exposure. In addition, there is evidence that individuals of the same species may have differing responses if the animal has been previously exposed to the sound versus if it is a completely novel interaction (Finley 1990). Reactions may also be correlated with other contextual features, such as the number of vessels present, their proximity, speed, direction or pattern of transit, or vessel type. For a more detailed and comprehensive review of the effects of vessel noise on specific marine mammal groups the reader is referred to Erbe et al. (2019).

Some marine mammals may change their acoustic behaviors in response to vessel noise, either due to a sense of alarm or in an attempt to avoid masking. For example, fin whales (Castellote et al. 2012) and belugas (Lesage et al. 1999) have altered the frequency characteristics of their calls in the presence of vessel noise. When vessels are present, bottlenose dolphins have increased the number of whistles (Buckstaff 2004; Guerra et al. 2014), while sperm whales decrease the number of clicks (Azzara et al. 2013), and humpbacks and belugas have been seen to completely stop vocal activity (Finley 1990; Tsujii et al. 2018). Some species may change the duration of vocalizations (fin whales shortened their calls [Castellote et al. 2012]) or increase call amplitude (killer whales [Holt et al. 2009]) to avoid acoustic masking from vessel noise. Understanding the scope of acoustic masking is difficult to observe directly, but several studies have modeled the potential decrease in “communication space” when vessels are present (Clark et al. 2009; Erbe et al. 2016; Putland et al. 2017). For example, Putland et al. (2017) showed that during the closest point of approach (<10 kilometers) of a large commercial vessel, the potential communication space of Bryde’s whale was reduced by 99 percent compared to ambient conditions.

Although there have been many documented behavioral changes in response to vessel noise (Erbe et al. 2019), it is important to consider the potential biological consequences of those changes. For example, Holt et al. (2015) found that as bottlenose dolphins increased the amplitude of their calls, metabolic rates increased by 20 to 50 percent. Although this study was not tied directly to exposure to vessel noise, it provides insight about the potential energetic cost of vocal changes (i.e., increases in vocal effort such as louder, longer, or increased number of calls). In another study, the energetic cost of high-speed escape responses in dolphins was modeled, and the researchers found that the cost per swimming stroke was doubled during such a flight response (Williams et al. 2017). When this sort of behavioral response was also coupled with reduced glide time for beaked whales, the researchers estimated that metabolic rates would increase by 30.5 percent (Williams et al. 2017). Despite these demonstrable examples of short-term biological consequences in individuals, it is still very challenging to draw conclusions regarding potential long-term or population-level effects. However, though vessel noise would be present throughout the geographic analysis area, impacts would be low intensity and limited to behavioral responses within a relatively small range around the vessels, and no population-level effects are anticipated. Impacts from ongoing vessel noise would therefore be minor for all marine mammal species.

Aircrafts

In general, marine mammal behavioral responses to aircraft have most commonly been observed at altitudes of less than 150 meters (492 feet) from the aircraft (Patenaude et al. 2002; Smultea et al. 2008). Aircraft operations have resulted in temporary behavioral responses including short surface durations (bowhead and belugas [Patenaude et al. 2002] and transient sperm whales [Richter et al. 2006]), abrupt dives (sperm whales [Smultea et al. 2008]), and percussive behaviors (i.e., breaching and tail slapping [Patenaude et al. 2002]). Responses appear to be heavily dependent on the behavioral state of the animal, with the strongest reactions seen in resting individuals (Würsig et al. 1998). BOEM requires all aircraft operations to comply with current approach regulations for NARWs or unidentified large whales (50 CFR § 222.32). These include the prohibition of aircraft from approaching within 457 meters (1,500 feet), which would minimize the potential responses of marine mammals to aircraft noise. In addition, based on the physics of sound propagation across different media (e.g., air and water), only a small portion of the acoustic energy from aircraft operations couples into the water. With the implementation of BMPs, noise impacts from aircraft are expected to be negligible for all marine mammal species.

Dredging

As described in Appendix E, there are nine dredging projects that are expected to occur within the geographic analysis area. Dredging produces distinct sounds during each specific phase of operation: excavation, transport, and placement of dredged material (Central Dredging Association 2011; Jiménez-Arranz et al. 2020). SPL source levels during backhoe dredge operations range from 163 to 179 dB re 1 µPa·m (Nedwell et al. 2008; Reine et al. 2012). As a whole, dredging activities generally produce low-frequency sounds; with most energy below 1,000 Hz and frequency peaks typically occurring between 150–300 Hz (McQueen et al. 2018). Additional detail and measurements of dredging sounds can be found in (Jiménez-Arranz et al. 2020; McQueen et al. 2018; Robinson et al. 2011), as well as Appendix B.

Given the low source levels and transitory nature of dredging sources, exceedance of PTS thresholds are not likely, but TTS and behavioral thresholds could be exceeded (Todd et al. 2015). For example, using measurements of the highest source level from multiple dredging vessel operations, Heinis et al. (2013) modeled harbor porpoise and seal exposure to a dredging operation. They found that TTS levels were not exceeded for harbor porpoise at any distance, and only exceeded for seals at distances within 90 meters (295 feet) of the dredging vessel. Empirical studies suggest that some HFCs may avoid dredging activities. For example, Diederichs et al. (2010) found short-term avoidance of dredging activities by harbor porpoises near breeding and calving areas in the North Sea. Pirotta et al. (2013) found that, despite a documented tolerance of high vessel presence, as well as high availability of food, bottlenose dolphins spent less time in the area during periods of dredging. The study also showed that with increasing intensity in the activity, bottlenose dolphins avoided the area for longer durations (with one instance being as long as 5 weeks) (Pirotta et al. 2013). Todd et al. (2015) provide an extensive review of the impacts of dredging on marine mammals. Some studies, primarily on seals and sea lions, found no observable response (Blackwell et al. 2004; ecologia Environment 2008; Gilmartin 2003), while several other studies showed temporary to long-term avoidance behavior for bowhead, gray, humpback, and minke whales (Anderwald et al. 2013; Borggaard et al. 1999; Richardson et al. 1990; Todd et al. 2015; Tyack 2008). For example, gray and humpback whales seemed to avoid certain areas—even key breeding habitats—when dredging was occurring (Borggaard et al. 1999; Tyack 2008). These studies suggest that dredging does not produce sounds sufficient to cause permanent hearing injuries, but at close ranges the sounds are at levels that have the potential to cause behavioral disturbance or temporary hearing impairment to marine mammals.

While behavioral responses may occur from dredging activities, they are expected to be short term and of low intensity. Masking and behavioral reactions from dredging may be more likely for mysticetes and pinnipeds due to the low-frequency spectrum over which the sounds occur and the overlap with their best hearing sensitivity. Therefore, impacts from dredging noise are expected to be low intensity, temporary, and short term; thus minor for all marine mammal species.

Port utilization: Vineyard Wind 1 would use port facilities in Connecticut, Massachusetts, Rhode Island, and Canada during construction and operations, and BOEM found that no changes to port utilization would occur (BOEM 2021b). South Fork would use existing port facilities in New York, Rhode Island, Massachusetts, Connecticut, New Jersey, Maryland, Virginia, or Nova Scotia, Canada for offshore construction, staging, fabrication, crew transfer, and logistics support; BOEM found that although dredging or in-water work could be required for the Port of Montauk, these actions would occur within heavily modified habitats (BOEM 2021b). Port expansion activities are localized to nearshore habitats and are expected to result in temporary, short-term impacts, if any, on marine mammals. Vessel noise (discussed in the noise IPF above) may affect marine mammals, but response would be expected to be temporary and short term. The impacts on water quality from sediment suspension during port expansion activities is temporary and short term, and would be similar to those described under the cable emplacement and maintenance IPF above. Impacts of port utilization from ongoing activities would likely be negligible for mysticetes, odontocetes, and pinnipeds and are likely to be of the lowest level of detection and barely measurable, with no perceptible consequences to individuals or the population.

Presence of structures: There are more than 130 existing artificial reefs in the geographic analysis area (MAFMC 2024). Artificial reefs are made of a variety of materials including cars, trucks, subway cars, bridge rubble, barges, boats, and large cables (MAFMC 2024). Additionally, ongoing offshore wind projects will add a total of 81 WTGs and 2 ESP to the geographic analysis area. The presence of these structures could lead to localized changes to hydrodynamic disturbance, prey aggregation, and associated increase in foraging opportunities, entanglement and gear loss/damage, migration disturbances, and displacement.

Although spacing between the WTG and ESP structures would be sufficient to allow marine mammals to use habitat between and around structures, information about large whale responses to offshore wind structures is lacking. Therefore, disruption of normal behaviors could occur due to the presence of offshore structures, though the magnitude and implications of this, if realized, remains unknown.

The presence of individual WTGs and ESPs could alter local hydrodynamic patterns at a fine scale. These changes, mainly resulting from the extraction of kinetic wind energy by turbine operations and reduction in wind stress at the air-sea interface, can lead to changes in horizontal and vertical water column mixing patterns (Miles et al. 2021). Laboratory measurements demonstrate that water flows are reduced immediately downstream of foundations but would return to ambient levels within relatively short distances (i.e., a few feet) or up to 3,281 feet (1,000 meters) depending on local conditions (Miles et al. 2017; Schultze et al. 2020b; Johnson et al. 2021). The downstream area affected by reduced flows is dependent on pile diameter. For monopiles (i.e., the structures with the largest diameter), effects are expected to dissipate within 300 to 400 feet. Hub height and oceanographic conditions (e.g., currents, stratification, depth) also influence hydrodynamic impacts of foundations. Individual foundations may increase vertical mixing and deepen the thermocline, potentially increasing pelagic productivity locally (English et al. 2017; Kellison and Sedberry 1998). Eddies may also form as a result of water flowing around WTG and ESP foundations (Chen et al. 2016), which could also increase local retention of plankton, though this is hypothesized based on modeling conducted based on conditions present during storm activities and not in situ observations. A recent modeling study found that offshore wind structures could deepen the thermocline in the wind farm area by 3.3 to 6.6 feet (1 to 2 meters) and also lead to a greater retention of cooler water in the wind farm area during the summer (Johnson et al. 2021). However, other studies indicate direct observations of the influence of a monopile extended to at least 984 feet (300 meters) but was indistinguishable from natural variability in a subsequent year (Schultze et al. 2020b). The range of observed changes in current speed and direction 984 to 3,281 feet (300 to 1,000 meters) from a monopile is likely related to local conditions, wind farm scale, and sensitivity of the analysis.

Atmospheric wakes, characterized by reduced downstream mean wind speed and turbulence, along with wind speed deficit, are documented with the presence of vertical structures. The magnitude of atmospheric wakes can change relative to instantaneous velocity anomalies. In general, lower impacts of atmospheric wakes are observed in areas of low wind speeds. Several hydrodynamic processes have been identified to exhibit changes from vertical structures:

- Advection and Ekman transport are directly correlated with shear wind stress at the sea surface boundary. Vertical profiles from Christiansen et al. (2022) exhibit reduced mixing rates over the entire water column. As for the horizontal velocity, the deficits in mixing are more pronounced in deep waters than in well-mixed, shallow waters where horizontal velocity is likely favored by the influence of the bottom mixed layer. In both cases, the strongest deficits occur near the pycnocline depth.

- Additional mixing downstream has been documented from Kármán vortices (i.e., a repeating pattern of swirling vortices) and turbulent wakes due to the pile structures of wind turbines (Carpenter et al. 2016; Grashorn and Stanev 2016; Forster 2018; Schultze et al. 2020b; Dorrell et al. 2022).
- Offshore wind farms have been documented to affect average surface elevation of waters and upwelling and downwelling dipoles that are most commonly formed with constant wind directions (Broström 2008; Paskyabi and Fer 2012; Ludewig 2015; Floeter et al. 2022). Mean surface variability is between 1 and 10 percent.
- With sufficient salinity stratification, vertical flow of colder/saltier water to the surface occurs in lower sea surface level dipoles and warmer/less saline water travels to deeper waters in elevated sea surface heights (Ludewig 2015; Christiansen et al. 2022; Floeter et al. 2022). This observation also suggested impacts on seasonal stratification, as documented in Christiansen et al. (2022).

Daewel et al. (2022) conducted a study of atmospheric wake effects of large clusters of WTGs. Their study modeled a hypothetical build out of 24,000 5 MW WTGs with a hub height of 295 feet (90 meters) in the North Sea (compared to the 2,930 WTGs and ESP in the geographic analysis area). The modeling results showed that extremely large clusters of offshore wind turbines provoke large-scale changes in annual primary productivity. The model found that there were areas with both increased and decreased productivity within and around the wind farms. There was a decrease in productivity in the center of large wind farm clusters but an increase around these clusters in the shallow, near-coastal areas of the inner German Bight and Dogger Bank (Daewel et al. 2022). However, the authors noted that when integrated over a larger area, the local decreases and increases averaged to a nominal (0.2 percent) increase across the entire North Sea.

Alterations in primary productivity due to hydrodynamic effects associated with the presence of structures may alter typical distributions of fish and invertebrates on the OCS, which are normally driven by primary productivity associated with cold pool upwelling (Chen et al. 2018; Lentz 2017; Matte and Waldhauer 1984). These localized and regional alterations to primary productivity could have impacts on prey species for marine mammals. The vertical structures in the water column associated with WTG and ESP foundations may increase vertical mixing driven by currents flowing around the foundations (Christiansen et al. 2022; Carpenter et al. 2016; Schultze et al. 2020b). This mixing could fundamentally change shelf sea systems, particularly in seasonally stratified seas, although enhanced mixing may positively affect some marine ecosystems (Dorrell et al. 2022). During times of stratification (i.e., summer), increased mixing due to the presence of structures could potentially result in increased pelagic primary productivity (English et al. 2017; Degraer et al. 2020). However, increased primary productivity may not lead to increases in marine mammal prey species, as the increased productivity may be consumed by filter feeders colonizing the structures (Maar et al. 2009; Slavik et al. 2019). This filter feeder colonization may lead to biological changes in the demersal community within up to 164 feet (50 meters) of the foundation due to increased local fecal pellet excretions (Maar et al. 2009).

Hydrodynamic impacts associated with WTG and ESP foundations may also directly influence distribution of zooplankton and larval transport. In existing offshore wind farms, which are in shallow waters where levels of turbulence are high, wakes have been observed due to the presence of the monopiles, which serve as cylindrical structures that affect flow (Dorrell et al. 2022). Wakes from individual structures may persist for 328 to 3,280 feet (100 to 1,000 meters) downstream (Schultze et al. 2020b; Dorrell et al. 2022). In the U.S., two available studies, summarized in Hogan et al. (2023), modeled the effects of offshore wind in southern New England indicating that zooplankton may be affected by wind turbines. Chen et al. (2020) modeled sea scallop larval transport, and dispersal of larvae was affected by Vineyard Wind 1 offshore Massachusetts and found that the presence of the WTG foundations altered the local vertical mixing and horizontal advections. Specifically, the change in local hydrodynamics shifted larval dispersal to new locations that could affect sea scallop abundance in the region (Chen et al. 2021). Johnson et al. (2021) modeled the effects from the full build out of all the southern New England offshore wind lease areas on larval transport. In the modeling results, the changes to depth-averaged currents varied from an 8 percent decrease to an 11 percent increase; the greatest changes in currents occurred in the regions north and south of the offshore wind lease areas (Johnson et al. 2021). Changes in currents east of the offshore wind lease areas, in the region of Nantucket Shoals, were minor. Johnson et al. (2021) also showed a relative deepening in the thermocline of approximately 3 to 7 feet (1 to 2 meters) and a retention of colder water inside the wind farm areas through the summer months compared to the baseline scenario where WTGs were not present. This result is somewhat contrary to some of the results in European studies that suggest a loss of stratification due to the introduction of turbulence by wind wakes. Chen et al. (2016) assessed how WTGs would affect oceanographic processes during storm events. The results showed that there would not be a significant influence on southward larval transport from Georges Bank and Nantucket Shoals to the Mid-Atlantic Bight due to the presence of WTGs, although it could cause increased cross-shelf larval dispersion. Broadscale atmospheric and hydrodynamic impacts could alter planktonic larval distribution and abundance, with impacts that may extend to tens of kilometers from structure foundations (Christiansen et al. 2022; Dorrel et al. 2022; van Berkel et al. 2020).

The presence of structures could also result in changes to fishing effort, which could result in changes to interactions between commercial and recreational fishing activities and marine mammals. In-water structures associated with planned offshore wind activities may serve as artificial reefs, resulting in increased commercial and recreational fishing activity in the vicinity of the structures. An increase in fishing activity increases the risk of marine mammals becoming entangled in lost fishing gear, which could result in injury or mortality due to infection, starvation, or drowning (as discussed previously under the anchoring and gear utilization IPF). Although commercial and recreational fishing would be expected to disperse effort across many WTG foundations to avoid overcrowding, risk of entanglement could increase, as fishermen and marine mammals may be attracted to the same areas. Abandoned or lost fishing gear may become tangled with foundations, reducing the chance that abandoned gear would cause additional harm to marine mammals and other wildlife, although debris tangled with WTG foundations may still pose a hazard to marine mammals, and this would not reduce the risk of entanglement in active gear such as lobster pots employed around the wind farm structures. These potential long-term, intermittent impacts would be low in intensity and persist until decommissioning is complete and structures are removed.

In-water structures result in the conversion of open water and soft-bottom habitat to hard-bottom habitat. This habitat conversion attracts and aggregates prey species (i.e., fish and decapod crustaceans), thus inducing the “reef effect” (Causon and Gill 2018; Taormina et al. 2018). The aggregation of prey resulting from the reef effect around these strictures could result in increased foraging opportunities for some marine mammal species. Studies of artificial reefs have demonstrated potential increased biomass of larger predator species, including pelagic fish, birds, and marine mammals (Raoux et al. 2017; Pezy et al. 2018; Wang et al. 2019), and attraction of predatory species, including sea birds, sea turtles, and marine mammals, to offshore wind structures (Degraer et al. 2020). Available data indicate that seals and harbor porpoises may be attracted to the structure provided by offshore wind facilities (Russell et al. 2014; Scheidat et al. 2011), indicating that pinnipeds and odontocetes are likely to use habitat created by offshore wind facility structures to forage. However, the presence of structures associated with offshore wind facilities could result in temporary to long-term avoidance of a facility by marine mammals, which could potentially move them into areas with lower habitat value or with higher risk of vessel collision or fisheries interactions. The evidence for long-term displacement is unclear and varies by species. For example, Long (2017) studied marine mammal habitat use around two commercial wind farm facilities before and after construction and found that habitat use appeared to return to normal after construction. In contrast, Teilmann and Carstensen (2012) observed clear long-term (greater than 10 years) displacement of harbor porpoise from commercial wind farm areas in Denmark. Displacement effects remain a focus of ongoing study (Kraus et al. 2019).

The widespread development of offshore renewable energy facilities may facilitate climate change adaptation for certain marine mammal prey and forage species. Hayes et al. (2021) note that marine mammals are following shifts in the spatial distribution and abundance of their primary prey resources driven by increased water temperatures and other climate-related impacts. These range shifts are primarily oriented northward and toward deeper waters. The artificial reef effect created by offshore wind structures forms biological hotspots that could support species range shifts and expansions and changes in biological community structure resulting from a changing climate (Degraer et al. 2020; Methratta and Dardick 2019; Raoux et al. 2017). There is no example of a large-scale offshore renewable energy project within the geographic analysis area for marine mammals. However, in a smaller-scale project, it is not expected that any reef effect would result in an increase in species preyed on by NARWs, fin whales, or sei whales (NMFS 2021b). Although reef effects may aggregate fish species and potentially attract increased predators, they are not anticipated to have any measurable effect on marine mammals. Furthermore, it is not expected that any effects on the distribution, abundance, or use of the offshore wind lease areas by ESA-listed whales would be attributable to the physical presence of the foundations (NMFS 2021b).

The physical processes described above could affect prey presence or distribution. This possible impact is primarily relevant to baleen whales, as their prey includes planktonic prey such as copepods whose aggregation and density are primarily driven by hydrodynamic processes. As aggregations of plankton, which provide a dense food source for NARWs to efficiently feed upon, are concentrated by physical and oceanographic features, increased mixing may disperse aggregations and decrease efficient foraging opportunities. Potential impacts of hydrodynamic changes in prey aggregations are specific to marine mammals that feed on plankton, whose movement is largely controlled by water flow, as opposed to other marine mammals that eat fish, cephalopods, crustaceans, and marine vegetation, which are either more stationary on the seafloor or are more able to move independent of typical ocean currents. However, there is considerable uncertainty as to how these broader ecological changes will affect marine mammals in the future and how those changes will interact with other human-caused impacts, including ongoing climate change. NAS 2023 included the following two conclusions:

- The paucity of observations and uncertainty of the modeled hydrodynamic effects of wind energy development at the turbine, wind farm, and regional scales make potential ecological impacts of turbines difficult to predict and/or detect.
- The hydrodynamic impacts from offshore wind development in the Nantucket Shoals region on zooplankton will be difficult to isolate from the much larger magnitude of variability introduced by natural and other anthropogenic sources (including climate change) in this dynamic and evolving oceanographic and ecological system.

Therefore, based on available data, the impact of the increased presence of structures on marine mammals and their habitats is uncertain, its significance unknown, and likely varies by species and location.

Impacts other than potential prey impacts from hydrodynamic changes from the presence of structures from ongoing and planned activities would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds; although impacts on individuals would be detectable and measurable, they would not lead to population-level effects for marine mammals. Impacts on odontocetes and pinnipeds may result in slight beneficial effects due to increases in aggregations of prey species. These beneficial effects have the potential to be offset by risk of entanglement in fishing gear for some marine mammal species. However, because of the uncertainty of the relative contribution of beneficial and adverse impacts on odontocetes and pinnipeds, the overall impact level determination is minor adverse. Given the uncertainty as described above, the hydrodynamic effects of offshore wind in some areas may result in increases, decreases, or no change in prey availability, including key foraging grounds for NARWs. Although the impact on prey availability in these areas is unknown. These impacts are unlikely able to be distinguished from natural variability and the significant impacts of climate change. No detectable impacts on the foraging success of any species of marine mammal are anticipated. BOEM is committed to further studying the impacts of offshore wind operations on NARW prey (BOEM 2024).

Traffic (vessel strike): Vessel collisions are a major source of mortality and injury for many marine mammal species (Hayes et al. 2020, 2021, 2022, 2023; Laist et al. 2001). Almost all sizes and classes of vessels have been involved in collisions with marine mammals around the world, including large container ships, ferries, cruise ships, military vessels, recreational vessels, commercial fishing boats, whale-watch vessels, research vessels, and even jet-skis (Dolman et al. 2006). Research into vessel strikes and marine mammals has focused largely on mysticetes given their higher susceptibility to a strike because of their larger size, slower maneuverability, larger proportion of time spent at the surface foraging, and inability to actively detect vessels using sound (i.e., echolocation) (Laist et al. 2001; Vanderlaan and Taggart 2007). Conversely, focused research on vessels strikes on odontocetes is lacking. Factors that affect the probability of a marine mammal vessel strike and its severity include number, species, age, size, speed, health, and behavior of animal(s) (Martin et al. 2016; Vanderlaan and Taggart 2007); number, speed, and size of vessel(s) (Martin et al 2016; Vanderlaan and Taggart 2007); habitat type characteristics (Vanderlaan and Taggart 2007); operator's ability to avoid collisions (Martin et al. 2016); vessel path (Martin et al. 2016; Vanderlaan and Taggart 2007); and the ability of a marine mammal to detect and locate the sound of an approaching vessel.

Vessel speed and size are important factors for determining the probability and severity of vessel strikes. The size and bulk of the large vessels inhibit the ability for the crew to detect and react to marine mammals along the vessel's transit route. In 93 percent of the marine mammal collisions with large vessels reported in Laist et al. (2001), whales were either not seen beforehand or were seen too late to be avoided. Laist et al. (2001) reported that most lethal or severe injuries are caused by ships 262-feet (80-meters)-long or longer traveling at speeds greater than 15 miles per hour (13 knots). An analysis conducted by Conn and Silber (2013) built upon collision data collected by Vanderlaan and Taggart (2007) and included new observations of serious injury to marine mammals as a result of vessel strikes at lower speeds (e.g., 2.3 miles per hour and 6.3 miles per hour [2 knots and 5.5 knots]). The relationship between lethality and strike speed was still evident; however, the speeds at which 50 percent probability of lethality occurred was approximately 10 miles per hour (9 knots). Smaller vessels have also been involved in marine mammal collisions. Minke, humpback, and fin whales have been killed or fatally wounded by whale-watching vessels around the world (Jensen et al. 2003). Strikes occurred when whale-watching boats were actively watching whales, as well as when they were transiting through an area, with the majority of reported incidences occurring during active whale-watching activities (Jensen et al. 2003; Laist et al. 2001).

In general, large mysticetes are more susceptible to a vessel strike than smaller cetaceans and pinnipeds. While there are rare reports of smaller odontocetes being struck by ships (Van Waerebeek et al. 2007; Wells and Scott 1997), these animals are at relatively low risk due to their speed and agility (Richardson et al. 1995). Pinnipeds are also fast and maneuverable in the water, which increases the chance the animal can avoid approaching vessels (Jensen et al. 2003; Laist et al. 2001). There are very few documented cases of seal mortalities resulting from vessel strikes (Richardson et al. 1995). As discussed above, large whales are more susceptible to vessel strikes than other marine mammals due to their large size, slower travel and maneuvering speeds, lower avoidance capability, and increased proportion of time they spend near the surface (Laist et al. 2001; Vanderlaan and Taggart 2007). In the marine mammal geographic analysis area, mysticetes at risk of collision include NARW, humpback whales, fin whales, blue whales, sei whales, sperm whales, and, to a lesser extent, minke whales due to their smaller size (Hayes et al. 2020, 2021, 2023).

A description of the existing vessel traffic conditions in the geographic analysis area is provided in Section 3.13, Navigation and Vessel Traffic. As discussed in Section 3.7.1, UMEs have been designated for NARW and humpback whales in the geographic analysis area due to a high number of mortalities and serious injuries reported that have been attributed to, in part, vessel strike injuries (NMFS 2024c, 2024d). Vessel strike is a serious threat to both species, though its effect on population sustainability is most pronounced for the NARW (Hayes et al. 2020, 2023). To address the number of NARW with reported vessel strike injuries, in 2008, NMFS implemented a seasonal, mandatory vessel speed rule in certain areas along the U.S. east coast to reduce the risk of vessel collisions with NARWs. These Seasonal Management Areas require vessel operators to maintain speeds of 11.5 miles per hour (10 knots) or less and to avoid Seasonal Management Areas when possible. Effectiveness of the program was reviewed by NMFS in 2020. Results indicated that while it was not possible to determine a direct causal link, the mortality and serious injury incidents on a per-capita basis suggest a downward trend in recent years (NMFS 2020a). Laist et al. (2014) and NMFS (2020a) compared the number of NARW and humpback whale carcasses attributed to ship strikes since 1990 to proximity to the Seasonal Management Areas. Prior to implementation of Seasonal Management Areas, they found that 87 percent of NARW and 46 percent of humpback whale ship-strike deaths were found either inside Seasonal Management Areas or within 52 miles (83 kilometers), and that no ship-struck carcasses were found within the same proximity during the first 5 years of Seasonal Management Areas (Laist et al. 2014; NMFS 2020a).

NMFS also recognized that NARW may be present outside of established Seasonal Management Areas; therefore, temporal voluntary Dynamic Management Areas are established when a group of three or more NARWs are sighted; similarly, a NARW acoustic Slow Zone is triggered if an acoustic detection is made. Right Whale Slow Zones and Dynamic Management Areas are voluntary programs NMFS uses to notify vessel operators to slow down to avoid right whales. Mariners are encouraged to avoid the Dynamic Management Area/Slow Zone or reduce speed to less than 10 knots when transiting through the area. NMFS establishes a Dynamic Management Area/Slow Zone boundary around the whales for 15 days and alerts mariners through radio and local notices. In 2022, NMFS proposed changes to the 2008 NARW vessel speed rule to further reduce the likelihood of mortalities and serious injuries to NARW from vessel collisions. However, this proposed rule has not yet been implemented as of the time of this Final EIS publication.

Large whales are most susceptible to vessel strikes. For example, a high proportion of humpback and NARWs involved in their respective UMEs, as described above, show evidence of vessel interactions. The impact of vessel strikes on mysticetes, with the exception of NARWs, from ongoing vessel activities (from any vessel) is moderate because it is likely to result in long-term consequences (i.e., injuries or mortalities) to individuals or populations that are detectable and measurable; population-level effects may occur, particularly for those populations listed under the ESA, but populations should sufficiently recover. BOEM notes that not all populations (e.g., minke whales, humpback whales) are experiencing population-level consequences from vessel strikes; however, vessel strikes are a threat for all whales. The impact of vessel strikes on NARW from ongoing vessel activities would be major because vessel strikes have had and continue to have population-level effects that compromise the viability of the species. Odontocetes (other than sperm whales) and pinnipeds are less susceptible to vessel strikes but they do occur. The impact of vessel strikes on odontocetes and pinnipeds from ongoing vessel activities would be moderate because while population-level effects are unlikely, consequences to individuals would be long-term, detectable, and measurable and potentially long-term if the strike results in an injury or mortality

For offshore wind vessels, BOEM is requiring developers to implement several vessel strike avoidance measures to reduce risk to a level that should functionally avoid vessel strikes. Further, while the number of vessels needed per project may be high, the amount of vessels necessary for offshore wind is relatively low compared to all vessel traffic. Therefore, interactions between offshore wind vessels and marine mammal are not expected to occur, and ongoing offshore wind activities are anticipated to have no effect on marine mammals via the vessel traffic IPF.

Climate change: Global climate change is also an ongoing risk for marine mammal species in the geographic analysis area. Climate change is known to increase temperatures, increase ocean acidity, change ocean circulation patterns, raise sea levels, alter precipitation patterns, increase the frequency and intensity of storms, and increase freshwater runoff, erosion, and sediment deposition. These effects have the potential to reduce long-term foraging and reproductive success, increase individual mortality and disease occurrence, and affect the distribution and abundance of prey resources for marine mammals (Fandel et al. 2020; Love et al. 2013; USEPA 2022a; NASA 2023; Gulland et al. 2022). Altered habitat/ecology associated with warming has resulting in northward distribution shifts for some prey species and marine mammals are adjusting their behavior and distribution in response to these changes (Davis et al. 2017, 2020; Hayes et al. 2020, 2021, 2022). Additionally, warming is expected to influence the prevalence, frequency, and severity of marine mammal diseases, particularly for pinnipeds (Burek et al. 2008; Burge et al. 2014). Over time, climate change and coastal development would alter existing habitats, rendering some areas unsuitable for certain species and their prey, and more suitable for others. For example, shifts in NARW distribution patterns are likely in response to changes in prey densities driven in part by climate change (O'Brien et al. 2022b; Reygondeau and Beaugrand 2011; Meyer-Gutbrod et al. 2015, 2021). These long-term, high-consequence impacts could include increased energetic costs associated with altered migration routes, reduction of suitable breeding, foraging habitat, or both, and reduced individual fitness. These factors individually and in combination can influence individual survivorship and fecundity over broad geographical and temporal scales. Therefore, ongoing global climate change and its associated consequences could lead to major, long-term, high-consequence impacts on marine mammals.

Ongoing offshore wind is expected to combat the effects from climate change over the long term by providing clean energy and reducing use of fossil fuels. Minor beneficial impacts on mysticetes, odontocetes, and pinnipeds are anticipated because planned offshore wind activities may reduce the ongoing and predicted rate of climate change.

3.7.3.2 Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A, as described above (i.e., ongoing non-wind and wind activities) in combination with planned non-offshore wind activities and planned offshore wind activities (without Alternative B).

Planned non-offshore wind activities that may affect marine mammals include new submarine cables and pipelines, dredging and port improvement, marine minerals extraction, military training and testing activities, marine transportation, and installation of new structures (such as artificial reefs) on the OCS (see Appendix E for a description of ongoing and planned activities). These activities could result in displacement and injury to or mortality of individual marine mammals.

BOEM expects the combination of ongoing activities and reasonably foreseeable (planned) activities other than offshore wind to result in moderate impacts on marine mammal species other than the NARW, primarily driven by vessel traffic and ship-strike risk, entanglement with fishing gear, anthropogenic (i.e., human introduced) noise, and climate change; these IPFs would likely result in impacts that are detectable and measurable, though populations are expected to sufficiently recover for species with annual mortality and serious injury below their respective PBR value. For the NARW, as described above, ongoing threats such as vessel strike and fishing gear entanglement are currently resulting in major impacts on NARWs. BOEM anticipates this major impact will continue when considering reasonably foreseeable future activities.

The IPFs deemed to have impacts on marine mammals are summarized herein for planned offshore wind activities on marine mammals during construction, operations, and decommissioning of projects without Alternative B. This section provides a general description of these mechanisms, recognizing that the extent and significance of potential effects of planned offshore wind projects on conditions cannot be fully quantified for projects that are in the conceptual or proposal stage and have not been fully designed. Where appropriate, potential effects resulting from planned activities are generally characterized by comparison to effects resulting from approved projects that have been evaluated and are likely to be similar in nature. Planned activities with federal funding or approval would be subject to independent NEPA analyses and regulatory approvals. The environmental effects of other offshore wind energy development activities would be fully considered before BOEM makes a decision on the respective COP.

BOEM expects that planned offshore wind activities may affect marine mammals through the following IPFs.

Accidental releases: Gradually increasing non-offshore wind vessel traffic over time would increase the risk of accidental releases. Planned offshore wind activities may also increase accidental releases of fuels, fluids, hazardous materials, and trash and debris due to increased vessel traffic and installation of WTGs and other offshore structures. The risk of accidental releases is expected to be highest during construction, but accidental releases could also occur during operation and decommissioning. Refueling of primary construction vessels at sea is anticipated for planned offshore wind projects.

As discussed in Section G.2.2, Water Quality, there would be a low risk of a leak of fuel, fluids, and/or hazardous materials from any single one of the approximately 3,104 WTGs and ESP, each with approximately 5,000 gallons stored. Total fuel, fluids, and/or hazardous materials within the geographic analysis area would be approximately 119 million gallons. Trash and debris may be released by vessels during construction, operations, and decommissioning of planned offshore wind projects. BOEM assumes operator compliance with federal and international requirements to minimize releases (USEPA 2021a). In the unlikely event of a trash or debris release, the same mechanisms of impacts on marine mammals from accidental releases described for the ongoing activities above would continue to affect marine mammals in the geographic analysis area for planned activities, including planned offshore wind projects (Appendix E). Impacts from accidental releases and discharges from ongoing and planned activities would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds and are unlikely to result in population-level effects, although consequences to individuals would be detectable and measurable.

Anchoring and gear utilization: As discussed in Section 3.7.3.1, ongoing offshore wind and non-offshore wind projects pose a risk of entanglement in fishing gear for all marine mammals. Anchors associated with vessels and met buoys would not pose a risk of entanglement or entrapment for any marine mammal species, and the relatively limited extent of seafloor disturbances due to anchoring from project equipment would result in negligible impacts for mysticetes (including NARWs), odontocetes, and pinnipeds.

Ongoing non-offshore wind activities, particularly commercial and recreational fishing activities, would continue to occur in the geographic analysis area and impacts from these activities (discussed in detail in Section 3.7.3.1) would continue to be moderate for mysticetes (except NARW) due to the risk of entanglement and bycatch. For NARWs, impacts would continue to be major because entanglements in fishing gear from ongoing commercial and recreational fishing has been identified as a leading cause for mortality, and given the vulnerability of this population, the loss of even on individual would compromise the viability of this species. For odontocetes and pinnipeds, impacts from entanglement and bycatch associated with ongoing commercial and recreational fishing would continue to be minor as the impacts are detectable and measurable, but because the documented risk of this IPF on these species is lower the risk of injury is also lower and no population-level effects are expected.

Planned offshore wind projects are likely to include plans that monitor biological resources in and nearby associated project areas throughout various stages of development. These could include trawl and pot/trap surveys, as well as other methods of sampling the biota in the area. Impacts of these surveys would be similar to those described for the ongoing offshore wind projects in Section 3.7.3.1, with the exception of the number of offshore wind projects in the geographic analysis area, which would increase with an increasing number of wind projects. The presence of monitoring gear associated with offshore wind projects could affect marine mammals by entrapment or entanglement; however, developers have included marine mammal mitigation and monitoring procedures in COPs submitted to date designed to avoid entanglement or entrapment in any biological survey plans. Due to the implementation of project-specific monitoring and mitigation measures for ongoing and planned offshore wind activities, these surveys are not expected to contribute appreciably to the above-described entanglement or entrapment risk for marine mammals. Additionally, based on the methods employed for these surveys, the likelihood of interactions with listed species of marine mammals is much lower than commercial and recreational fishing activities. The potential for impacts on NARWs, mysticetes, and large odontocetes is anticipated to be negligible, while the potential for impacts on small odontocetes and pinnipeds is negligible to minor. However, the potential extent and number of animals potentially exposed cannot be determined without project-specific information.

Cable emplacement and maintenance: Planned offshore wind activities will involve the placement and maintenance of export and inter-array cables. Cable emplacement and maintenance activities disturb bottom sediment, resulting in temporary local increases in suspended sediment concentrations that are generally limited to the emplacement corridor. Emplacement of submarine cables would also produce noise, which is discussed in the trenching and cable laying section under the noise IPF below. All effects discussed in this section pertain to non-acoustic impacts. Cable emplacement associated with ongoing and planned offshore wind activities (not including the Proposed Action) is estimated to disturb up to 70,706 acres (Appendix E) of seafloor. The key factors that affect the volume of seabed sediment disturbed and suspended, dispersed in the surrounding sea area, and redeposited on the seabed during cable burial operations include the cable technique being used (i.e., the type of tool selected to bury the cable) and local site conditions, including seabed type and local currents and wave conditions (BERR 2008). The impact on water quality from sediment suspension during cable-laying activities is expected to be temporary and short term.

The effects of cable emplacement and maintenance for planned offshore wind projects would be similar in nature to those observed during construction of the Block Island Wind Farm (Elliot et al. 2017). While suspended sediment impacts would vary in extent and intensity depending on project- and site-specific conditions, measurable impacts are likely to be on the order of 500 mg/L or lower, short term lasting for minutes to hours, and limited in extent to within a few feet vertically and a few hundred feet horizontally from the point of disturbance.

Data are not available regarding marine mammal avoidance of localized turbidity plumes; however, Todd et al. (2015) suggested that since some marine mammals often live in turbid waters and some species of mysticetes employ feeding methods that create sediment plumes, some species of marine mammals have a tolerance for increased turbidity. These species have developed echolocation for communicating, foraging, and navigating by evolving in an environment with variable and predominantly low visibility (Tyack and Miller 2002). Similarly, McConnell et al. (1999) documented movements and foraging of gray seals in the North Sea. One tracked individual was blind in both eyes but otherwise healthy. Despite being blind, observed movements were typical of the other study individuals, indicating that visual cues are not essential for gray seal foraging and movement (McConnell et al. 1999). If elevated turbidity caused any behavioral responses such as avoiding the turbidity zone or changes in foraging behavior, such behaviors would be temporary, and any impacts would be short term and temporary. This suggests that temporary reduction in visibility would not significantly impair behavior and any potential exposures would be localized in extent, limited in magnitude, short term, and unlikely to result in biologically significant impacts.

Turbidity associated with increased sedimentation has some potential to result in temporary and short-term impacts on marine mammal prey species. While the cable routes for future offshore wind developments are unknown at this time, the areas subject to increased suspended sediments from simultaneous activities would be limited, and all impacts would be localized and temporary. Sediment plumes would be present during construction for 1 to 6 hours at a time. Any dredging necessary prior to cable installation could also contribute additional impacts. Given that impacts would be temporary and generally localized to the emplacement corridor, no individual fitness or population-level impacts on threatened or endangered marine mammals would be expected (NMFS 2021f). Similarly, the temporary and localized impacts associated with cable emplacement and maintenance are only expected to result in impacts ranging no response to short-term impacts on the behavior of non-threatened and endangered marine mammals. Based on the current anticipated construction schedule provided in Table E-1 in Appendix E, construction impacts associated with multiple projects could overlap in time and space and potentially result in more frequent impacts, though no individual fitness or population-level impacts would be expected. Threatened and endangered marine mammals do not appear to be affected by increased turbidity and would be able to successfully forage in adjacent areas not affected by sediment plumes (NMFS 2021f).

Impacts from cable emplacement and maintenance from ongoing and planned activities would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds and are likely to result in short-term, localized consequences to individuals that are detectable and measurable but do not lead to population-level effects.

EMF: Under Alternative A, export cables would be added in 26 BOEM offshore wind lease areas, with at least 6,552 miles of offshore export, inter-array, and inter-link cable would be added in the geographic analysis area in association with planned offshore wind projects based on submitted COPs to date (Appendix E). Although this will result in an increase in the production of EMF in the geographic analysis area, EMF effects would be reduced by cable burial to an appropriate depth and the use of shielding based on submitted COPs to date, if necessary. As discussed in Section 3.7.3.1, EMF effects on marine mammals from planned offshore wind projects would vary in extent and magnitude depending on overall cable length, the proportion of buried versus exposed cable segments, and project-specific transmission design (e.g., high-voltage AC or DC, transmission voltage). However, measurable EMF effects are generally limited to within tens of feet of cables (Section 3.7.3.1).

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable effect into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. As a result, heat from submarine high-voltage cables is not expected to affect marine mammals.

Impacts from EMF and cable heat from ongoing and planned activities would likely be negligible for mysticetes, odontocetes, and pinnipeds, of the lowest level of detection, and barely measurable, with no perceptible consequences to individuals or the population.

Lighting: The addition of over 3,073 new offshore structures associated with planned and ongoing offshore wind projects in the geographic analysis area with long-term hazard and aviation lighting, as well as lighting associated with construction vessels, would increase artificial lighting. Vessel-related lighting impacts would be localized and temporary; this could attract potential prey species to construction zones, potentially aggregating some marine mammal species (primarily odontocetes), exposing them to greater harm from other IPFs associated with construction, including an increased risk of collision with vessels.

Orr et al. (2013) concluded that the operational lighting effects from wind farm facilities on marine mammal distribution, behavior, and habitat use were uncertain but likely negligible if recommended design and operating practices are implemented. Given the highly localized extent of artificial lighting, impacts from ongoing and planned activities would be negligible for mysticetes (including NARW), odontocetes, and pinnipeds, of the lowest level of detection, and barely measurable, with no perceptible consequences to individuals or the population.

Noise: Noise sources from ongoing and planned offshore wind and non-offshore wind activities are similar to those described previously in Section 3.7.3.1. Potential impacts (e.g., PTS, behavioral impacts) are also similar. The analysis provided below describes of the amount and scope of work associated with planned offshore wind and non-offshore wind activities to build upon the impact analysis provided in Section 3.7.3.1.

The same sources described in Section 3.7.3.1 for ongoing non-offshore wind activities would continue to be present in the geographic analysis area and the potential effects on marine mammals would continue to be the same as what was described in Section 3.7.3.1. The following noise IPFs discuss the additional risk of impacts from planned offshore wind projects in the geographic analysis area in relation to those impacts discussed in Section 3.7.3.1.

Impact and Vibratory Pile Driving

In the planned activities scenario (Appendix E), the construction of up to 3,073 new WTG foundations in the geographic analysis area is expected to occur intermittently over an approximate 30-year period. During the installation of WTG foundations, underwater sound related to impact pile driving would likely occur within the geographic analysis area. Offshore wind activities may also require the installation and removal of sheet piles for cofferdams or other structures, which may require the use of a vibratory hammer. The sounds generated during pile driving will vary depending on the piling method (impact or vibratory), pile material, size, hammer energy, water depth, and substrate type. Pile driving in the nearshore environment (e.g., at export cable landfalls in nearshore areas) is even more spatially dependent (i.e., more affected by the bathymetry of the surrounding seabed) than in the offshore environment. A description of the physical qualities of pile-driving noise can be found in Appendix B.

Impact pile driving may result in both PTS impacts and behavioral impacts on marine mammals due to the acoustic properties of impulsive sound in relation to marine mammal hearing and the relatively high source levels associated with this activity. Noise levels vary depending on the size of the hammer, diameter of the pile, properties of the seabed, and other environmental factors (Amaral et al. 2018, 2020; Bellmann et al. 2020; JDN 2020). This noise would be produced intermittently during construction of each project; although the exact duration of noise produced would vary depending on the details of a given project. Construction of offshore wind facilities is expected to occur intermittently from 2023 to 2030 and beyond in lease areas that are anticipated to be developed in the geographic analysis area. Construction of 3,073 offshore structures would result in temporary increases in noise that may affect marine mammals. Depending on their distribution in relation to construction activities and the timing of that construction, the duration and frequency of any exposure of marine mammals to noise would be variable. An individual may be exposed to pile driving intermittently over a period of weeks if it remains within the ensonified area of a given project or travels over the larger geographic analysis area where concurrent pile driving may be occurring. The potential impacts of exposure to pile-driving noise range from minor and temporary behavioral disturbance to auditory injury (PTS).

All offshore wind projects are expected to implement mitigation similar to that outlined in the COP (Volume III, Section 6.7.4, Table 6.7-20; Epsilon 2023), which would reduce the risk of long-lasting impacts, such as PTS or disruptions of important biological behaviors. Mitigation and monitoring measures applied to offshore wind construction may include use of noise attenuation systems (e.g., double bubble curtains), which effectively put up a physical barrier around the pile being installed to reduce the noise level propagated from the impact and vibratory pile driving; soft starts such that the impact hammer would begin using the lowest possible energy and slowly increase its power until it reaches the maximum to give animals a chance to leave the area; delay or stopping pile driving if an animal is within a designated distance, and use of PSOs to effectively monitor the ensonified area for the presence of marine mammal species to stop piling. Even with mitigation, some marine mammals may experience PTS; however, no non-auditory injury from pile driving has been documented for any marine mammal species, and mitigation would likely reduce the risk of any population-level impacts (Stöber and Thomsen 2019; Harding and Cousins 2022). The probability and extent of potential impacts are situational and dependent on several factors including pile size, impact energy, duration, site characteristics (i.e., water depth, sediment type), time of year, and species, among others that would be considered in the acoustic exposure modeling, which is typically conducted for each project's COP.

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

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

Concurrent pile driving at neighboring projects is anticipated under Alternative A. Concurrent pile driving could occur for one or more projects on the same day. Concurrent pile driving increases the daily amount of noise exposure in a broader area but decreases the total number of days of potential exposure from each project in the same area. Concurrent pile driving occurring within the same 24-hour period may create a greater overall impact area(s) among neighboring projects in which marine mammals could be exposed to noise that may cause auditory or behavioral impacts. The number of foundations for each project is the primary factor determining the maximum number of overlapping pile-driving days from neighboring projects. One foundation per project installed per day results in the maximum-case scenario for the greatest number of overlapping pile-driving days for neighboring projects. The RI/MA Lease Areas have the greatest potential for concurrent pile driving due to the number of projects that may have construction schedules overlapping with one another. The total number of possible concurrent construction days, the remaining number of pile driving days required to complete construction of proposed projects, and the total pile driving days in a given year are provided in Table 3.7-7 for each geographic region. This is a conservative estimate that reflects the maximum-case scenarios identified in PDEs and may overestimate the actual number of foundations installed for each project and consequently overestimate the number of concurrent pile-driving days. Marine mammals present in these areas could be exposed to the noise from more than one pile-driving event per day, repeated over a period of days, dependent on the movement patterns of that animal. It is unlikely that individual marine mammals would be exposed to pile-driving noise generated on the same day from non-neighboring projects because of the distances between such projects and considering the distance and speed at which an individual would be expected to travel over the course of a day.

Table 3.7-7: Concurrent and Non-Concurrent Impact Hammer Pile-Driving Days

Geographic Region	2022	2023	2024	2025	2026	2027	2028	2029
Maine[a]								
Multiple projects[b]	0	0	0	0	0	0	0	0
Single project[c]	0	2 (1)	0	0	0	0	0	0
Total pile-driving days[d]	0	2 (1)	0	0	0	0	0	0
RI/MA Lease Areas[a]								
Multiple projects[b]	0	102 (51)	0	149 (75)	0	0	0	0
Single project[c]	63 (32)	21 (11)	68 (34)	16 (8)	0	0	0	0
Total pile-driving days[d]	63 (32)	123 (62)	68 (34)	165 (83)	0	0	0	0
New York/New Jersey Lease Areas								
Multiple projects[b]	0	101 (51)	72 (36)	0	113 (57)	0	0	82 (41)
Single project[c]	0	3 (2)	38 (19)	100 (50)	46 (23)	0	0	36 (18)
Total pile-driving days[d]	0	104 (52)	110 (55)	100 (50)	159 (80)	0	0	118 (59)
Delaware/Maryland Lease Areas								
Multiple projects[b]	0	0	17 (9)	0	0	0	0	0
Single project[c]	0	0	108 (54)	93 (47)	100 (50)	0	0	0
Total pile driving-days[d]	0	0	125 (63)	93 (47)	100 (50)	0	0	0
Virginia/North Carolina Lease Areas								
Multiple projects[b]	0	0	0	0	0	0	0	80 (40)
Single project[c]	0	208 (104)	0	70	0	0	0	43 (22)
Total pile driving-days[d]	0	208	0	70	0	0	0	123

RI/MA Lease Areas = Rhode Island and Massachusetts Lease Areas
[a] The number of pile driving days is provided for the pile-driving scenarios: one pile per day (two piles per day).
[b] This number represents the maximum number of days that two or more concurrent projects could be pile driving within the geographic region. Additional information regarding the total number of concurrent projects within a given year are provided in Table E-1 in Appendix E.
[c] This number represents the maximum number of days that one project could be pile driving to complete construction within a given year.
[d] This number represents the total number of days that pile driving (concurrent and non-concurrent) could occur within the geographic region within a given year.

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

Impact pile driving for planned offshore wind projects under Alternative A is anticipated over multiple years (2023 to 2030 and beyond). Overall, a total of 3,166 or 1,522 non-concurrent pile-driving days under the one-pile-per-day or two-piles-per-day scenarios, respectively, may occur over this period under the maximum-case scenario, where an individual marine mammal could be exposed to pile driving in each geographic region. Marine mammals could be intermittently exposed to pile-driving noise throughout this period, from one or more projects, with additional potential exposure from 2029 and beyond. Offshore wind activities may also require the installation and removal of sheet piles for cofferdams or other structures, which may require the use of a vibratory hammer. The sounds generated during pile driving will vary depending on the piling method (impact or vibratory), pile material, size, hammer energy, water depth, and substrate type.

Pile driving in the nearshore environment (e.g., at export cable landfalls in nearshore areas) is even more spatially dependent (i.e., affected by the shape of the surrounding seabed) than in the offshore environment. Sounds from pile driving may affect marine mammal species in the area. The impacts would vary in extent and intensity based on the scale and design of each project, as well as the schedule of project activities. Potential construction scenarios may include concurrent or non-concurrent pile-driving events over 1 or more years. Concurrent pile-driving scenarios would increase the geographical extent of noise that is introduced into the marine environment on a given day but would decrease the total number of days that the environment is ensonified (assuming that the proposed Project can be completed faster) in comparison to a non-concurrent construction scenario. Results from Southall et al. (2021) showed that concurrent construction of multiple windfarms, if scheduled to avoid critical periods when NARW are present in higher densities, reduces the overall risk to this species. However, it could increase risk for PTS or TTS or behavioral impacts for species that are present during construction. Given the migratory movements and seasonal abundances of marine mammals throughout the offshore wind energy areas, it is likely that some individuals would be exposed to multiple days of construction noise within the same year.

Pile-driving activities from other offshore wind development projects have the potential to affect all marine mammal functional hearing groups around each project site. Depending on the hearing sensitivity of the species, exceedance of PTS thresholds may occur on the scale of several kilometers, whereas exceedance of TTS thresholds and behavioral impacts may occur on the order of tens of kilometers from the center of pile-driving activity. However, because marine mammals are mobile, they may move away from a sound before sufficient duration has passed to cause PTS or TTS. In addition, if mitigations are applied (bubble curtains, exclusion zones, etc.) all of these effects and exposure ranges can be reduced.

The most commonly reported behavio”al effect of pile-driving activity on marine mammals has been short-term avoidance or displacement from the pile-driving site, though there are some studies that indicate a longer-term avoidance of the wind farm areas for specific species (Teilmann and Carstensen 2012). Short-term avoidance has been documented for harbor porpoises, a species of high concern in European waters. Harbor porpoise produce echolocation clicks nearly constantly (Osiecka et al. 2020); therefore studies using strategically placed passive acoustic instruments can allow researchers to derive detailed insights about the animals’ presence and behavior around wind farms by listening for their clicks. A 2011 study of harbor porpoise acoustic activity in the North Sea at the Horns Rev 2 Offshore Wind Farm revealed that porpoise vocal activity was reduced as distant as 11.1 miles from the construction site during pile driving. At the closest measured distance of 1.6 miles, vocal activity completely ceased at the start of pile driving, did not recommence for up to 1 hour after pile driving ended, and remained below average levels for 24–72 hours (Brandt et al. 2011). Dahne et al. (2013) visually and acoustically monitored harbor porpoises during construction of the Alpha Ventus Offshore Wind Farm in German waters and found a decline in porpoise detections at distances up to 6.7 miles from pile driving, while an increase in porpoise detections occurred at points 16 and 31 miles away, suggesting displacement away from the pile-driving activity. During several construction phases of two Scottish windfarms, an 8 to 17 percent decline in porpoise acoustic presence was seen in the 16 miles by 16 miles block containing pile-driving activity in comparison to a control block. Displacement within the pile-driving monitored area was seen up to 7 miles away (Benhemma-Le Gall et al. 2021).

A more recent analysis In the North Sea looked at harbor porpoise density and acoustic occurrence relative to the timing and location of pile-driving activity, as well as the sound levels generated during the development of eight wind farms (Brandt et al. 2016). Using data from PAM pooled across all projects, changes in porpoise detections across space and time were modeled. Compared to the 25- to 48-hour pre-piling baseline period, porpoise detections during construction declined by about 25 percent at SELs over 1 second of piling between 145 and 150 dB re 1 μPa^2 s and 90 percent at SELs above 170 dB re 1 μPa^2 s. Across the eight projects, a graded decline in porpoise detections was observed at different distances from pile-driving activities. The results revealed a 68 percent decline in detections within 3 miles (5 kilometers) of the noise source during construction, 33 percent decline 3 to 6 miles away, 26 percent decline 6 to 9 miles away, and a decline of less than 20 percent at greater distances, up to the 37 miles modeled. As a note, the authors' used a 20 percent decline to indicate an adverse effect had occurred. However, within 20 to 31 hours after pile driving, porpoise detections increased in the 0- to 3-mile range, suggesting no long-term displacement of the animals. Little to no habituation was found (i.e., over the course of installation, porpoises stayed away from pile-driving activities). However, there was substantial inter-project variability in the reactions of porpoises that were not all explained by differences in noise level. The authors hypothesized that the varying qualities of prey available across the sites may have led to a difference in motivation for the animals to remain in an area. Temporal patterns were also observed: porpoise abundance was significantly reduced in advance of construction up to 10 kilometers around the wind farm area, likely due to the increase in vessel traffic activity. This study showed that although harbor porpoises actively avoid pile-driving activities during the construction phase, these short-term effects did not lead to population-level declines over the 5-year study period (Brandt et al. 2016).

A study conducted during wind farm construction In Cromarty Firth, Scotland, compared the effect of impact and vibratory pile driving on the vocal presence of both common bottlenose dolphins and harbor porpoises in and outside the Cromarty Firth area (Graham et al. 2017). There were no statistically significant responses attributable to either type of pile-driving activity in the three metrics considered: daily presence/absence of a species, number of hours in which a species was detected, or duration of daytime (between 6:00 a.m. and 6:00 p.m.) encounters of a species. The only exception was seen in bottlenose dolphins on days with impact pile driving. The duration of common bottlenose dolphin acoustic encounters decreased by an average of approximately 4 minutes at sites within the Cromarty Firth (closest to pile-driving activity) in comparison to areas outside the Cromarty Firth. The authors hypothesized that the lack of a strong response was because the received levels were very low in this particularly shallow environment (129 dB re 1 μPa^2 s over 1 second of vibratory and 133 dB re 1 μPa^2 s over 1 strike of impact, both at 2,664 feet from the pile), despite similar size piles and hammer energy to other studies. Comparatively, measurements taken during installation of two 5 MW turbines in the Moray Firth in Northeast Scotland indicated a peak-to-peak sound pressure level (Lpk-pk) source level estimated from the noise measurements of 252 decibels referenced to 1 micropascal at 1 meter (dB re 1 μPa m) (Bailey et al. 2010), compared to the Lpk-pk source level of 240 dB re 1 μPa m estimated based on the measurements from Graham et al. (2017). The difference in estimated source levels between these two studies is likely driven by the difference in the size of the piles being installed. The overall source levels reported by Bailey et al. (2010) were higher than those reported by Graham et al. (2017), the authors concluded that auditory injury effects such as PTS and TTS would not be expected beyond 328 feet of the pile for cetaceans and pinnipeds, so only changes in behavior in response to pile-driving noise would be expected. These studies underscore the influence of sources and environmental conditions on the propagation of sound and its subsequent impacts on marine mammals.

In addition to avoidance behavior, several studies have observed other behavioral responses in marine mammals. A playback study on two harbor porpoises revealed that high-amplitude sounds, like pile driving, may adversely affect foraging behavior in this species by decreasing catch success rate (Kastelein et al. 2019). In another playback study, trained dolphins were asked to perform a target detection exercise during increasing levels of vibratory pile driver playback sounds (up to 140 dB re 1 μPa) (Branstetter et al. 2018). Three of the five dolphins exhibited either a decrease in their ability to detect targets in the water, or a near complete cession of echolocation activity, suggesting the animals became distracted from the task by the vibratory pile-driving sound, while the remaining two dolphins did not exhibit any changes in their performance (Branstetter et al. 2018).

In addition to common bottlenose dolphins and harbor porpoises, the effects of pile driving conducted for offshore wind projects have been studied on a limited set of additional species. Würsig et al. (2000) studied the response of Indo-Pacific humpbacked dolphins (*Sousa chinensis*) to impact pile driving in the seabed in water depths of 20 to 26 feet (6 to 8 meters). No overt behavioral changes were observed in response to the pile-driving activities, but the animals' speed of travel increased, and some dolphins remained in the vicinity while others temporarily abandoned the area. Once pile driving ceased, dolphin abundance and behavioral activities returned to pre-pile-driving levels. A study using historical telemetry data collected before and during the construction and operation of a British wind farm showed that harbor seals may temporarily leave an area affected by pile-driving sound beginning at estimated received peak-to-peak pressure levels between 166 and 178 dB re 1 μPa (Russell et al. 2016). Seal abundance was reduced by 19 to 83 percent during individual piling events (i.e., the installation of a single pile) within 16 miles of the center of the pile. Displacement lasted no longer than 2 hours after the cessation of pile-driving activities, and the study found no significant displacement during construction as a whole. Interestingly, the study also showed that seal usage in the wind farm area increased during the operational phase of the wind farm, although this may have been due to another factor, as seal density increased also outside the wind farm area.

Since there are no studies that have directly examined the behavioral responses of baleen whales to pile driving, studies using other impulsive sound sources such as seismic airguns serve as the best available proxies. Bailey et al. (2010) estimated minke whales may exhibit behavioral disturbances during pile driving in the Moray Firth out to 25 miles, but this is based on sound propagation modeling using in situ measurements to the acoustic thresholds defined by Southall et al. (2007), rather than studies directly observing marine mammal behavioral changes in response to noise as discussed in this paragraph. With seismic airguns, the distance at which responses occur depends on many factors, including the volume of the airgun (and consequently source level), as well as the hearing sensitivity, behavioral state, and even life stage of the animal (Southall et al. 2021). In a 1986 study, researchers observed the responses of feeding gray whales to a 100-cubic inch airgun and found that there was a 50 percent probability that the whales would stop feeding and move away from the area when the received levels reached 173 dB re 1 μPa SPL (Malme et al. 1986). Other studies have documented baleen whales initiating avoidance behaviors to full-scale seismic surveys at distances of less than 6 miles (Johnson et al. 2007; Ljungblad et al. 1988; McCauley et al. 1998; Richardson et al. 1986) and as far away as 12 miles (Richardson et al. 1999). Bowhead whales (*Balaena mysticetus*) have exhibited other behavioral changes, including increased calling rates as airgun pulse energies increase from their lowest detectable levels. The increase in rates then leveled off at a received cumulative SEL around 94 dB re 1 μPa^2 s and decreased once the 10-minute cumulative SEL exceeded 127 dB re 1 μPa^2 s (Blackwell et al. 2015). A more recent study by Dunlop et al. (2017) compared the migratory behavior of humpback whales exposed to a 3,130-cubic-inch airgun array with those that were not. There was no gross change in behavior observed (including respiration rates), although whales exposed to the seismic survey made a slower progression southward along their migratory route compared to the control group. This was largely seen in female-calf groups, suggesting there may be differences in vulnerability to underwater sound based on life stage (Dunlop et al. 2017). The researchers produced a dose-response model that suggested behavioral change was most likely to occur within 4 kilometers of the ship at received SELs over 135 dB re 1 μPa^2 s (Dunlop et al. 2017).

Acoustic masking can occur if the frequencies of the sound source overlap with the frequencies of sound used by marine species. LFC and PPW, in particular, are more likely to experience acoustic masking of communication signals from pile driving than other species due to the overlapping frequency content of their vocalizations with the acoustic energy from pile driving, which is mostly below 1 kHz. In addition, low-frequency sound can propagate greater distances than higher frequencies, meaning masking may occur over larger distances than masking related to higher frequency noise. There is evidence that some marine mammals can avoid acoustic masking by changing their vocalization rates (e.g., bowhead whale [Blackwell et al. 2013]; blue whale [Di Iorio and Clark 2010]; humpback whale [Cerchio et al. 2014]), increasing call amplitude (e.g., beluga whale [Scheifele et al. 2004]; killer whales [Holt et al. 2009]), or shifting dominant frequencies (Lesage et al. 1999; Parks et al. 2007). When masking cannot be avoided, increasing noise could affect the ability to locate and communicate with other individuals. Given that pile driving occurs intermittently, with some quiet periods between pile strikes, it is unlikely that complete masking would occur with impact pile driving. For vibratory pile driving, sound levels are lower, but noise is generated nearly continuously. This means that the distance at which masking could occur from vibratory pile driving is smaller than that of impact pile driving, but the proportion of time during active pile driving for which masking might occur would be greater.

Overall, it is reasonable to assume that there would be a greater risk of impacts on LFC (i.e., mysticetes) than other species groups, given low-frequency pile driving noise most overlaps the generalized hearing range of baleen whales, even though direct research on pile-driving noise on LFC is limited. Available evidence suggests LFC may avoid or change their behavior when exposed to impulsive sounds (e.g., cessation of foraging, decreased vocalizations, changes in dive and swim speeds), and their primary frequency range for listening to their environment and communicating with others overlaps with the dominant frequency of pile-driving noise. Additionally, as LFC have specific feeding and breeding grounds (unlike other species who can perform these life functions over broader spatial scales), disturbance by anthropogenic noise occurring in one of these key areas may come at an increased cost to these species. Impacts on LFC could be reduced with implementation of project-specific avoidance, mitigation, and monitoring measures. Noise abatement devices, such as double bubble curtains, can be used to reduce the overall acoustic energy that is propagated from the pile and thus decreases the geographic extent of noise-related impacts. The implementation of clearance and shut down zones and seasonal restrictions based on species presence in an area can reduce the intensity and likelihood of effects by allowing piling activity when specific animals are not present or present in only low density. Many of these measures are requirements as conditions of compliance with the lease, ESA, MMPA, and other federal regulations. These measures would reduce the potential for PTS and TTS effects from pile driving on all marine mammals. The likelihood of behavioral avoidance, stress, masking, and other effects associated with disturbance are still high, especially for LFC. Considering the number and extent of projects planned in the geographic analysis area, moderate impacts are expected to marine mammals from impact pile-driving activities, that could reduce fitness of those individuals, but would not result in population-level impacts for any species. Vibratory pile driving activities pose a lower risk of PTS. Behavioral responses to vibratory pile driving noise, though present around all planned offshore wind projects, would be short term and would not have population-level effects resulting in minor impacts.

Drilling

Drilling activities may occur during foundation installation associated with offshore wind projects to modify soil and/or boulders from inside the piles in cases of pile refusal. Geotechnical drilling SPLs (in the 30 to 2,000 Hz band) have been measured up to 145 dB re 1 µPa m from a jack-up platform (Erbe and McPherson 2017), and up to 162 dB re 1 µPa m from an anchored drilling vessel (Huang et al. 2023). This could exceed the continuous noise threshold for behavioral disturbances of 120 dB re 1 µPa (Table 3.7-3) out to approximately 126 meters (143 feet), but these events are expected to be short term, which limits the number of marine mammals potentially present during construction and contextually, drilling is similar to vessel noise, which, as described above, does not tend to elicit more than minor reactions.

Research suggests that the sensitivity of marine mammals to drilling noise varies between and within species and is likely context-dependent (Richardson et al. 1990). For example, ringed seals (*Pusa hispida*) and harbor porpoises may be relatively tolerant to drilling activities (Moulton et al. 2003; Todd et al. 2009). Todd et al. (2020) measured drilling noise from jack-up platforms and concluded that harbor porpoises can only detect drilling noise out to a distance of approximately 70 meters (230 feet) from the source at the study site and concluded that the noise is unlikely to interfere with or mask echolocation clicks. In terms of behavioral disturbance, drilling activities may exceed the continuous noise threshold of 120 dB re 1 µPa out to approximately 126 meters (143 feet) from the source, and given the low-frequency nature of drilling sounds, baleen whales may be more vulnerable to disturbance. The majority of studies on baleen whale behavioral responses to drilling noise have been conducted on arctic species in the context of oil and gas extraction, and these studies currently serve as the best available proxies. Bowhead whales have been reported to avoid a radius of approximately 6 miles around an operating drillship, with some individuals avoiding the site up to 19 kilometers (12 miles) away (Richardson et al. 1995). Richardson et al. (1990) performed playback experiments of drilling and dredging noises and observed bowhead whale responses. Behavioral reactions were observed for most of the animals, such as orienting away from the sound, cessation of feeding, and altered surfacing, respiration, and diving cycles (Richardson et al. 1990). Roughly half of the bowhead whales responded to the drilling noise playback at a received level of 115 dB re 1 µPa (20- to 1,000-Hz band) (Richardson et al. 1990). Blackwell et al. (2017) reported that bowhead whale calling rates correlated with increasing levels of drilling noise, where calling rates initially increased, peaked, and then decreased. Therefore, while drilling may cause behavioral responses, these responses are not expected to be long lasting or biologically significant to marine mammal populations. While behavioral responses may occur from drilling noise, responses are expected to be short term and of low intensity. Impacts from potential drilling activities on all marine mammals would therefore be minor.

Geological and Geophysical Surveys

G&G surveys in the geographic analysis area would produce similar impacts as described for the ongoing activities above in Section 3.7.3.1, except surveys would be associated with all planned offshore wind projects described in Appendix E. Reasonably foreseeable development under the planned activities scenario includes 28 active wind energy lease areas (Appendix E), only seven of which are also included in the ongoing activities scenario and previously discussed in Section 3.7.3.1. Therefore, G&G surveys associated with future offshore wind projects would comprise surveys prior to and during construction and during operations for 21 wind energy lease areas. However, as discussed previously, impacts from G&G surveys would be limited to short-term behavioral disturbances within a localized area around the G&G survey equipment with no population-level impacts expected for any species. Impacts would therefore be minor for all marine mammals.

Vessel Noise

Vessel activity associated with both offshore wind and non-offshore wind would continue to affect marine mammals in the geographic analysis area as described for the ongoing activities above. New vessel traffic expected under the planned activities scenario would predominantly be associated with the planned offshore wind projects; although increases in commercial traffic cannot be ruled out. During construction and operational phases of offshore wind development, several types of vessels will be used to transport crew and supplies, and to install infrastructure. DP systems may be used for several purposes like keeping the pile-driving vessel in place during construction, placing noise mitigation equipment, or in providing platforms for workers to move between vessels. A description of the physical qualities of vessel noise and DP systems can be found in Appendix B and a summary of the general effects of vessel noise on marine mammals can be found above in the description of ongoing activities. Note that the specific effects of DP noise on marine mammals have not been studied, but are expected to be similar to that of transiting vessels.

During construction, vessel noise associated with other offshore wind projects is expected to be nearly continuous and have extensive geographical extent, whereas during the operational phase, vessel noise is expected to be infrequent (occurring mostly for maintenance work) and should be localized in extent due to the use of smaller vessels for maintenance work. The required vessel slow-downs to reduce strike risk are expected to reduce the amount of noise emitted into the environment (Joy et al. 2019). In addition, helicopters may be used to transport crew from land to the construction site, which would further reduce noise transmitted into the water. Increased vessel noise from planned offshore wind projects is expected to have minor impacts for NARWs and all other marine mammals.

Unexploded Ordnance Detonations

As discussed in Section 3.7.3.1, UXOs on the seafloor may be encountered in offshore wind lease areas or along export cable routes. If found, UXO may be left alone, moved, or removed by controlled explosive detonation or low-order deflagration. Further information on UXO detonations can be found in Appendix B. While developers may only use detonation as a last resort, of the offshore wind project COPs submitted to date, the Revolution Wind Project (OCS-A 0486), Sunrise Wind Project (OCS-A 0487), and South Coast Wind Project (OCS-A-0521) off the coast of Massachusetts and Rhode Island have proposed up to 13 UXO, 3 UXO, and 10 UXO detonations, respectively. Empire Wind (OCS-A-0512) off the coast of New York, Atlantic Shores South Offshore Wind Project (OCS-A 0499), off the coast of New Jersey, and the Coastal Virginia Offshore Wind-Commercial Project (OCS-A 0483), off the coast of Virginia, and US Maryland Wind (OCS-A-0490) off the coast of Maryland are not proposing UXO detonation. As discussed in Section 3.7.3.1, UXO detonations proposed by Revolution Wind are considered part of the ongoing offshore wind project activities and discussed in that section.

The number, charge mass, and location of UXOs that may need controlled detonation for planned offshore wind projects are relatively unknown until a site assessment is performed. Additionally, not all planned offshore wind projects will require controlled detonations as avoidance, or non-explosive methods of disposing with UXOs will be effective. Therefore, it is difficult to predict the potential likelihood and frequency of impacts of UXO detonation from other projects in the geographic analysis area. However, while the likelihood of encountering this stressor is unknown, the impacts are well documented. As detailed in Section 3.7.3.1, At close ranges, UXO detonations can be injurious or lethal. Measures for handling UXOs are likely to be required to decrease the chance that a marine mammal will be severely injured or killed from an explosion. For example, seasonal and time-of-day restrictions can be put in place to avoid times when marine mammals may be present, noise mitigation devices (e.g., double bubble curtain) can be applied to reduce noise beyond a certain radius of the detonation, and visual and PAM of clearance zones can be used to reduce the number of marine mammals present within the predicted distance from a UXO that could cause injury or death. In addition, lower order detonation methods, such as deflagration, are in development and could substantially decrease the energy released into the environment, therefore decreasing the effect ranges (Robinson et al. 2020). With measures in place, the intensity of this IPF is expected to be reduced. The likelihood of UXO detonation associated with planned offshore wind projects is unknown; but is expected to be low given the preferred, non-detonation options available.

The risk of PTS is low due to the required permitting and monitoring and mitigation for all potential UXO clearance activities. PTS is not expected to result for NARW. Because other marine mammals could receive PTS exposures during high order detonations, but no mortalities or non-auditory injury are expected to occur, no population-level impacts are expected and impacts on mysticetes (including the NARW), odontocetes, and pinnipeds from UXO detonations would be moderate.

Site Preparation

Site preparation activities may include mechanical and/or hydraulic dredging to prepare an area for foundation installation, as well as boulder and/or sand wave clearance. Underwater noise generated by site preparation activities depends on the specific type of equipment used; however, it would likely be comparable to dredges and barges used for traditional waterways deepening and widening.

Todd et al. (2015) provide an extensive review of the impacts of dredging on marine mammals. Given the low source levels and transitory nature of dredging sources, exceedance of PTS thresholds is not likely, but TTS and behavioral thresholds could be exceeded at very close distances (Todd et al. 2015). For example, using measurements of the highest source level from multiple dredging vessel operations, Heinis et al. (2013) modeled harbor porpoise and seal exposure to a dredging operation. They found that TTS levels were not exceeded for harbor porpoise at any distance and only exceeded for seals at distances within 295 feet of the dredging vessel. Empirical studies suggest that some HFCs may avoid dredging activities. For example, Diederichs et al. (2010) found short-term avoidance of dredging activities by harbor porpoises near breeding and calving areas in the North Sea. Pirotta et al. (2013) found that, despite a documented tolerance of high vessel density and as high availability of food, common bottlenose dolphins spent less time in the area during periods of dredging. The study also showed that with increasing intensity in the activity, common bottlenose dolphins avoided the area for longer durations (with one instance being as long as 5 weeks) (Pirotta et al. 2013). Some studies, primarily on seals and sea lions, found no observable response (Blackwell et al. 2004; ecologia Environment 2008; Gilmartin 2003), while several other studies showed temporary to long-term avoidance behavior for bowhead, gray, humpback, and minke whales (Anderwald et al. 2013; Borggaard et al. 1999; Richardson et al. 1990; Todd et al. 2015; Tyack 2008). For example, gray and humpback whales seem to avoid certain areas—even key breeding habitats—when dredging occurred (Borggaard et al. 1999; Tyack 2008). These studies suggest that dredging does not produce sounds sufficient to cause PTS, but at close ranges, the sounds have the potential to cause behavioral disturbance to, or temporary hearing impairment in, marine mammals.

While behavioral responses may occur from site preparation activities, they are expected to be short term and of low intensity due to ongoing and planned offshore wind projects. Masking and behavioral reactions from dredging may be more likely for mysticetes and pinnipeds due to the low-frequency spectrum over which the sounds occur and the overlap with their best hearing sensitivity, but the extent over which this would occur would be temporary and localized. Therefore, impacts from site preparation activities would be minor for all marine mammals.

Trenching and Cable Laying

Preparing a lease area for turbine installation and cable laying may require jetting, plowing, or removing soft sediments, as well as excavating rock and other material through various dredging methods. Cable installation vessels are likely to use DP systems while laying the cables. The sound associated with DP generally dominates over other sound sources present, especially in the situation of cable laying. Given the low source levels and transitory nature of these sources, exceedance of PTS levels is not likely for harbor porpoise and seals, according to measurements and subsequent modeling by Heinis et al. (2013). Of the few studies that have examined behavioral responses from cable-laying and trenching noise, most have involved other industrial activities, making it difficult to attribute responses specifically to dredging noise. Some found no observable response (Hoffman 2012), while others showed avoidance behavior (Richardson et al. 1990; Pirotta et al. 2013). Impacts on all marine mammals are expected to be of the lowest level of intensity due to the low sound levels and localized nature of the sound source. Impacts such as brief behavioral effects or acoustic masking over small spatial scales may occur for LFC species due to the low-frequency nature of these sound sources and the number of ongoing and planned offshore wind projects in the geographic analysis area, but these would be of low intensity, short term, and localized to the immediate area around the cable installation activity. Based on existing conditions, the potential impacts from cable-laying noise are expected to be minor for all marine mammal species.

Aircraft

Other planned offshore wind activities may employ helicopters and fixed-wing aircraft for transporting construction and maintenance crew, or monitoring during construction activities, which emit sound that could affect marine mammals. In general, marine mammal behavioral responses to aircraft have most commonly been observed at altitudes of less than 492 feet from the aircraft (Patenaude et al. 2002;

Smultea et al. 2008). Aircraft operations have resulted in temporary behavioral responses, including short surface durations in bowhead and beluga whales (Patenaude et al. 2002) and transient sperm whales (Richter et al. 2006), abrupt dives in sperm whales (Smultea et al. 2008), and percussive behaviors like breaching and tail slapping (Patenaude et al. 2002). Responses appear to be heavily dependent on the behavioral state of the animal, with the strongest reactions seen in resting individuals (Würsig et al. 1998). BOEM requires all aircraft operations to comply with current approach regulations for NARWs or unidentified large whales (50 CFR § 222.32). These include the prohibition of aircraft from approaching within 1,500 feet, which would minimize the potential responses of marine mammals to aircraft noise. In addition, based on the physics of sound propagation across different media (e.g., air and water), an animal must be directly below an aircraft (within a 13° cone) to hear the sound from the aircraft. With the implementation of BMPs, no biologically notable adverse impacts are expected for marine mammals from aircraft operations related to ongoing and planned offshore wind projects and impacts would therefore be negligible for all marine mammal species.

Operational Wind Turbine Generators

The operation of turbines during ongoing and planned offshore windfarms may result in long-term, low level, continuous sound in the offshore environment. Reported sound levels of operational WTGs is generally low (Madsen et al. 2006; Tougaard et al. 2020; Stöber and Thomsen 2021), with a source SPL of approximately 151 dB re 1 µPa m and a frequency range of 60 to 300 Hz (Wahlberg and Westerberg 2005; Tougaard et al. 2020). At the Block Island Wind Farm, low-frequency noise generated by turbines reaches ambient levels at 164 feet (Miller and Potty 2017). Measurements from the Coastal Virginia Offshore Wind-Pilot Project indicated that SPL will range from approximately 110 to 125 dB re 1 µPa based on measured data normalized to a distance of 100 meters from the source and a wind speed of 10 m/s (HDR 2023). Tougaard et al. (2020) summarized available monitoring data on wind farm operational noise, including older generation, geared turbine designs and quieter, modern, direct-drive systems like those proposed for the proposed Project. They determined that operating WTGs produce underwater noise on the order of 110 to 125 dB re 1 µPa SPL at a reference distance of 164 feet, occasionally reaching as high as 128 dB re 1 µPa SPL, in the 10 Hz to 8 kHz range.

SPL measurements from operational WTGs in Europe indicate a range of 109 to 127 dB re 1 µPa at 46 and 66 feet from the WTGs (Tougaard et al. 2009). Thomsen et al. (2016) indicated SPL ranging from 122 to 137 dB re 1 µPa at 492 and 131 feet, respectively, with peak frequencies at 50 Hz and secondary peaks at 150, 400, 500, and 1,200 Hz from a jacket foundation turbine and from 133 to 135 dB re 1 µPa at 492 and 131 feet, respectively, with peak frequencies at 50 and 140 Hz from a steel monopile foundation turbine. Measurements within 131 feet of the monopile were similar to those observed at the jacket foundation WTG, though at the greater distance of 492 feet, the jacketed turbine was quieter. However, the measurements and reported noise levels available from these studies are all for WTG that are 6.15 MWs or smaller, which are less than half the size of the 18-MW WTG included under Alternative B.

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

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

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

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

In addition to the size of the WTG, when evaluating WTG noise, it is crucial to factor in the presence of vessels relating to the operation of WTG (Betke and Bellmann 2023). Results of the analyses from Tougaard et al. (2020) showed sound levels produced by individual WTGs were low and comparable to or lower than sound levels within 0.6 mile of commercial ships. Holme et al. (2023) conducted measurements of broadband underwater noise levels from windfarms consisting of 6.3- to 8.3-MW WTG using hydrophones positioned 230 feet to 3.1 miles away from the WTG. The results showed no relationship between the recorded underwater sound levels and the turbine activity, which was assessed using the WTG blades revolutions per minute (Holmes et al. 2023). Variation was still observed in the ambient recorded sound levels when the WTGs were at a standstill (i.e., not moving), indicating that other processes, either natural or anthropogenic, are the main drivers for underwater noise levels (Holmes et al. 2023).

Overall, due to their low sound levels, behavioral and masking effects associated with turbine operational noise are not expected to have significant impacts on individual survival, population viability, distribution, or behavior. Effects, while long term, would be low intensity and highly localized around a given turbine. In addition, the audibility of turbine operational noise may be further limited by the ambient noise conditions of the environment (Jansen and de Jong 2016, as an example). Therefore, turbine operational noise is expected to have a negligible to minor impact on marine mammals. Minor impacts, such as masking in low ambient noise conditions, may be more likely for LFC, due to the low-frequency nature of operational noise and this group's hearing sensitivity (note: PPW also have low-frequency hearing but their threshold of underwater hearing is higher), while impacts on MFC, HFC, and PPW are expected to be negligible as there is less overlap between these groups hearing sensitivity and WTG operational noise, and the threshold of underwater hearing is higher. As larger turbines and/or differing technologies (e.g., direct-dive) come online, more acoustic measurements are necessary to characterize the relationship between foundation size, type, and the sound levels associated with operation of a single or an array of WTGs, as this may affect the physical distance in which potential behavioral or masking impacts may be possible (Thomsen and Stöber 2022).

Decommissioning

The methods that may be used for decommissioning are not well understood at this time. It is possible that explosives may be used. However, given the general trend of reducing the use of underwater explosives that has been observed in the oil and gas industry, it is likely that offshore wind structures would instead be removed by cutting. While it is difficult to extrapolate directly, a recent study measured received sound levels during the mechanical cutting of well conductor casings on oil and gas platforms in California. The cutters operated at 60 to 72 revolutions per minute, and the cutting time varied widely between cuts (on the order of minutes to hours). At distances of 348 to 384 feet from the cutting, received SPLs were 120 to130 dB re 1 µPa, with most acoustic energy falling between 20 and 2,000 Hz (Fowler et al. 2022). This type of sound is considered to be non-impulsive and could be continuous while cuts are actually being made, with quieter periods between cuts. Additional noise from vessels and other machinery may also be introduced throughout the decommissioning process. The impacts from noise generated during decommissioning activities are likely be similar to those outlined for construction activities, except no impact pile driving or underwater explosions are anticipated. Therefore, impacts would be minor for all marine mammals.

Summary of Noise Impacts

Underwater noise impacts on marine mammals from planned and ongoing offshore wind activities are anticipated to occur. Noise generated from planned and ongoing offshore wind activities include impulsive (e.g., impact pile driving, UXO detonations, some HRG surveys) and non-impulsive sources (e.g., vibratory pile diving, some HRG surveys, vessels, aircraft, cable laying or trenching, site preparation activities, turbine operations). Of those activities, only impact pile driving and UXO detonations would pose a risk of PTS-level effects in marine mammals. Vibratory pile driving of WTG and ESP foundations is not expected to result in PTS due to the short duration of the activity and the necessary time exposure that would be required to meet or exceed acoustic thresholds. If vibratory pile driving is conducted continuously for long time periods and marine mammals fail to leave behavioral threshold zone, PTS may occur. UXO detonation may also cause mortality, slight lung injury, and gastrointestinal tract injury at close range; however, there is a low likelihood of detonations. Any potential detonations would be spatially and temporally separate events with no overlap in the produced sound fields; mitigation measures that would be implemented for these activities further reduce any risk of mortality or non-auditory injuries. All noise sources that are audible by a given species have the potential to cause behavioral responses ranging from very low to more severe. All projects are expected to include applicant-proposed measures (e.g., exclusion zones, PSOs) that would minimize underwater noise impacts on marine mammals. The impacts of implementing underwater noise impact minimization measures would likely be similar to those described for Alternative B in Section 3.7.5.

The anticipated impacts from UXO detonations would be moderate for marine mammals because PTS is possible for all species except NARW. Impacts on NARW would also be moderate, but would be limited to short-term, medium intensity impacts, such as behavioral responses or TTS because PTS is not likely to occur for this species with mitigation. Likewise, impacts from impact pile driving would be moderate for marine mammals because PTS thresholds could be exceeded for all species except NARW. PTS is not expected for NARW from impact pile-driving noise; however, the spatial extent of pile-driving noise below PTS thresholds would be extensive, so short-term, moderate impacts are expected for NARW.

All other noise impacts (excluding UXO detonations and impact pile driving) considered under Alternative A would be negligible to minor for marine mammals because PTS is not expected to result from other activities in Alternative A; however, behavioral disturbances would be expected to occur. Based on the above analysis and in consideration of all the discussed noise sources, the final noise impact determination would be moderate for all marine mammals.

Port utilization: Global shipping traffic increased fourfold between 1992 and 2012 (Tournadre 2014). Growth worldwide is expected to continue, including on the U.S. OCS. Increases in global shipping traffic and expected increases in port activity along the U.S. East Coast from Maine to Virginia would require port modifications to receive the increase in shipping traffic and increased ship size. Port expansion is also likely in order to accommodate the increased size of vessels and increased volume of vessel traffic associated with planned offshore wind activities. However, future offshore wind development is expected to be a minor component of total port expansion activities required to meet increased commercial, industrial, and recreational demand. At larger ports such as Charleston and Norfolk, offshore wind-related activities would make up a small portion of the total activities at the port; therefore, offshore wind activities are likely to have little impact on marine mammals through increased port utilization at these ports. However, for smaller ports within the geographic analysis area, such as Paulsboro and Hope Creek, port expansion may be necessary to accommodate the increased activity, resulting in more significant increases to vessel traffic, dredging, and shoreline construction. Additionally, future channel deepening that may be necessary to accommodate larger ships required to carry offshore WTG components and/or increased vessel traffic associated with offshore wind projects may result in increased potential high-intensity impacts including noise impacts, vessel strikes, and impacts on prey species, but exposure and risk would be localized to nearshore habitats.

Future offshore wind activity could lead to port expansion and increased port utilization in Massachusetts, Rhode Island, Connecticut, New York, and other states along the U.S. East Coast (Section G.2.7, Land Use and Coastal Infrastructure). At least three proposed offshore wind projects are considering port expansion, and other ports along the east coast may be upgraded. The State of New Jersey is planning to build an offshore wind port on the eastern shore of the Delaware River in Lower Alloways Creek. The Atlantic Shores South Offshore Wind project would construct an operations facility in Atlantic City, New Jersey on a shoreside parcel that was formerly used for vessel docking and other port activities. A new offshore wind port in Salem, Massachusetts is being proposed that could accommodate heavy-lift deployment and logistics services for U.S. east coast offshore wind operations.

Increased port utilization and expansion would result in increased vessel noise, increased suspended sediment concentrations, and benthic disturbance during port expansion activities. Impacts on marine mammal prey species due to benthic disturbance would be short term and localized. Additionally, the area affected by benthic disturbance would be small compared to available foraging habitat. Increases in port utilization due to other offshore wind energy projects would lead to increases in vessel traffic and associated risk of vessel strike (analyzed in the traffic IPF below) and vessel noise. This increase would be at its peak during construction activities and would decrease during operations but increase again during decommissioning. Effects of vessel noise on marine mammals associated with port utilization are expected to be limited to short-term responses. See the noise IPF discussion above for potential marine mammal responses to vessel noise. In addition, any related port expansion and construction activities related to the additional offshore wind projects would add to increased turbidity in the coastal waters. Impacts on water quality associated with increased suspended sediment would be temporary and localized, as previously described for the cable emplacement and maintenance IPF in this section.

Impacts from port utilization from ongoing and planned activities on mysticetes (including NARW), odontocetes, and pinnipeds would likely be minor, with effects that would be detectable and measurable but not lead to population-level impacts. However, any future port expansion and associated increase in vessel traffic would be subject to independent NEPA analysis and regulatory approvals requiring full consideration of potential effects on marine mammals regionwide.

Presence of structures: The presence of structures can lead to impacts, both beneficial and adverse, on marine mammals through localized changes resulting from hydrodynamic effects, prey aggregation and associated increase in foraging opportunities, entanglement and gear loss/damage, migration disturbances, and displacement. These impacts may arise from buoys, offshore wind structure foundations, scour/cable protections, and transmission cable infrastructure during any stage of a project. Alternative A would include up to 3,104 foundations, 31,173 acres of new scour protection, and hard protection atop cables (Table E-1). Projects may also install more buoys and met towers. Structures would be added intermittently beginning in 2023 and continuing through 2030 and beyond, and they would remain until decommissioning of each facility is complete (30 years).

Potential impacts from the presence of structures on marine mammals would be similar to those described in Section 3.7.3.1 for ongoing offshore wind and non-offshore wind activities, except the total number of structures expected for planned offshore wind projects would be substantially greater than those described for the ongoing offshore wind projects (i.e., 3,104 foundations versus 83 foundations). Although effects from individual structures are highly localized, the presence of an estimated 3,104 foundations could result in widespread, but localized impacts. Studies or modeling of regional effects of the presence of offshore wind structures have been completed almost exclusively for regions outside the Atlantic OCS, and these modeling results are quite variable. Recently, the National Academy of Sciences, Engineering, and Medicine reviewed and summarized the oceanographic and atmospheric effects from the presence of offshore wind energy structures (NAS 2023). The following summarizes Chapter 3, Hydrodynamic Effects of Offshore Wind Developments, from that report.

Oceanographic Effects

The physical presence of wind turbines acts as a barrier to hydrodynamic flow compared to baseline flow conditions (no turbines), as well as acting as a source of additional turbulent mixing of water around the foundations. Miles et al. (2021) summarizes existing laboratory and modeling studies that describe the influence of turbine-induced ocean wakes on downstream hydrodynamics. Laboratory studies (Miles et al. 2017) and numerical modeling (Carpenter et al. 2016; Cazenave et al. 2016; Schultze et al. 2020b) focused on monopile structures similar to the structures planned for wind farm deployment in the Nantucket Shoals region. These studies concluded that the magnitude and extent of the turbine's impact varies depending on the magnitude of the existing ocean currents at a particular location, including subtidal and tidal flows around the structure, the strength of stratification, and the turbine structure geometry and farm layout. Miles et al. (2017) showed that at the individual turbine scale, the peak turbine-induced turbulence occurs within one monopile diameter of the structure, with weaker downstream effects extending up to 8 to 10 monopile diameters from the foundation. This scale of direct influence is confirmed with high-resolution numerical modeling, with modeled turbulence impacts extending up to 100 meters downstream of an individual turbine (Schultze et al. 2020b). The types of environmental variables impacted up to 100-meter distance includes temperature and suspended sediment (Vanhellemont and Ruddick 2014; Schultze et al. 2020b).

Using an idealized one-dimensional mixing parameterization model, Carpenter et al. (2016) estimated that the impact of offshore wind turbines on the duration of typical North Sea seasonal stratification was uncertain. Variations in the turbine structure geometries and layouts alone could produce an expected difference in turbulence produced by a factor of 4.6. Combining this uncertainty with the different possible environmental scenarios of the stratification and turbine-enhanced mixing rates, thermal stratification during a typical summer could possibly be eroded (waters becomes mixed) by a wind farm as rapidly as 37 days and as long as 688 days. The modeled range of durations in which this could occur is shorter and significantly longer than the typical length of seasonal stratification in this [North Sea] region of ~80 days; thus, any modeled duration longer than 80 days would have no impact on the duration of thermal stratification. The modeled variability in turbulence-induced mixing by foundations is dependent on the magnitude of the water velocity moving past the turbine, the strength of stratification and its evolution under turbine-enhanced mixing, and turbine structures differences, and wind farm layouts.

Whether or not models predict a cumulative impact from multiple turbine foundation on hydrodynamics is dependent on the relative size of developed areas and number of foundations. Using an unstructured grid model, Cazenave et al. (2016) expanded results for an idealized single turbine to an entire farm of turbines and found a localized weakening of stratification of about 5 to 15 percent of simulated seasonal stratification, consistent with previous results. Carpenter et al. (2016) extended these results to a larger geographic region and included natural ocean current estimates that restore seasonal stratification in the absence of turbines. This analysis showed that physical oceanographic forces can counteract the effect of wind farm–induced mixing when wind farm area coverage is small relative to size of the surrounding continental shelf region. These results for the North Sea are not directly applicable to the Nantucket Shoals region. Ocean conditions within the Nantucket Shoals region vary from those conditions observed and modeled in the North Sea. The impact of turbine-induced ocean wakes on stratification must be evaluated within the context of the shelf-wide physical forces specific to the Nantucket Shoals region that affect seasonal stratification. An important additional difference between results for the North Sea and the Nantucket Shoals region is the wider spacing of the turbine structures in the Nantucket Shoals region. This is expected to result in a lower concentration of hydrodynamic impacts, other factors being equal (e.g., foundation structure geometry).

Atmospheric Effects

In addition to changes in mixing due to the physical presence of the turbine foundations (monopiles or jackets), wind-driven ocean circulation can potentially be affected via reductions in wind speeds in the lee of a turbine. Since each turbine acts as a momentum sink and source of turbulence, energy extraction from the ambient wind field results in reduced wind speeds downstream of a turbine. The theoretical maximum efficiency of a turbine has been found to be ~59 percent (known as the Betz Limit; Betz 1966), and modern offshore wind turbines extract ~50 percent of the energy from the wind that passes through the rotor area (DOE 2015), subject to a cutoff wind speed above which wind energy extraction reaches a saturation limit. The maximum reduction in wind speeds is at hub height (in the range of 118 meters to 152 meters above the sea surface; Beiter et al. 2020), with a decay in the wind speed reductions above and below hub height. Xie and Archer (2015) modeled the horizontal and vertical structure of wind turbine wakes and found that while the largest reductions in wind speed are at hub height, the vertical extent of the region of wind speed reductions begins to extend down to the sea surface within a horizontal distance of 8 rotor diameters and may become more pronounced beyond this distance. At the scale of an offshore wind farm, wakes have been observed over several tens of kilometers downstream of the wind farm under stable atmospheric stratification conditions (Christiansen and Hasager 2005; Platis et al. 2018). Additionally, modeling studies of the atmosphere have generally reproduced these measured wake effects downstream of wind farms (Fischereit et al. 2021). In the North Sea, Duin (2019) examined wind stress reductions for a large offshore wind farm and reported that typical wind speeds at 10 meters above the sea surface are reduced by up to 1 m/s, and other effects were observed including increases and decreases in air temperature at various locations around the wind farm, decreases in relative humidity above the wind farm, and decreases in shortwave radiation near the windfarm.

Ocean circulation processes such as upwelling or downwelling are influenced by wind stress at the sea surface. In the Nantucket Shoals region, the wake behind a single standalone turbine is unlikely to affect wind-driven circulation. However, wind stress changes from a large offshore wind farm could occur over spatial scales large enough that wind-driven ocean circulation (e.g., upwelling/downwelling) can be influenced. Several studies have examined the effects of offshore turbines on wind-driven ocean circulation. Most of these studies have focused on the North Sea. Other studies focused on atmospheric circulation, larval transport studies and upwelling circulation have been executed for coastal areas on the U.S. east and west coasts. The effect of wind stress reductions on ocean circulation (upwelling/downwelling) were examined using an analytical framework that showed the presence of a wind stress curl-driven upwelling/downwelling dipole in the lee of offshore turbines (Broström 2008). The relation between coastal upwelling and wind farm size was examined by Paskyabi and Fer (2012), and Paskyabi (2015), who found that wakes increase the magnitude of pycnocline displacements (the boundary layer of water between warmer and colder stratified water), and in turn, upwelling/downwelling. A recent observational study conducted by Floeter et al. (2022) found the occasional presence of a curl-driven upwelling/downwelling dipole in the vicinity of a wind farm in the North Sea, similar to what was modeled for hypothetical wind farms in the California Current System by Raghukumar et al. (2023). A coupled physical–biological model implemented by Daewel et al. (2022) examined the effects of wind energy extraction by turbines in the southern North Sea and found changes in modeled primary production over a much larger area. While the appearance of an upwelling/downwelling dipole is justified by a clear, mechanistic understanding of the underlying physics, the appearance of changes (Daewel et al. 2022; Raghukumar et al. 2023) in other tracer fields, far from the wind farm areas requires further study, particularly from the point of view of understanding whether these changes are driven by numerical noise in instantaneous wind forcing or if there are indeed mechanistic processes that drive changes far from the wind farms.

Based on available information the potential impacts of planned offshore wind projects would be similar to those described for ongoing activities in Section 3.7.3.1. Impacts other than potential prey impacts from hydrodynamic changes from the presence of structures from ongoing and planned activities would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds; although impacts on individuals would be detectable and measurable, they would not lead to population-level effects for most species. Impacts on odontocetes and pinnipeds may result in slight beneficial effects due to increases in aggregations of prey species. These beneficial effects have the potential to be offset by risk of entanglement in fishing gear for some marine mammal species. However, because of the uncertainty of the relative contribution of beneficial and adverse impacts on odontocetes and pinnipeds, the overall impact level determination is minor adverse. Given the uncertainty as described above, the hydrodynamic effects of offshore wind in some areas on prey, including key foraging grounds for NARWs such as the area in and around Nantucket Shoals, the impact on foraging in these is unknown but unlikely able to be distinguished from natural variability and the significant impacts of climate change. BOEM is committed to further studying the impacts of offshore wind operations on NARW prey (BOEM 2024).

Traffic (vessel strike): Vessel traffic associated with future offshore wind development poses a high frequency, high exposure collision risk to marine mammals, especially NARWs, other baleen whales, and calves that spend considerably more time at/near the ocean surface. Vessel strike is relatively common with cetaceans (Kraus et al. 2005). Large whales are more susceptible to vessel strikes than other marine mammals due to their large size, slower travel and maneuvering speeds, lower avoidance capability, and surface behaviors (Laist et al. 2001; Vanderlaan and Taggart 2007). NARWs are particularly vulnerable to vessel strikes due to their slow swim speeds and the relatively high amount of time they spend at or near the surface; vessel strikes are a primary cause of death for this species (Kite-Powell et al. 2007; Hayes et al. 2023). As noted in Section 3.7.1, the NARW has been experiencing an UME since 2017 attributed to anthropogenic causes, including vessel strike (NMFS 2024c). An annual average of 2.4 NARW vessel strikes per year have been recorded for the period of 2016 through 2020, though this is likely an underestimate of total vessel strikes per annum (Hayes et al. 2023). Vessel strikes have also been preliminarily determined as a leading cause of death for humpback whales during the current UME (NMFS 2024d).

Marine mammals are more vulnerable to vessel strike when they are within the draft of the vessel and beneath the surface and not detectable by visual observers. Some conditions that make marine mammals less detectable include weather conditions with poor visibility (e.g., fog, rain, and wave height) or nighttime operations. Vessels operating at speeds exceeding 10 knots have been associated with the highest risk for lethal vessel strikes of NARWs (Pace and Silber 2005; Vanderlaan and Taggart 2007). The increase in vessel traffic associated with future offshore wind development has the potential to increase the risk of marine mammal/vessel interactions, which have been known to cause serious injury and mortality in other large whale species, including fin, blue, and humpback whales (Berman-Kowalewski et al. 2010; Douglas et al. 2008; Rockwood et al. 2021).

It is assumed that construction of each individual offshore wind project would generate approximately 20 to 65 simultaneous construction vessels operating in the geographic analysis area for marine mammals at any given time between 2023 and 2030. Once projects are operational, they would be serviced by crew transfer vessels making routine trips between the wind farms and port-based operations facilities several times per week. 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. The number and size of crew transfer vessels and number of trips per week required for unplanned maintenance would vary by project based on the number of WTGs. Vessel requirements for unplanned maintenance would also likely vary based on overall project size. Additionally, vessels required to complete monitoring programs at various stages of project development will add to the number of vessel trips undertaken by other projects.

Offshore wind development would result in a small incremental increase in vessel traffic volume relative to ongoing and future non-offshore activities, and minimal overall impacts would be expected as result. Vessel collision risk is expected to be highest during construction, when traffic volumes would be greatest; risk of collisions is expected to be highest when vessels are transiting to and from offshore wind lease areas. Within offshore wind lease areas, vessels are expected to be largely stationary and to travel at slow speeds when transiting between locations within the offshore wind lease area. At the peak of proposed construction, up to 896 vessels associated with offshore wind development along the U.S. East Coast may be operating in the geographic analysis area. The increase in traffic associated with planned offshore wind activities would only be a small, incremental increase in overall traffic in the geographic analysis area based on the large volume of existing vessel traffic on the Atlantic OCS. Therefore, the incremental traffic impacts contributed by offshore wind activities would not increase the overall level of traffic impacts beyond those described for ongoing and planned non-offshore wind activities. At this time, there is currently a high degree of uncertainty regarding the number of vessels, ports to be used, and primary transit routes that future offshore wind developments would use. Additional information regarding the expected increase in vessel traffic is provided in Section 3.13.

The increase in vessel traffic associated with future offshore wind development has the potential to increase the risk of marine mammal/vessel interactions. Therefore, marine mammal vessel strikes are possible. However, BOEM expects minimization measures for vessel impacts would be required for planned offshore wind activities, further reducing the risk of injury or mortality for marine mammals. If those measures are successful in avoiding vessel strikes, there would be no impact on marine mammal species from this IPF. If a vessel strike from ongoing and planned offshore wind activities (without the Proposed Action) did occur, the outcome could range from no apparent injury to mortality. As discussed previously, the relative risk of vessel strikes from offshore wind industry vessels is dependent on the stage of development, time of year, number of vessels, and speed of vessels during each stage.

With the exception of NARWs, the impact of vessel strikes on mysticetes from the No Action Alternative would be moderate because vessel strikes are likely to result in long-term consequences (i.e., injuries or mortalities) that are detectable, measurable, and could have population-level effects, particularly for those listed under the ESA; however, affected populations should sufficiently recover.

The impact of vessel strikes on NARW from the No Action Alternative vessel activities would be major because vessel strikes have had and would continue to have population-level effects that compromise the viability of the species.

The impact of vessel strikes from the No Action Alternative activities on odontocetes and pinnipeds would be moderate because, while population-level effects are unlikely, consequences to individuals would be detectable and measurable and potentially long term if the strike results in an injury or mortality.

Therefore, impacts from vessel strike would be moderate for all marine mammals except for NARWs; impacts from vessel strike would major for NARWs. Measures to minimize vessel impacts from ongoing and planned offshore wind energy construction and operations are required, which reduces the risk of injury or mortality for marine mammals from those activities such that offshore wind energy projects do not increase the impact level from other offshore activities discussed analyzed under the No Action Alternative scenario.

Climate change: Climate change would continue to affect marine mammals under the planned activities scenario in the same way as described above for the ongoing activities. However, planned offshore wind is expected to combat the effects from climate change over the long term by providing clean energy and reducing reliance on and use of fossil fuels. Minor beneficial impacts on mysticetes, odontocetes, and pinnipeds are anticipated because planned offshore wind activities may reduce the ongoing and predicted rate of climate change. Therefore, impacts on marine mammals from climate change may be reduced.

Conclusions

Incremental Impacts of Alternative A. Under Alternative A, not approving the COP would have no additional incremental effect on marine mammals. Therefore, NMFS's No Action Alternative (i.e., not issuing the requested Incidental Take Authorization [ITA]) would also have no additional incremental impact on marine mammals and their habitat.

Marine mammals would continue to be affected by existing environmental trends and ongoing activities. Ongoing activities are expected to have continued impacts on marine mammals, primarily through pile-driving and construction noise, vessel noise, presence of structures, vessel traffic, commercial and recreational fisheries gear interactions, and climate change. Under the No Action Alternative, ongoing stressors and activities contributing to existing conditions would result in a range of temporary to long-term impacts (disturbance, displacement, injury, mortality, and reduced foraging success) on marine mammals. BOEM anticipates that the impacts of Alternative A would be **major** for NARW due to ongoing high rates of entanglement and vessel strikes from non-offshore wind activities that are currently resulting in severe population-level impacts. As noted previously in Section 3.7.3.1, BOEM is requiring offshore wind project developers to implement several vessel strike avoidance measures to reduce risk to a level that should functionally avoid vessel strikes. For all other mysticetes, odontocetes, and pinnipeds, the impacts of ongoing, non-offshore wind and offshore wind activities would be **moderate** due to vessel strike, entanglement, and PTS resulting from exposure to anthropogenic noise (e.g., pile driving, military munitions training), which are of high intensity and long term but not expected to result in population consequences for these species, except for NARW. 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 mitigation measures implemented during construction, operation, and maintenance. Therefore, the

No Action Alternative would result in **major** impacts on NARW, **moderate** impacts on mysticetes (with the exception of NARW), odontocetes, and pinnipeds and could include **minor** beneficial impacts for some species (e.g., pinnipeds and delphinids) that benefit from increased prey availability, which may be offset by the potential risks associated with entanglement from fishing gear.

Cumulative Impacts of Alternative A. Under Alternative A, existing environmental trends and ongoing activities would continue, and marine mammals 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 impacts associated with planned and ongoing non-offshore wind and offshore wind activities in the geographic analysis area would result in impacts from individual IPFs that would be **moderate** on mysticetes (except NARW), odontocetes, and pinnipeds due to pile driving and UXO detonation noise, vessel traffic, and commercial and recreational fisheries gear interactions; and **major** on NARW due to vessel traffic from non-offshore wind activities, and commercial and recreational fisheries gear interactions. Moderate impacts are expected for mysticete (except NARW), odontocete, and pinniped species, as detectable and measurable impacts would occur that would be of medium intensity and would occur over a longer period of time and broader geographic region; impacts would not be expected to have any long-term effects on the populations.

For NARW, given the declining population status and impacts from ongoing and planned non-offshore wind vessel traffic and commercial and recreational fisheries gear interactions, impacts on NARWs resulting from all IPFs combined are expected to be major because serious injury or loss of an individual would result in population-level impacts that threaten the viability of the species if a vessel strike or entanglement were to occur. While vessel activity would increase due to the planned offshore wind projects compared to the ongoing activities under Alternative A, the planning, monitoring, mitigation, and enforcement of vessel activity, including speed restrictions, would minimize the effects from increased vessel numbers or transits compared to non-offshore wind activities. Additional vessel speed rules may be implemented that could result in a lowered risk from ongoing activities under Alternative A (87 Fed. Reg. 46921); however, until those are in place and efficacy of enforcement is established, this assessment has assumed current conditions in the impact analysis. Additionally, the presence of structures could result in **minor** beneficial impacts on some marine mammal species (e.g., pinnipeds and delphinids), which may be offset by the potential risks associated with entanglement from fishing gear.

3.7.3.3 Relevant Design Parameters and Potential Variances in Impacts

The following Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of impacts on marine mammals:

- The WTG foundation type used. The potential acoustic impacts on marine mammals are different for each foundation type that uses driven piles. For example, although monopile foundations have a higher sound-source level than jacket-type piles due to higher hammer power required, more jacket-type piles would be installed per day (up to four 13-foot pin piles per jacket), increasing the risk of PTS to marine mammals (COP Appendix III-M; Epsilon 2023). Consequently, cumulative SELs are higher for marine mammals with jacket foundations than monopiles (COP Appendix III-M; Epsilon 2023).

- Sound produced by pile driving. To assess daily underwater sound produced by pile driving, sound from each pile type would be analyzed independently due to differences in source levels produced by the hammer power needed to drive each pile type, daily pile-driving duration for each foundation type, and the frequency spectrum produced by each pile diameter. Depending on the species' hearing differences and pile differences, the relative impacts on each hearing group vary considerably, warranting a separate analysis for each pile type.
- Total days of pile driving. At the installation rate of one monopile or jacket foundation per day, the applicant would need a total of 62 days of pile driving. At two monopiles foundation installed per day, only 31 days of pile driving would be needed. In terms of total days of pile driving, the maximum-case scenario would be 62 days of work (COP Appendix III-M; Epsilon 2023).
- Vessels and ports. Alternative B would use a number of ports during Project activities. Section 2.1.2 provides more details.
- Mitigation and monitoring measures. In instances where the implementation of a mitigation or monitoring measure could have a measurable reduction in the level of the stressor of a potential impact, that measure would be considered in the level of impact in the analysis.

Aspects of the proposed Project design include the OECC, the WTG design selected (e.g., 13 MW, 16 MW), the exact placement and number of WTGs and ESPs, the final inter-array cable layout, and the construction schedule, which would be determined based on-site assessment data, engineering requirements, and other factors. Although some variation is expected in the design parameters, the impact assessment analyzes the maximum-case scenario.

3.7.3.4 Impacts of Alternative B – Proposed Action on Marine Mammals

The following discussions summarize the potential incremental impacts of Alternative B on marine mammals when compared to Alternative A during the various phases of the proposed Project, as described in Chapter 2, Alternatives. The analysis considered an incremental impact as one occurring as a result of Alternative B alone, without addition of existing conditions or other ongoing offshore wind and non-offshore wind activities. Routine activities would include construction, operations, and decommissioning of Alternative B, as described in Chapter 2. Additionally, impacts of Alternative B were similarly addressed for ESA-listed marine mammal species in the BA prepared for NMFS, which found that Alternative B may adversely affect marine mammals (BOEM 2023b).

Impacts of Phase 1

Phase 1 would affect marine mammals through the following primary IPFs during construction, operations, and decommissioning.

Accidental releases: The incremental impacts of Phase 1 construction, operations, and decommissioning from accidental releases of hazardous materials and trash/debris would not increase the risk beyond that described under Alternative A due to requirement of 30 CFR § 285.105. Further, Phase 1 would comply with the USCG requirements (International Convention for the Prevention of Pollution from Ships, Annex V; Public Law No. 100−220 (§ 101 Stat. 1458]) for the prevention and control of oil and fuel spills and would implement proposed BMPs for waste management and mitigation, as well as marine debris awareness training for Project personnel, reducing the likelihood of an accidental release (COP Appendix I-F; Epsilon 2023). In the unlikely event of an accidental oil spill, oil may impact marine mammals within 34 to 50 miles of the spill, based on modeling performed for the proposed Project (COP Appendix I-F; Epsilon 2023). The impacts would be sublethal due to quick dispersion, evaporation, and weathering, all of which would limit the amount and duration of exposure of marine mammals to hydrocarbons. The applicant would have an OSRP in place that would decrease potential impacts from spills. Informational training on proper storage and disposal practices to reduce the likelihood of accidental discharges would further reduce the likelihood of an accidental spill from occurring. Therefore, due to the unlikelihood of accidental releases, the sublethal level of impact, the implementation of an OSRP, and Project personnel training, potential temporary impacts on mysticetes (including the NARW), odontocetes, and pinnipeds from accidental releases of oil or fuel, fluids, trash or debris, and other hazardous materials during Phase 1 construction, operations, and decommissioning would be negligible, if at all, due to the rare, brief, and highly localized nature of accidental releases.

Anchoring and gear utilization: Construction under Alternative B would be conducted from vessels utilizing spuds, jack-up legs, anchors, DP, and securing to existing structures; therefore, limited anchoring would occur. The amount of seabed disturbance from jack-up, anchored vessels, cable installation, and metocean buoy anchors would be up to 421 acres as stated in the COP (Volume III, Section 6.5.2.1.1). As described for Alternative A in Section 3.7.3.1, anchors associated with vessels and met buoys would not pose a risk of entanglement or entrapment for any marine mammal species, and the relatively limited extent of seafloor disturbances due to anchoring from project equipment would not result in impacts beyond those described below for cable emplacement and maintenance. Monitoring survey methods for Alternative B may include otter trawl, ventless trap sampling, lobster tagging, Neuston net sampling, video and still imaging, and grab sampling. As described in Section 3.7.3.1, survey gear could affect marine mammals through entanglement or entrapment. Trawl nets pose a discountable threat to mysticetes, and the slow speed of mobile gear and the short tow times (less than 30 minutes) further reduce the potential for entanglements or other interactions. Fish traps and anchoring lines and buoys used to secure them may pose an entanglement risk to marine mammals, although these risks would be mitigated because trap surveys would be required to utilize mitigation measures to further reduce entanglement risk (e.g., ropeless gear, biodegradable components). Therefore, impacts on marine mammals from traps are expected to be negligible based on the limited number of associated buoy lines, the short duration of sampling events, and low probability for gear entanglement. Given the short-term, low-intensity, and localized nature of the impacts of gear utilization for Alternative B, as well as the proposed mitigation and minimization measures, impacts on mysticetes (including the NARW), odontocetes, and pinnipeds would be negligible.

Cable emplacement and maintenance: Construction of Alternative B would physically disturb the water column and seabed. However, the area affected at any given time would be minimal relative to the size of the area of direct impacts and insignificant compared to current levels of disturbance. Seabed disturbance during Project construction would result in temporary plumes of suspended sediments in the immediate construction area as a result of jet trenching or mechanical plowing. Some dredging of the upper portions of sand waves may be required within the OECC to allow for effective cable laying. The majority of dredging would occur on large sand waves, which are mobile features predominantly located along the OECC within Muskeget Channel (COP Volume II-A, Section 2.1.3; Epsilon 2023). Dredging may be accomplished by use of a TSHD or by jetting (also known as mass flow excavation).

Phase 1 would incrementally disturb up to 442 acres of seafloor by cable installation, which would include up to 52 acres affected by dredging prior to cable installation that would result in turbidity impacts with the potential for temporary impacts on some marine mammal prey species. Model results indicate moderate to relatively high turbidity plumes may be possible extending several miles from the OECC centerline, with concentrations persisting several hours as a result of dredging and dumping activities, though this may be less extensive at varying locations along the route (COP Appendix III-A; Epsilon 2023). Elevated turbidity levels would be short term and temporary, and several marine mammal species reside often in turbid waters (e.g., dolphin species that reside in coastal habitats), so significant impacts from turbidity are not likely (Todd et al. 2015). Sediment dispersal model results indicate that during inter-array cable-laying activities, most of the mass settles out quickly and is not transported for long by the currents. Modeling results predict the sediment plume is confined to the bottom few feet of the water column, which is only a fraction of the total water column in the SWDA (COP Appendix III-A;

Epsilon 2023). Therefore, there would be short-term and localized water quality impacts from inter-array cable installation and undetectable negligible impacts on mysticetes (including the NARW), odontocetes, and pinnipeds from turbidity. Suspended sediment concentrations during activities other than dredging would be within the range of natural variability for this location. Any dredging necessary prior to cable installation could also generate additional impacts. Marine mammals in the proposed Project area are not expected to face a risk of entrainment, impingement, or capture in dredging equipment associated with Alternative B due to their relatively large body size and through the implementation of standard vessel strike avoidance mitigation measures that require minimum separation distances. The physical presence of dredging vessels and equipment could potentially displace marine mammals. However, given the limited spatial extent predicted for dredging, any impact on marine mammals would be so small that it could not be meaningfully evaluated. Dredging and increased turbidity could affect marine mammal prey species. However, given the limited spatial extent of the area where dredging would occur, the short duration of dredging, and that individual marine mammals, if present, would be expected to successfully forage in nearby areas not affected by increased sedimentation, the potential impacts of dredging on mysticetes (including the NARW), odontocetes, and pinnipeds; including entrainment, displacement, and impacts on prey species; would be negligible.

Phase 1 operations would require routine preventative maintenance and equipment inspections. These activities could involve activities similar to those described for construction, but they would be limited to the cable segment being maintained or repaired. As a result, Phase 1 cable maintenance impacts on mysticetes (including the NARW), odontocetes, and pinnipeds would be negligible.

EMF: Both OECC and inter-array cable arrays are high-voltage AC, and the applicant would bury these cables at a depth of 5 to 8 feet with appropriate cable shielding and scour protection (where needed). Modeled and measured magnetic field levels from various existing submarine power cables indicate that AC cables buried to a depth of 3 feet or which are covered with cable shielding would emit field intensities less than 0.05 µT up to 82 feet above the cable and 79 feet along the seafloor (Section 3.7.3.1). These factors will effectively limit marine mammal exposure to both EMF and heat originating from Alternative B's high-voltage AC cables. These factors indicate that the likelihood of marine mammals encountering detectable EMF is low, and any exposure would be below levels associated with measurable biological impacts. Therefore, EMF and cable heat impacts on mysticetes (including the NARW), odontocetes, and pinnipeds would be negligible.

Lighting: Alternative B would introduce stationary artificial light sources in the form of navigation, safety, and work lighting. Orr et al. (2013) summarized available research on potential operational lighting effects from offshore wind energy facilities and developed design guidance for avoiding and minimizing lighting impacts on aquatic life, including marine mammals. BOEM concluded that the operational lighting effects on marine mammal distribution, behavior, and habitat use were negligible if recommended design and operating practices are implemented. Therefore, BOEM anticipates that operational lighting effects on mysticetes (including the NARW), odontocetes, and pinnipeds would be non-measurable and negligible, with no perceptible individual or population-level consequences.

Noise: A short-term increase in underwater noise could affect marine mammals, predominantly during installation of the WTG and ESP foundations. Other anticipated construction activities that would result in noise include cable laying, vessel noise, and aircraft noise. Noise produced during impact and vibratory piling for the installation of WTG and ESP foundations is expected to be the IPF with the greatest potential for impact on marine mammals.

Foundation Installation

The WTG and ESP foundations would be installed using a combination of vibratory pile setting and impact pile driving. Sixty-three of the total 132 foundations, which includes all pile types (i.e., 12-meter monopile, 13-meter monopile, and 4-meter pin pile for the jacket foundations), would be installed using impact pile driving; the remaining 70 foundations would be installed first using vibratory pile setting followed by impact pile driving. The applicant has determined it may be necessary to start pile installation using a vibratory hammer rather than using an impact hammer, a technique known as vibratory setting of piles. The vibratory method is particularly useful when seabed sediments are not sufficiently stiff to support the weight of the pile during the initial installation, increasing the risk of 'pile run' where a pile sinks rapidly through seabed sediments. Based on a seabed drivability analysis conducted by the applicant to estimate the number of foundation positions that could potentially require vibratory setting of piles. The analysis suggested that up to 50 percent of foundations (approximately 66 foundations) could require vibratory setting. An additional 6 percent conservatism is assumed (6 percent of 66 is approximately 4 additional foundations), resulting in approximately 70 total foundations (53 percent of all proposed foundations) that may require vibratory setting (JASCO 2023; COP Appendix III-M; Epsilon 2023).

Acoustic modeling of foundation installation activities was conducted and is presented in the proposed Project COP (Appendix III-M; Epsilon 2023). Additional details of the modeling can be found in Appendix B of this Final EIS, as well as the modeling report (Appendix III-M; Epsilon 2023). For the purposes of the acoustic modeling, multiple construction scenarios were assessed including two foundation types (jacket and monopile); three pile sizes (4-, 12-, and 13-meter diameter); and three levels of noise attenuation (0-, 10-, and 12-dB attenuation) (COP Appendix III-M; Epsilon 2023). Although multiple attenuation levels were evaluated, BOEM anticipates that the noise attenuation system chosen will be capable of reliably reducing source levels by 10 dB. Noise mitigation systems, such as those proposed by the applicant (COP Volume III, Section 6.7.4; Epsilon 2023) and described within the noise IPF in Section 3.7.3.1 and Appendix H, Mitigation and Monitoring, are used to create a local barrier around a sound source, which acts as an impedance to noise transmission (COP Appendix III-M; Epsilon 2023). Attenuation from a noise mitigation system was incorporated into the pile driving sound propagation modeling, whereby a broadband reduction of 10 or 12 dB was applied to the noise produced by the modeled pile strikes. As a result, this reduces the sound energy propagated through the water column and decreases the range over which above-threshold noise will travel (COP Appendix III-M; Epsilon 2023). However, BOEM determined 10 dB to be the appropriate level of attenuation for the proposed Project, and this level of attenuation was carried forward in the impact determinations discussed in this section.

For the purposes of this assessment, two pile sizes were assessed for Phase 1 (the 4-meter jacket and the 12-meter monopile foundations), and two pile sizes were assessed for Phase 2 (the 4-meter jacket and the 13-meter monopile foundations), which are described further under Phase 2. The results summarized here represent the maximum potential ranges modeled, meaning the results provided assume the highest hammer energy included in the acoustic modeling was used to assess the potential for impacts on marine mammals.

Additionally, to provide a realistic estimate of distances at which acoustic thresholds for marine mammals may be met, the COP (Appendix III-M; Epsilon 2023) modeled exposure-based ranges to PTS and behavioral thresholds (Table 3.7-6) that incorporate animal movement modeling. To determine exposure ranges, pile strikes are propagated to create an ensonified environment while simulated animals (i.e., animats) are moved about the ensonified area following expected species-specific behaviors. Modeled animats that have received sound energy that exceeds the acoustic threshold criteria are registered, and the closest point of approach recorded at any point in that animal's movement is then reported as its exposure range. This process is repeated multiple times for each animat. The exposure-based ranges comprise 95 percent of the closest points of approaches for animats that exceeded the threshold (i.e., 95th percentile exposure-based range [$ER_{95\%}$]). The potential for noise from vibratory pile setting to induce PTS is low relative to impact pile driving; however due to the relatively short (15-minute) period between vibratory and impact piling for each foundation, vibratory setting and impact pile driving must be considered together as part of the total received acoustic energy for the entire pile installation (JASCO 2023; COP Appendix III-M; Epsilon 2023).

There is a risk of noise impacts on marine mammals from both the vibratory pile setting and impact pile-driving activities for Phase 1 due to the large radial distance to PTS and behavioral harassment thresholds over the maximum total of 62 days that pile driving may occur. Up to 64 foundations (including up to 2 ESPs, with the remainder for WTGs) would be installed during Phase 1 of Alternative B. The Phase 1 PDE includes two WTG foundation types: monopiles and jacket foundations, both of which would be installed using a combination of vibratory pile setting followed by impact pile driving and impact pile driving only (as described previously in this section). Table 3.7-8 summarizes modeled exposure ranges for up to two 12- and 13-meter monopiles installed per day and up to four, 4-meter pin piles installed per day using impact pile driving only and 10-dB noise attenuation. Table 3.7-9 summarizes modeled exposure ranges for up to two 12- and 13-meter monopiles installed per day and up to four, 4-meter pin piles installed per day using vibratory pile driving followed by impact pile driving and 10-dB noise attenuation. The COP also modeled the number of animals estimated to be exposed to sound levels above PTS and behavioral disturbance thresholds during installation of all foundations, which includes a combination of foundations installed with vibratory setting of piles followed by impact pile driving and foundations installed with impact pile driving alone for all foundation types (JASCO 2023). The results of the exposure modeling are provided in Appendix B of this Final EIS.

Table 3.7-8: Summary of 95th Percentile Exposure-Based Ranges (Meters) to PTS and Behavioral Thresholds for Impact Pile Driving Only of Two Monopile or Four Pin Piles per Day and 10-Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, 6,000 kJ Hammer			13-Meter Monopile, 6,000 kJ Hammer			4-Meter Pin Pile, 3,500 kJ Hammer[a]		
	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)
LFC									
NARW (*Eubalaena glacialis*)	0	1,340	4,830	0	1,620	5,180	0	2,350	4,540
Fin whale (*Balaenoptera physalus*)	0	2,160	5,290	0	2,580	5,400	<10	3,730	4,660
Sei whale (*Balaenoptera borealis*)	0	1,270	5,170	0	1,310	5,340	<10	2,100	4,520
Minke whale (*Balaenoptera acutorostrata*)	0	1,120	4,870	0	1,190	5,050	<10	1,760	4,240
Humpback whale (*Megaptera novaeangliae)*	0	1,970	5,120	<10	1,990	5,400	<10	2,940	4,650
MFC									
Sperm whale (*Physeter macrocephalus*)	0	0	5,160	0	0	5,270	0	0	4,520
Atlantic white-sided dolphin (*Lagenorhynchus acutus)*	0	0	4,830	0	0	4,980	0	0	4,400
Atlantic spotted dolphin (*Stenella frontalis)*	0	0	4,510	0	0	4,840	0	0	4,470
Short-beaked common dolphin (*Delphinus delphis)*	0	0	4,880	0	0	5,100	0	0	4,480
Common bottlenose dolphin (*Tursiops truncates)*	0	0	4,180	0	0	4,650	0	0	4,020
Risso's dolphin (*Grampus griseus)*	0	0	4,740	0	0	5,050	0	0	4,310
Long-finned pilot whale (*Globicephala melas)*	0	0	4,720	0	0	4,760	0	0	4,110
Short-finned pilot whale (*Globicephala macrorhynchus)*	0	0	0	0	0	0	0	0	0
HFC									
Harbor porpoise (*Phocoena phocoena)*	120	0	4,440	230	0	4,750	230	0	4,200

Common Name (Scientific Name)	12-Meter Monopile, 6,000 kJ Hammer PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	13-Meter Monopile, 6,000 kJ Hammer PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	4-Meter Pin Pile, 3,500 kJ Hammer[a] PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)
PPW									
Gray seal (*Halichoerus grypus)*	0	0	5,530	0	0	5,770	0	790	4,970
Harbor seal (*Phoca vitulina)*	0	0	4,410	0	0	4,560	0	20	4,090
Harp seal (*Pagophilus groenlandicus)*	0	0	5,310	0	0	5,450	<10	110	4,650

Source: COP Appendix III-M; Epsilon 2023; JASCO 2023

μPa^2 s = micropascal squared second; dB = decibel; HFC = high-frequency cetacean; kJ = kilojoule; LFC = low-frequency cetacean; Lpk = peak sound pressure (dB re 1 µPa); MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PPW = phocid pinnipeds in water; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours (dB re 1 μPa^2 s); SPL = root-mean-square sound pressure level (dB re 1 µPa)

Table 3.7-9: Summary of Modeled 95th Percentile Exposure Ranges (Meters) for Marine Mammals Acoustic Thresholds for Two Monopile or Four Pin Piles per Day Installed using Vibratory Setting of Piles Followed by Impact Pile Driving and 10-Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, 6,000 kJ Hammer PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[b]	13-Meter Monopile, 6,000 kJ Hammer PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL) [b]	4-Meter Pin Pile, 3,500 kJ Hammer[a] PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL) [b]
LFC									
NARW (*Eubalaena glacialis*)	0	1,440	21,100	0	1,590	27,450	0	2,440	25,660
Fin whale (*Balaenoptera physalus*)	0	2,240	22,140	0	2,690	29,410	<10	4,020	27,740
Sei whale (*Balaenoptera borealis*)	0	1,260	22,080	0	1,330	29,020	<10	2,160	28,050
Minke whale (*Balaenoptera acutorostrata*)	0	1,210	21,930	0	1,180	28,380	<10	1,940	26,940
Humpback whale (*Megaptera novaeangliae)*	0	1,980	22,280	<0.01	2,070	29,030	<10	3,320	27,430
MFC									
Sperm whale (*Physeter macrocephalus*)	0	0	21,950	0	0	28,870	0	0	27,110
Atlantic white-sided dolphin (*Lagenorhynchus acutus)*	0	0	21,720	0	0	28,640	0	0	27,160
Atlantic spotted dolphin (*Stenella frontalis)*	0	0	23,100	0	0	31,120	0	0	29,060
Short-beaked common dolphin (*Delphinus delphis)*	0	0	21,890	0	0	28,530	0	0	27,040
Common bottlenose dolphin (*Tursiops truncates)*	0	0	20,810	0	0	27,420	0	0	25,850
Risso's dolphin (*Grampus griseus)*	0	0	20,790	0	0	27,410	0	0	26,510
Long-finned pilot whale (*Globicephala melas)*	0	0	21,590	0	0	27,450	0	0	26,890
Short-finned pilot whale (*Globicephala macrorhynchus)*	0	0	0	0	0	0	0	0	0
HFC									
Harbor porpoise (*Phocoena phocoena)*	140	0	19,030	60	0	23,200	230	0	23,260
PPW									
Gray seal (*Halichoerus grypus)*	0	0	22,290	0	0	29,530	0	790	27,410

Common Name (Scientific Name)	12-Meter Monopile, 6,000 kJ Hammer			13-Meter Monopile, 6,000 kJ Hammer			4-Meter Pin Pile, 3,500 kJ Hammer[a]		
	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[b]	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[b]	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[b]
Harbor seal (*Phoca vitulina)*	0	0	19,890	0	0	24,580	0	70	23,550
Harp seal (*Pagophilus groenlandicus)*	0	0	22,430	0	0	29,440	0	120	27,650

Source: COP Appendix III-M; Epsilon 2023; JASCO 2023

μPa^2 s = micropascal squared second; dB = decibel; HFC = high-frequency cetacean; kJ = kilojoule; Lpk = peak sound pressure (dB re 1 μPa); LFC = low-frequency cetacean; MFC = mid-frequency cetacean; NARW = North Atlantic right whale; PPW = phocid pinnipeds in water; PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours (dB re 1 μPa^2 s); SPL = root-mean-square sound pressure level (dB re 1 μPa)

[a] Modeling of the 4-meter pin piles includes both the jacket foundations and the bottom-frame foundations proposed for Phase 2 of the proposed Project given the similarity in the acoustic characteristics for construction expected for both foundation types.

[b] For behavior, the SPL threshold does not account for duration and instead assumes exposure if an animal is exposed to above-threshold noise in that instant an exposure could occur. Conversely, the SEL_{24h} thresholds for PTS account for the entire exposure duration required to meet the threshold level. Therefore, the SEL_{24h} threshold accounts for the vibratory pile setting followed by impact pile driving to reach the PTS threshold, whereas the behavior threshold only accounts for the second over which vibratory pile setting may exceed the threshold, and these ranges are based only on vibratory pile setting activities.

The applicant has committed to implement measures, including soft start, a noise attenuation system, visual PSOs, and PAM, which are designed to reduce the potential impacts on marine mammals.[27] Sound attenuation technology under consideration for the applicant during foundation installation includes installation equipment optimized for sound reduction (e.g., integrated pile installer), underwater noise abatement systems (e.g., AdBm encapsulated bubble sleeve), and/or bubble curtains. Various studies have demonstrated these mitigation and monitoring measures are capable of attenuating sounds during pile driving by approximately 10 to 23 dB (Bellmann et al. 2020; Christopherson and Lundberg 2013; Reinhall et al. 2015). Attenuation levels vary by equipment type, frequency band, and location, which is part of the reason multiple attenuation levels were included in the acoustic modeling assessment (COP Appendix III-M; Epsilon 2023). The modeling assessment also includes the seasonal restriction wherein no pile driving would occur during the peak season of NARW occurrence in the SWDA (between January 1 and April 30) to help reduce the impacts on this species and others with seasonal occurrence (Section 3.7.1) would be avoided during this timeframe, as no pile driving would occur. Additional detail on the voluntary measures the applicant has committed to are described in detail in Appendix H, Mitigation and Monitoring. Additional measures that must be applied to the proposed Project, including mandatory terms and conditions and reasonable and prudent measures to minimize the extent or amount of incidental take of endangered species, are included as part of the Incidental Take Statement included with the BO issued by NMFS. General conditions and mitigation and monitoring measures relative to marine mammals provided in the LOA are also discussed in detail in Appendix H.

Overall, the modeled exposure ranges (COP Appendix III-M; Epsilon 2023) and exposure estimates (Appendix B) indicate that the risk of PTS is lowest for MFC species due to the of the small exposure ranges and small number of individuals of any species that would be exposed to both vibratory pile setting and impact pile-driving noise. Exposure ranges were modeled to be 0 feet (0 meters) for both the Lpk and SEL_{24h} metrics for all MFC species, and no exposures were modeled for MFC species for vibratory pile setting and impact pile-driving activities (Appendix B). Therefore, the only impacts expected for MFC species during foundation installation are behavioral responses. In this group, only the sperm whale is endangered; no injury or mortality of any sperm whales is anticipated, and impacts would be limited to temporary behavioral disruptions of a very small number of individuals. Given the fact that PTS is not likely to occur for any MFC species, impacts would be short term and moderate as they would

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

be of medium intensity, but localized to the area around the proposed Project area (compared to a broader extent expected by pile-driving activities under Alternative A).

For all other hearing groups under the maximum-case scenario, the modeled predicted risk of non-lethal auditory injury (i.e., PTS) was for LFC, HFC, and PPW (Appendix B; COP Appendix III-M; Epsilon 2023). The PTS modeled exposure ranges for LFC species ranged from 0.7 to 1.7 miles (1.2 to 2.7 kilometers) for the monopile foundations and from 1.2 to 2.5 miles (1.9 to 4.0 kilometers) for the pin piles installed using vibratory pile setting followed by impact pile driving (Table 3.7-9). PTS and behavioral exposures are based on the number of Level A and Level B takes requested in the draft ITA application addendum (JASCO 2023). PTS exposures were requested for all LFC species except NARW. For NARW, the potential for PTS exposures is expected to be reduced to zero given the mitigation measures proposed by the proposed Project (Appendix H). Most mitigation measures will also reduce PTS risk for other LFC species; however, several mitigation measures further decrease the risk of PTS exposures to NARW specifically and include:

- A seasonal restriction on piling activities such that they would not occur between January 1 and April 30 to avoid the period when NARW abundance is greatest, which would help reduce the risk of PTS occurring for this species and also reduce the risk to species present during that period (Section 3.7.1);
- A real-time PAM monitoring program will be implemented to help detect NARWs from greater distances and in more conditions to initiate timely mitigation measures and reduce the accumulation of acoustic energy;
- A NARW acoustic detection that is localized and confirmed within 5,000 meters (16,404 feet) of the source will be considered equivalent to a visual detection and a delay or shutdown will be implemented. However, the final monitoring, clearance, and shut down zones may be modified in final rulemaking by NMFS under the MMPA for the incidental taking of marine mammals. the 5,000-meter (16,404-foot) range represents a 58 percent increase in the PTS $ER_{95\%}$ range, thus providing significant buffer between the maximum acoustic detection range and the PTS range;
- The PAM clearance zone will be adjusted relative to the PTS risk for larger piles. The PAM clearance zone will extend to 15,092 feet (4,600 meters) for monopile foundations, and the PAM clearance zone will extend to 17,389 feet (5,300 meters) for jacket foundations, though the final monitoring, clearance, and shut down zones may be modified in final rulemaking by NMFS under the MMPA for the incidental taking of marine mammals;
- The applicant will complete an aerial or a boat survey prior to piling across an extended 6-mile (10-kilometer) monitoring zone for NARW. Aerial surveys will not begin until the lead PSO determines adequate visibility and at least 1 hour after sunrise (on days with sun glare as determined by the lead PSO on duty). Boat surveys will not begin until the lead PSO determines there is adequate visibility;
- In order to reduce the amount of accumulation in acoustic energy, a NARW visually detected at any range or acoustically detected within 5,000 meters (16,404 feet) during a time when a shutdown could not occur, reduced hammer energy and strike rate, as practicable to maintain safety, will be employed and the NARW monitored until it exists the clearance zone, at which time a soft-start procedure will be initiated to resume piling. However, the final monitoring, clearance, and shut down zones may be modified in final rulemaking by NMFS under the MMPA for the incidental taking of marine mammals;

- Nighttime pile driving may be required for up to three ESP jacket foundations and some of the WTG foundations. If nighttime pile driving is required during Project construction, additional measures, which will be developed in the nighttime pile driving monitoring plan through consultation with BOEM and NMFS, will be implemented such that no PTS exposures would be realized for NARW. The nighttime pile driving monitoring plan will include defining the technologies and methodologies effective for nighttime monitoring of marine mammals and the environmental conditions affecting efficacy of these technologies and methodologies such as sea state, precipitation, temperature, and atmospheric condition. If the nighttime pile driving monitoring plan is not in place and approved by the relevant agencies, it is required that no nighttime pile driving will occur under Alternative B.

Based on the analysis and proposed mitigation, PTS is not expected for NARW; however, given the characteristics of impact and vibratory pile-driving noise during foundation installation under Alternative B, short-term, moderate impacts are expected for NARW that would be of medium intensity, but localized to the area around the proposed Project area (compared to a broader extent expected by pile-driving activities under Alternative A).

Even with mitigation measures, the potential risk of PTS to LFC species cannot be fully mitigated and therefore PTS takes have been requested for LFC species in the amended ITA application (JASCO 2023). Therefore, BOEM considers impacts from foundation installation activities to be moderate for all LFC species except NARW due to the potential risk of PTS for non-NARW LFCs. Behavioral disturbances would occur, but these are expected to be short term and would dissipate once the pile driving has ceased (Würsig et al. 2020). No population-level impacts are expected to any LFC species including NARW.

Results of the modeling show the exposure ranges to the PTS for HFC ranged from 197 to 755 feet (60 to 230 meters) and from 230 to 2,592 feet (70 to 790 meters) for PPW for all foundation types installed using vibratory pile setting followed by impact pile driving (3.7-10). The proposed clearance and shutdown zones under the COP for these species are 820 feet (250 meters) and 164 feet (50 meters) for HFC and PPW, respectively, which will cover some but not all of the range over which PTS was modeled to occur, and therefore cannot be fully eliminated. This is further evidenced by the PTS exposures requested in the proposed Project's LOA application for HFC and PPW species during foundation installation activities. Therefore, BOEM considers impacts from foundation installation activities to be moderate for all HFC and PPW species due to the risk of PTS occurring for these species even with the proposed mitigation measures (Appendix H). It is also likely behavioral disturbances would occur, but these are expected to be short term and would dissipate once the pile driving has ceased (Würsig et al. 2020). No population-level impacts are expected to HFC or PPW species.

Take estimates of marine mammals during construction of Alternative B will be provided in the proposed Project ITA issued by NMFS, and are summarized in Appendix B of this Final EIS. In summary, impacts from foundation installation on marine mammals, with the exception of the NARW, would be moderate and long term (i.e., PTS) for all LFC, HFC, and PPW species. Impacts would be moderate but short term for NARW and MFC because no PTS is expected for these species.

Foundation Drilling

Foundation drilling activities may also be conducted prior to impact pile driving to reduce the risk of pile run, an effect where unstable soil conditions cause the pile to move under its own weight through the soil in an uncontrolled manner (JASCO 2023). Acoustic ranges to the PTS thresholds for these activities were modeled using representative source levels from Amaral et al. (2018) at a representative location near the proposed drilling sites assuming 10 dB noise attenuation using the same noise mitigation systems as described above for impact and vibratory pile driving of the foundations (JASCO 2023). Ranges to the PTS threshold assuming 10 dB of noise attenuation for LFC species were estimated to be 2,132 feet (650 meters); <164 feet (<50 meters) for HFC species; and modeling indicated the PTS thresholds would not be exceeded for MFC and PPW species during foundation drilling with 10 dB noise attenuation. Additionally, during foundation drilling, both the clearance and shutdown zones for NARW will extend to any distance from the foundations; the clearance and shutdown zone for LFC and sperm whales will extend out to 8,858 feet (2,700 meters) for monopile foundations and 13,451 feet (4,100 meters) for jacket foundations; the clearance and shutdown zone for small whales, dolphins, and PPW will extend out to 164 feet (50 meters) for all foundation types; and the clearance and shutdown zone for HFC will extend out to 820 feet (250 meters) for all foundation types (Appendix H). These mitigation zones fully cover the modeled PTS ranges for all species, and no PTS exposures are expected for any marine mammal species. The behavioral threshold range was estimated to be 4 miles (7 kilometers) for all marine mammal species (JASCO 2023) so behavioral disturbances may occur. However, the final monitoring, clearance, and shut down zones may be modified in final rulemaking by NMFS under the MMPA for the incidental taking of marine mammals. Up to 12 hours of drilling could be required per pile; however, not all piles will require pre-piling drilling. It was estimated that up to 48 piles of the 132 (36 percent) may require drilling across both Project phases (JASCO 2023). Therefore, though the behavioral disturbance threshold may be exceeded over a large distance, the overall duration of exposure to noise from these activities would be limited, making the likelihood of long-term avoidance of the area or population-level behavioral impacts extremely low. Additionally, all mitigation and monitoring measures described for impact pile driving, except the noise attenuation, would also apply to foundation drilling, further reducing the risk of any biologically relevant impacts. Foundation drilling would, therefore, result in minor impacts on LFC (including the NARW), MFC, HFC, and PPW as all effects would be short term and low intensity.

Unexploded Ordnance Detonations

Initial geophysical survey results suggest there is a moderate risk of encountering UXOs within the proposed Project area. If UXOs are encountered, the applicant’s preferred approach is avoidance, by relocating WTG and ESP foundations and associated cables to circumvent the UXOs. Where avoidance or shifting of UXOs is not feasible, the applicant would first pursue less impactful (low-order) disposal options such as lift and shift, cut and capture, low-order disposals, and deflagration; high order disposals (i.e., in situ detonation) would be used as a last resort (JASCO 2022). Because low-order disposal methods may not be possible, the potential impacts from in situ UXO disposal assumed high order detonations. For the purposes of the LOA application, it was assumed up to 10 UXO may be detonated under Alternative B (JASCO 2023).

The acoustic modeling assessment for UXO detonations followed the study recently conducted for the Revolution Wind Project (Hannay and Zykov 2022). This study modeled UXO detonations in multiple locations to account for water depth and employed the use of U.S. Navy bins (Hannay and Zykov 2022). This approach groups potential UXOs into five “bins” or categories based on the maximum UXO charge weights, as shown in Table 41 of the LOA application (JASCO 2022). Although slight bathymetric differences exist between the Revolution Wind Project area and the geographic analysis area for the proposed Project, the results from the Revolution Wind Project study are approximately transferrable and were, therefore, used for the modeling and exposure assessment (JASCO 2022). The applicant assumed that up to 10 UXOs would be encountered within the geographic analysis area during construction and modeled 0 and 10 dB noise attenuation. The estimated impact areas for hearing groups to the PTS and TTS thresholds are provided in Table 3.7-10, and the impulse exceedance ranges to the non-auditory injury thresholds are provided in Table 3.7-11.

Table 3.7-10: Impact Areas (in Square Kilometers) to the Permanent Threshold Shift- and Temporary Threshold Shift-Onset Thresholds for Potential Unexploded Ordnance Detonations for Various Depths with 10-Decibel Noise Attenuation

	PTS Onset (Depth in Meters)				TTS Onset (Depth in Meters)			
Hearing Group	**12**	**20**	**30**	**45**	**12**	**20**	**30**	**45**
LFC	32.57	44.89	40.94	40.94	380.13	444.88	415.48	437.44
MFC	0.67	0.47	0.53	0.53	20.43	18.55	19.32	19.32
HFC	120.76	120.37	120.37	119.21	624.58	598.28	555.72	589.65
PPW	8.04	6.42	6.88	5.73	143.14	153.50	149.57	154.82

Source: JASCO 2022

HFC = high-frequency cetacean; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PPW = phocid pinnipeds in water; PTS = permanent threshold shift; TTS = temporary threshold shift

Table 3.7-11: Impact Areas (in Square Kilometers) to the Non-Auditory Injury Thresholds for Potential Unexploded Ordnance Detonations for Various Depths with 10-Decibel Noise Attenuation

	Onset of Lung Injury (Depth in Meters)				Onset of Mortality (Depth in Meters)			
Marine Mammal Group	**12**	**20**	**30**	**45**	**12**	**20**	**30**	**45**
Baleen and sperm whales (calf/pup)	151	204	226	237	90	105	109	108
Baleen and sperm whales (adult)	73	80	81	78	34	34	31	29
Pilot and minke whales (calf/pup)	192	275	310	330	120	150	157	162
Pilot and minke whales (adult)	103	126	131	132	56	58	57	50
Beaked whales (calf/pup)	250	366	413	448	161	206	220	234
Beaked whales (adult)	171	237	267	282	105	127	132	135
Dolphins, Kogia, and pinnipeds (calf/pup)	347	508	557	606	228	285	308	332
Dolphins, Kogia, and pinnipeds (adult)	241	351	400	429	154	198	211	224
Porpoises (calf/pup)	377	541	594	648	248	307	330	353
Porpoises (adult)	260	381	429	465	167	215	231	243

Source: JASCO 2022

Due to the proposed mitigation and monitoring measures (Appendix H) and the relatively small size of the peak pressure and acoustic impulse threshold ranges compared to PTS and TTS ranges for potential UXO detonations, no non-auditory injury or mortality is expected for any species (JASCO 2022). There is, however, potential for PTS and TTS during this activity. The estimated impact areas for PTS and TTS onset (Table 3.7-10) indicate the greatest risk of exposure for HFC species (e.g., harbor porpoise) with the lowest risk for MFC species. The assessment in the ITA application (JASCO 2022) assumed that up to 10 UXO would require detonation throughout construction. A noise attenuation system such as a double bubble curtain would be used during UXO detonations to achieve approximately 10 dB broadband attenuation, and other mitigation such as pre-clearance surveys and visual monitoring would also be implemented to reduce the potential for impacts on marine mammals (Appendix H; JASCO 2022). Because marine mammals could receive PTS exposures during high order detonations but no mortalities or non-auditory injury are expected to occur, and no population-level impacts are expected; impacts on mysticetes (including the NARW), odontocetes, and pinnipeds from UXO detonations would be moderate.

Trenching and Cable Laying

Cable-laying noise associated with Phase 1 may also affect marine mammals. The timeframe for offshore export cable installation is still being developed in response to time-of-year considerations. It is possible that NARW would be active in the vicinity of the OECC. However, all appropriate mitigation and monitoring measures would be implemented to minimize potential impacts. The SEL_{24h} during cable laying is expected to reach approximately 237 μPa^2 s at 1 meter (3.3 feet) (Xodus Group 2015), which exceeds the NMFS threshold criteria for PTS from non-impulsive noise (SEL_{24h} 199 dB re 1 μPa^2 s) at that distance (COP Appendix III-M; Epsilon 2023). The distance to the threshold for Level A Harassment is expected to be relatively small (Xodus Group 2015), and the distance to threshold for Level B Harassment is expected to be in the range of other vessel noise. Temporary and minor impacts are anticipated for mysticetes (including the NARW), odontocetes, and pinnipeds from cable-laying noise, with populations fully recovering following cable installation.

Geological and Geophysical Surveys

G&G survey equipment may produce both impulsive and non-impulsive noise depending on the type of equipment. The range to the PTS threshold for both sources modeled was estimated to be less than 3.3 feet (1 meter) for both boomers and sparkers (JASCO 2022), which would not present a PTS risk to marine mammals given the mitigation measures and adherence to BOEM Project Design Criteria and BMPs included under Alternative B. The maximum range to behavioral thresholds was estimated to be 584 feet during operation of boomer equipment and 463 feet (141 meters) during sparker operation (JASCO 2022). HRG surveys would occur irregularly between 2025 and 2030; however, only 25 surveys days are expected per year. Overall, no acoustic injury is expected from operations of any G&G survey equipment, and the proposed mitigation (COP Volume III, Section 6.7.4, Table 6.7-20; Epsilon 2023) would effectively reduce the risk of biologically significant behavioral disturbances. The proposed mitigation is consistent with the June 29, 2021, programmatic consultation on data collection activities (Baker and Howsen 2021). As discussed in Section 3.7.3.1, impacts on all marine mammal species would be limited to short-term, low-intensity behavioral disturbances that would not result in population-level impacts for any species. Impacts on mysticetes (including the NARW), odontocetes, and pinnipeds are, therefore, expected to be minor.

Vessel Noise

Current vessel traffic in the proposed Project area and surrounding waters is relatively high. COP Section 3.3.1.12.1 (Volume I; Epsilon 2023) indicates an average of 30 Project-related vessels operating within the SWDA or along the OECC at any given time and up to approximately 60 Project-related vessels operating concurrently within the SWDA during high-traffic periods. This traffic would vary monthly and would depend on weather and Project activities. Over the course of construction, Phase 1 would generate an average of six daily vessel trips between both the primary and secondary ports and the SWDA. During the period of maximum activity, Phase 1 construction would generate an average of 15 construction vessel trips per day in or out of construction ports. (COP Volume I, Section 3.3.1; Epsilon 2023). Vessel activities would include Project-related biological surveys, including pre- and post-operations environmental surveys for fish and benthic habitat monitoring, though the magnitude of the vessel traffic is unknown at this time. The navigation safety risk assessment (COP Appendix III-I; Epsilon 2023) provides further details of vessel activity during construction. The applicant would use vessels with ducted propeller thrusters, including DP systems. Of the different Phase 1 vessel types listed in COP Table 3.3-1 (Volume I, Section 3.3.1; Epsilon 2023), all except smaller support vessels that use jet-drive propulsion are described as having “blade propeller system/blade thrusters.” Assuming sound sources for blade propeller system/blade thrusters are similar to those for ducted propellers, vessel noise may cause behavioral modification for some marine mammals. Sound-source levels for ducted propeller thrusters were modeled for a project offshore of Virginia (BOEM 2015) and measured during the installation of the Block Island Wind Farm transmission cable. For both projects, the root-mean-squared sound-source level was 177 dB re µPa m. Ducted propeller thruster use may exceed threshold criteria for injury out to 351 feet (107 meters) (BOEM 2014a). However, marine mammals would need to remain within that distance for a prolonged period to receive enough acoustic energy to meet PTS thresholds, which is extremely unlikely and not expected. Distances to the threshold criteria for behavioral modification for marine mammals would be approximately 0.9 to 2 miles. Potential behavioral impacts on marine mammals from Phase 1-related vessel traffic noise would be intermittent and temporary as animals and vessels pass near each other. During construction, there is a higher risk of impacts for all mysticetes because the lower frequency of sound emitted from vessels overlaps in the most sensitive hearing range of mysticetes and may affect mysticetes over larger areas compared to the other marine mammals. However, these impacts would be temporary, limited to construction months within the proposed Project area, and are not expected to have stock or population-level impacts. Further, populations would be expected to fully recover once the IPF is removed, and no ESA take of marine mammals would be expected as a result of vessel presence and vessel noise (NMFS 2020a). Potential temporary behavioral impacts on mysticetes (including the NARW), odontocetes, and pinnipeds from vessel traffic noise are expected to be minor.

Aircrafts

Aircraft noise may result in behavioral responses in marine mammals when flying at altitudes below 984 feet. However, aircraft transiting to the SWDA would fly at altitudes above those that would cause behavioral responses from marine mammals except when flying low to inspect WTGs, conduct biological surveys, or to take off and land. Aircraft activities for Alternative B would include minimum altitude requirements for preventing impacts on marine mammals. While aircraft traffic may cause some short-term behavioral reactions in mysticetes (including the NARW), odontocetes, and pinnipeds, these impacts would be negligible.

Construction Noise Summary

Overall, the impacts of noise from Phase 1 construction on marine mammals would be negligible to moderate, depending on the source and species or species group affected. The use of noise-reduction technologies during all pile-driving activities to ensure a minimum attenuation of 10 dB would reduce the area impacted by noise during construction. The specific technologies have not yet been selected; potential options include a noise mitigation system, hydro-sound damper, noise abatement system, a bubble curtain, or something similar (COP Appendix III-M; Epsilon 2023). The use of PSOs during pile driving and G&G survey activities would reduce the potential noise impacts by establishing and maintaining exclusion zones to minimize marine mammal exposure to injurious levels of noise. The detectability of marine mammals is dependent on meteorological conditions, PSO training, PSO fatigue, animal behavior, and vocalization rates (relevant for PAM). PSO training and shift requirements, as detailed in Appendix H, would increase the ability of PSOs to detect listed species. The applicant will also submit an alternative monitoring plan to ensure the ability to maintain exclusion zones during visibility conditions. Further, PAM would provide an additional means of detecting vocalizing marine mammals that are not visible at the surface. In addition, BOEM is evaluating the following mitigation and monitoring measures to address impacts on marine mammals, as described in detail in Table H-2 of Appendix H:

- Use long-term PAM buoys or autonomous PAM devices;
- Implement noise-reduction technologies to achieve a reduction of noise;
- Implement a pile driving monitoring plan;
- Monitor pile-driving noise pursuant to an approved sound field verification plan (as described in Measure 31 in Table H-2 in Appendix H) to ensure compliance with required noise reductions and consistency with modeled noise attenuation estimates;
- Enlarge exclusion zones based on field measurements, if necessary, to reduce risk of exposure of marine mammals to injurious levels of noise;
- Conduct daily pre-construction surveys to ensure that marine mammals and sea turtles are not present in the area during foundation installation;
- Use a real-time PAM system to monitor for NARW presence;

- Use PSOs to establish and maintain marine mammal clearance zones prior to and during construction activities;
- Establish a restriction on pile-driving activities (i.e., impact pile driving, vibratory driving, and drilling) between January 1 and April 30;
- Establish time-of-day restrictions such that no UXO will be detonation during nighttime hours and only one detonation may occur in a 24-hour period;
- If nighttime pile driving is approved, implement mitigation measures for nighttime to ensure adequate visibility during required monitoring of clearance zones. If not approved, implement pile driving time-of-day restrictions to ensure adequate visibility during required monitoring of clearance zones;
- Implement shut down and power-down procedures when marine mammals are detected in the exclusion zone;
- Conduct daily and weekly reporting of marine mammals observed, if any, during construction activities; and
- Use PSOs on Project vessels to enhance detection of marine mammals and reduce risk of vessel strike.

Wind Turbine Generator Operational Noise

Marine mammals would be able to hear the continuous underwater noise of operational WTGs. Given the range of SPLs produced by operational WTG and the dependency of the SPLs on the WTG type and wind speed (Tougaard et al. 2020), operational noise could be slightly higher than ambient noise, which ranged from 95 to greater than 104 dB re 1 µPa in the waters near the RI/MA Lease Areas measured from 2011 to 2015 (Kraus et al. 2016a). Therefore, operation of the WTGs would result in long-term, low-level, continuous noise in the proposed Project area, which could result in behavioral disturbances and auditory masking at close distances (i.e., tens of meters) (Lucke et al. 2007; Tougaard et al. 2005, 2020; Thomsen and Stöber 2022). However, the potential for impact is not likely to occur outside a relatively small radius surrounding the proposed Project foundations, and the audibility of the WTGs may be further limited by the ambient noise conditions of the proposed Project area (Jansen and de Jong 2016). Sound levels are expected to be comparable to or lower than sound levels within 1 kilometer (0.6 mile) of commercial vessel noise (Tougaard et al. 2020). Additionally, studies suggest marine mammal species may use the wind farm for foraging, following prey species that are attracted to the foundations (Scheidat et al. 2011; Russell et al. 2014). Marine mammals in the SWDA are not expected to avoid the area due to WTG noise (Mikkelsen et al. 2013; Russel et al. 2014) throughout the operational life of the proposed Project.

Behavioral and masking effects associated with turbine operational noise would be low intensity and localized around individual piles, and are not expected to affect individual survival, population viability, distribution, or behavior. Therefore, turbine operational noise is expected to have a negligible to minor impact on marine mammals. Minor impacts, such as masking in low ambient noise conditions, may be more likely for LFC, due to the low-frequency nature of operational noise and this group’s hearing sensitivity (note: PPW also have low-frequency hearing but their threshold of underwater hearing is higher). Impacts on MFC, HFC, and PPW are expected to be negligible as there is less overlap between these groups hearing sensitivity and WTG operational noise, and the threshold of underwater hearing is higher. As larger turbines and/or differing technologies (e.g., direct-dive) come online, more acoustic measurements are necessary to characterize the relationship between foundation size, type, and the sound levels associated with operation of a single or an array of WTGs, as this may affect the physical distance in which potential behavioral or masking impacts may be possible (Thomsen and Stöber 2022).

Decommissioning

Decommissioning of the WTGs and ESPs is anticipated to have the same sequence and timeframe but in reverse of construction. Decommissioning impacts not generated during construction would include underwater noise emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jet, and vacuum pump. SPLs are not available for these types of equipment but are not expected to be higher than construction vessel noise (generally between 150 and up to 180 dB re 1 μPa [Pangerc et al. 2016]). The applicant would return the sediments previously removed from the inner space of the pile to the depression left after the pile is removed. In addition, the applicant would likely use a vacuum pump and diver or ROV-assisted hoses to minimize sediment disturbance and turbidity. The applicant may abandon the offshore export cables in place, in which case there would be no impacts from their decommissioning. If required, the applicant would remove the cables from their embedded position in the seabed. Where necessary, the applicant would jet plow the cable trench to remove the sandy sediments covering the cables and reel the cables onto barges. Seabed surveys where offshore facilities were located would be conducted to verify site clearance.

Although some of the decommissioning activities (e.g., acoustic impacts and increased levels of turbidity) may cause marine mammals, including listed species, to avoid or leave the area, this disturbance would be short term and temporary. The increased vessel traffic associated with decommissioning could also cause a temporary increase in potential impacts, including vessel strike risk. An increase in underwater noise as a result of decommissioning construction activities, vessel traffic, and site clearance verification surveys is expected but would remain localized and temporary. Details regarding potential impacts on listed species are found in the proposed Project BA (BOEM 2023b). As a result, the impacts of Phase 1 decommissioning noise on mysticetes (including the NARW), odontocetes, and pinnipeds would be minor, with populations fully recovering following decommissioning activities.

Port utilization: A number of existing ports would be used by Project vessels throughout the duration of construction and operations activities of Phase 1 (COP Volume I, Section 3.2.2.5; Epsilon 2023). However, Phase 1 of Alternative B does not include implementing any port upgrades or modifications (COP Volume I, Section 3.2.2.5; Epsilon 2023). As no port expansion activities are considered, Phase 1 would not be anticipated to cause impact on marine mammal populations. Impacts on mysticetes (including the NARW), odontocetes, and pinnipeds would, therefore, be negligible.

Vessel activity associated with port utilization during Phase 1 operations would be less than the levels described for construction; therefore, Phase 1 port utilization impacts on mysticetes (including the NARW), odontocetes, and pinnipeds would be negligible.

Presence of structures: The various types of impacts on marine mammals that could result from the presence of structures are described in detail in Section 3.7.3.1. There could be up to approximately 31,482 acres of structures and associated scour protection, as well as new hard protection (Table E-1). Of this area, only 108 acres would result from Alternative B, and the remainder would result from other offshore wind projects in the geographic analysis area. Of the estimated 3,259 structures, up to 64 would result from Phase 1. The structures and scour/cable protection and the potential impacts would remain at least until decommissioning of each facility is complete (33 years). The presence of the new structures over the life of the proposed Project would alter the character of the ocean environment that could indirectly affect marine mammals; however, the likelihood and significance of these effects are difficult to determine. The various types of impacts on marine mammals that could result from the presence of structures (i.e., hydrodynamic and artificial reef effects and their influence on the availability of prey and forage resources, potential for interaction with active or abandoned fishing gear, and displacement) are described in detail in Section 3.7.3.1.

The addition of the WTGs and an ESP foundation structure, spaced 1.0 nautical mile apart, is expected to result in a localized habitat shift in the area immediately surrounding each monopile from soft sediment, open water habitat system to a structure-oriented system, including an increase in fouling organisms. As discussed in Section 3.7.3.1, hard-bottom (scour control and rock mattresses used to bury required offshore export cables) and vertical structures (i.e., WTG and ESP foundations) in a soft-bottom habitat can create artificial reefs, thus inducing the reef effect that is associated with higher densities and biomass of fish and decapod crustaceans (Causon and Gill 2018; Taormina et al. 2018). The presence of new structures could result in a localized increase of prey items for some marine mammal species (e.g., seals, dolphins) at individual WTG foundations.

As discussed in Section 3.7.3.1, the impacts of changes to oceanographic conditions caused by the presence of offshore structures on marine mammal prey species and, therefore, marine mammals are difficult to discern and likely to vary seasonally and regionally. Project foundations would be located over 12 miles from the 98-foot (30-meter) isobath along the western edge of Nantucket Shoals. The 98-foot (30-meter) isobath generally corresponds with the well-mixed tidal front that supports prey aggregations and, therefore, represents important feeding habitat for the NARW (Quintana-Rizzo et al. 2021). The exact location of this tidal front can vary from the 98 foot (30-meter) to the 164-foot (50-meter) isobath (Ullman and Cornillon 2001; Wilkin 2006); While broadscale hydrodynamic impacts could alter zooplankton distribution and abundance (van Berkel et al. 2020), there is considerable uncertainty as to the magnitude and extent of these changes, especially when coupled with broader ecological changes such as climate change. However, based on available data and the analysis presented in this Final EIS, measurable changes in zooplankton aggregations and NARW foraging success due to Alternative B are not anticipated.

The presence of structures could also result in interaction with active or abandoned fishing gear or a shift from mobile to fixed fishing methods (commercial and recreational) that could increase entanglement risk to large whales. Periodic monitoring and reporting of marine debris around WTG foundations (Appendix H, Table H-2) provides BOEM with the ability to better assess these risks. Commercial and recreational fishing efforts and their impacts on protected species are managed through state and federal regulations. The likelihood of an increased risk of entanglement directly resulting from the presence of proposed Project structures beyond existing commercial and recreational fishing conditions in the northeastern United States is considered low. Thus, the incremental impact of additional structures is not expected to lead to population-level effects for any mysticetes (including the NARW), odontocetes, and pinnipeds. An increase in interactions with active or ghost fishing gear could occur. Bottom tending mobile gear is more likely to be displaced than fixed gear; as such, gear associated with sink gill nets and lobster pots has the potential to affect marine mammals. BOEM has determined that the potential for displacement of fixed gear from the geographic analysis area is low due to the gear able to be deployed in a fixed location. There is the potential that sink gill net effort, in the short term, could shift into the geographic analysis area if catch is higher around wind turbine foundations.

While the significance level of impacts would remain the same, BOEM may include the following mitigation and monitoring measure to address impacts on marine mammals, as described in detail in Table H-2 of Appendix H:

- Require periodic underwater surveys and monofilament line and other fishing gear cleanup efforts around WTG foundations.

This would remove any identified fishing gear and reduce the potential for impacts on marine mammals and may serve to reduce potential entanglement risk to all marine mammals. However, the potential for entanglement associated with active commercial or recreational fishing gear would still exist.

Currently, there is a large amount of uncertainty around large whale response to offshore wind facilities due to the novelty of this type of development in the geographic analysis area. Monitoring studies would be able to determine more precisely any changes in whale behavior. Based on the best available information, no changes are anticipated. However, long-term and intermittent impacts on foraging, migratory movements, or other important behaviors may occur as a result of Phase 1. Additionally, temporary displacement from the SWDA during construction of Alternative B into areas with higher risk of interactions with fishing and commercial vessels (see traffic IPF below) may also contribute to impacts on marine mammals.

Based on the information above, impacts other than potential prey concentration shifts from hydrodynamic changes from the presence of structures under Alternative B would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds. Impacts on individuals would be detectable and measurable; however, they would not lead to population-level effects for most species. Impacts on odontocetes and pinnipeds may result in slight beneficial effects due to increases in aggregations of prey species. These beneficial effects have the potential to be offset by risk of entanglement in fishing gear for some marine mammal species. However, because of the uncertainty of the relative contribution of beneficial and adverse impacts on odontocetes and pinnipeds, the overall impact level determination is minor adverse. Given the uncertainty as described above, the hydrodynamic effects of offshore wind on prey in the key foraging grounds for NARWs identified in the area in and around Nantucket Shoals, the impact on foraging resulting from the presence of structures in these areas is unknown but unlikely be distinguishable from natural variability or from impacts of climate change. BOEM is committed to further studying the impacts of offshore wind operations on NARW prey (BOEM 2024).

Traffic (vessel strike): With respect to vessel strike risk, the applicant estimates that an average of approximately 30 vessels and up to a maximum of approximately 60 vessels could operate simultaneously within the proposed Project area during Alternative B's most active construction period (COP Volume III 7.8). The maximum number of vessels involved in the proposed Project at any one time is highly dependent on the final schedule, final design of its components, and the logistics solution used to achieve compliance with the Jones Act. As discussed in Section 3.7.3.1, vessel strike is one of the primary causes of NARW deaths and is a contributing cause of mortality for the ongoing NARW UME (NMFS 2024c). Given that vessel strike is a known risk for marine mammals (Kraus et al. 2005), vessel traffic associated with Alternative B has the potential to pose a collision risk to marine mammals, especially NARWs, and other baleen whales and their calves that spend considerably more time at/near the ocean surface.

Based on a USCG analysis of AIS data for 2015 through 2018, 13,000 to 46,900 vessel transits occur annually in the wind energy areas and surrounding region, with vessel density in the wind energy areas is up to four times higher during the summer months than during the winter months (USCG 2020). The majority of traffic occurs outside the RI/MA Lease Areas. Within the SWDA, AIS data indicate relatively low vessel traffic levels, averaging 862 unique vessel tracks annually transiting the SWDA from 2016 through 2019 (COP Volume III, Section 7.8; Epsilon 2023). Vessel density within the OECC is likewise relatively low (63 to 73 AIS-equipped vessels per day on average), with the highest concentration of traffic midway through Nantucket Sound (COP Volume III, Section 7.8; Epsilon 2023). Vessel traffic along the OECC is also highly seasonal, with up to 200 to 300 vessels per day during peak summer months (July and August). These data, however, only represent vessels equipped with AIS, which is generally limited to vessels greater than 20 meters (65 feet). Existing vessel traffic within the proposed Project area is further described in the NSRA provided in COP Appendix III-I (Epsilon 2023). Phase 1 is expected to contribute an average of 7 and up to 15 Project-related vessels during peak months of activity within the OECC (COP Appendix III-I; Epsilon 2023). The highest Project-related vessel activity within the proposed Project area would occur during peak construction. No significant disruption of normal traffic patterns is anticipated in the SWDA associated with Alternative B. Although Phase 1 would result in an increase in regional vessel traffic above historical baseline averages, a significant increase the overall risk of vessel collisions is not expected due to the implementation of mitigation and monitoring measures (Appendix H).

The applicant anticipates that WTG and ESP components, as well as offshore export cables, would be shipped from Canadian and European ports, either directly to the SWDA or through a U.S. port. Approximately 3,200 total vessel round trips are expected to occur during offshore construction of Phase 1, which equates to an approximate average of 6 vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 3.3.1.12.1; Epsilon 2023). These estimates are based on the installation of up to 64 foundations (including up to 2 ESPs, with the remainder for WTGs) during Phase 1 and represent the maximum-case scenario. The applicant anticipates that WTG and ESP components, as well as offshore export cables, would be shipped from Canadian and European ports, either directly to the SWDA or through a U.S. port. These vessels would follow the major navigation routes and make similar trips to U.S. ports in the absence of Phase 1 (Michael Clayton, Pers. Comm., July 23, 2020). During operations, approximately 250 vessel round trips are estimated to take place annually for Phase 1, equating to less than 1 round-trip transit per day (COP Volume I; Epsilon 2023).

Temporary and/or permanent increases in vessel traffic outside of the SWDA may also occur due to displacement of commercial and recreational fishing vessels. Environmental surveys to monitor impacts of Alternative B (including Phase 1) on marine mammals would contribute to vessel traffic in and near the SWDA. Added vessel traffic and use of nets and towed gear for biological sampling is associated with risk of vessel allision/collision and entanglement.

The geographic extent of this IPF is considered localized to the vessel transit routes and the offshore Project area. As Project vessels would operate throughout construction, operations, and decommissioning, the potential for a vessel to strike a marine mammal is considered continuous (over the life of Alternative B). Impacts from vessel strikes range from short term in duration for minor injuries to permanent in the case of death of an animal. Proposed measures to mitigate vessel-marine mammal strikes (e.g., vessel speeds) are expected to be highly effective and reduce the likelihood of occurrence to low.

Vessel collisions are a key source of mortality and serious injury for many marine mammal species (Hayes et al. 2021, 2022, 2023; 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 individual marine mammals could cause injuries ranging from minor to mortality; therefore, population-level impacts would range from negligible to major, depending on the species and severity of the strike. However, the applicant has committed to a range of mitigation and monitoring measures to avoid vessel collisions with marine mammals (Appendix H, Table H-1). These mitigation and monitoring measures would minimize encounters that have a high risk of resulting in collision or injury by reducing both the encounter potential (e.g., trained visual observers, vessel separation distances, seasonal restrictions, avoidance of aggregations, strict adherence to NMFS Regional Viewing Guidelines for vessel strike avoidance) and severity potential (e.g., vessel speed reduction, vessel positioning parallel to animals). These mitigation and monitoring measures, plus additional strike avoidance measures (Appendix H, Table H-2), are considered effective at avoiding and minimizing collision risk. Therefore, with implementation of these known and effective measures, BOEM concludes that vessel strikes are unlikely to occur. As a result, there is no anticipated effect on marine mammals and collision effects due to Alternative B. Vessel strikes would, therefore, be negligible for mysticetes (including NARW), odontocetes, and pinnipeds.

Impacts of Phase 2

Impact levels from IPFs during Phase 2 are expected to be similar to those of Phase 1 with similar construction, operations, and decommissioning methods and techniques. However, if each phase is fully built using the maximum design scenario for each, impacts on marine mammals would be marginally greater during Phase 2 than Phase 1 due to the larger number of foundations. If the applicant includes the SCV as part of the final Project design, some or all of the impacts on marine mammals from the Phase 2 OECC through Muskeget Channel would not occur. BOEM will provide a more detailed analysis of the impacts of the SCV on marine mammals in a supplemental NEPA analysis, if the SCV is selected.

Phase 2 operations would require routine, preventative maintenance, and equipment inspections equivalent to Phase 1 (COP Volume III, Section 4.3.2; Epsilon 2023). The maximum-case scenario for Phase 2 includes 400 nautical miles (460 miles) of offshore export, inter-array, and inter-link cables (Appendix III-T; Epsilon 2023), which represents an increase of 159 nautical miles (182 miles) of cable compared to Phase 1. However, impacts on marine mammals during Phase 2 operations are not anticipated to be appreciably different from Phase 1 and, therefore, would be the same as for the Phase 1 operations. Under the maximum-case scenario for the Phase 2 SCV, routine maintenance, preventative maintenance, and equipment inspections would still occur, but overall impacts on marine mammals are not likely to appreciably differ from OECC cables routed through Muskeget Channel alone.

Phase 2 decommissioning is anticipated to be the same sequence and timeframe but in reverse of construction and would require the removal of all Project components, including foundations, cables, fluids, and chemicals (COP Volume III, Section 4.3.3; Epsilon 2023). The process is expected to be equivalent to Phase 1 decommissioning. Impacts on marine mammals during Phase 2 decommissioning, including the SCV, are not anticipated to be appreciably different from Phase 1 and would be the same as for Phase 1 decommissioning. The impact determinations for IPFs associated with Phase 2 decommissioning, inclusive of the SCV, would not change or would be greatly reduced for marine mammals compared to Phase 2 construction.

Accidental releases: The incremental impacts of Phase 2 from accidental releases of hazardous materials and trash/debris would be the same as Phase 1. Because Phase 1 would be operational during construction of Phase 2, impacts of accidental releases during Phase 2, including the SCV, would have the same impacts as Phase 1 and would remain negligible.

Anchoring and gear utilization: The incremental impacts of Phase 2 from anchoring and gear utilization would be the same as Phase 1. Impacts of anchoring and gear utilization during Phase 2, including the SCV, would have the same impacts as Phase 1 and therefore would remain negligible.

Cable emplacement and maintenance: The maximum design scenario for Phase 1 states that 442 acres of seafloor would be disturbed as a result of cable installation and dredging prior to cable installation in the proposed Project area (COP Appendix III-T; Epsilon 2023). Under the maximum-case scenario for Phase 2, 732 acres of seafloor would be disturbed, or 290 more acres than Phase 1. Under the maximum-case scenario for the Phase 2 SCV, up to 629 acres of bottom disturbance would occur within federal waters in addition to Phase 2 OECC routed through Muskeget Channel Phase 2 and Phase 2 SCV would result in elevated turbidity with the potential for temporary impacts on some marine mammal prey species. However, elevated turbidity levels would be short term, temporary, and localized. Although modeling results indicate a slightly larger area of impact for the Phase 2 SCV when compared to the OECC route through Muskeget Channel, it is unlikely to differentially impact marine mammals. The impacts from cable emplacement and maintenance as a result of Phase 2, including the SCV, would not be expected to be greater than those discussed for Phase 1 and would remain negligible.

EMF: The maximum-case scenario for Phase 2 includes 400 nautical miles (460 miles) of offshore export, inter-array, and inter-link cables (Appendix III-T; Epsilon 2023), which represents an increase of 159 nautical miles (182 miles) of cable compared to Phase 1. However, impacts on marine mammals from Phase 2 are not expected to differ appreciably from that of Phase 1. Therefore, the incremental impacts of

Phase 2 from EMF and cable heat would be the same as Phase 1. Impacts of EMF and cable heat during Phase 2, including the SCV, would remain negligible.

Lighting: The incremental impacts of Phase 2 from lighting would be the same as Phase 1 and therefore would remain negligible. While Phase 1 would be operational during construction of Phase 2, impacts of lighting during Phase 2, including the SCV, would have the same impacts as Phase 1 and thus would remain negligible.

Noise: Noise generated during Phase 2 (inclusive of the Phase 2 OECC SCV option) from construction, vibratory pile setting and impact pile driving during installation of the foundations, drilling, potential UXO detonations, G&G survey activities, aircraft, cable laying, operations, and vessel traffic could contribute to impacts on marine mammals. The SCV option would shift the location of noise-producing activities but is not expected to differentially impact marine mammals. The noise with the greatest impact is expected to come during foundation installation. Up to 89 foundations (including up to 3 ESPs, with the remainder for WTGs) would be installed during Phase 2, which could include three foundation types: monopiles, jackets, or bottom-frame foundations, all of which would be installed using a combination of vibratory pile setting followed by impact pile driving and impact pile driving only. The Phase 2 PDE also includes the 12- and 13-meter monopile and 4-meter jacket pile foundation types used for Phase 1. A bottom-frame foundation may also be used during Phase 2, which would have the same 4-meter maximum pile diameter as the jacket foundation, but with shallower penetration. Although the bottom-frame foundation was not modeled separately, it is assumed that the potential acoustic impact would be equivalent to or less than that predicted for the jacket foundation as noted in the footnotes for Tables 3.7-8 and 3.7-9 (COP Appendix III-M; Epsilon 2023).

Due to the temporary, localized nature of noise produced during foundation installation under Phase 2, avoidance of peak seasons of NARW occurrence, and the implementation of extensive mitigation and monitoring measures (Appendix H), risk of exposure to above-threshold noise levels is expected to be minimized. The impacts of pile driving for bottom-frame foundations would be similar to those described for jacket foundations (COP Appendix III-M; Epsilon 2023). The potential for impact on marine mammals from noise exposure is not expected to differ if the applicant includes the SCV as part of the final Project design. Additionally, construction of Phase 2 would occur after construction of Phase 1 has been completed rather than occurring concurrently, so it would not be expected to result in any additive risk to marine mammal species. Therefore, impacts from Phase 2 would be the same as under Phase 1 and considered moderate for all marine mammals, driven by the potential impacts resulting from UXO detonations and foundation installation activities. All other noise impacts considered under Alternative B would be negligible to minor for all marine mammals, as PTS is not expected to occur but behavioral disturbances would. However, based on the above analysis and in consideration of all the discussed noise sources, the final noise impact determination would be moderate for all marine mammals. Similar to Phase 1, no population-level impacts are expected.

Port utilization: A number of existing ports would be used by Project vessels throughout the duration of Phase 2 construction and operations activities (COP Volume I, Section 4.2.2.5; Epsilon 2023). Vessel traffic and port utilization during construction of Phase 2 is expected to remain the same as under Phase 1; therefore, impacts on mysticetes (including the NARW), odontocetes, and pinnipeds would remain negligible. If the applicant includes the SCV as part of the final Project design, different ports may be used, but impacts on all marine mammals are not likely to differ.

Presence of structures: Phase 2 would add up to 89 foundations (of which up to 3 would be for ESPs, with the remainder for WTGs). The number of foundations would be the same if the Phase 2 SCV is implemented. Phase 1 structures would exist in the vicinity where Phase 2 foundations would be added, which would increase the total space occupied by structures. As such, impacts on marine mammals would be greater for Phase 2 compared to Phase 1, though this potential increase in risk is not anticipated to increase the IPF impact rating. Impacts on marine mammals and their habitats resulting from the disruption in hydrodynamics due to the increased presence of structures is uncertain, their significance unknown, and they likely vary by species and location (see the discussion of hydrodynamic impacts in Section 3.7.3.1). As discussed in Section 3.7.3.1, the primary impact on marine mammals associated with the presence of structures is due to entanglement risk resulting from an increased interaction with active or abandoned fishing gear. Long-term and intermittent impacts on foraging, migratory movements, or other important behaviors may also occur as a result of Phase 2, though there remains a large degree of uncertainty around large whale response to offshore wind facilities in the Atlantic. Overall, as described for Phase 1, impacts other than potential prey impacts from hydrodynamic changes from the presence of structures under Alternative B would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds. Impacts on individuals would be detectable and measurable; however, they would not lead to population-level effects for most species. Impacts on odontocetes and pinnipeds may result in slight beneficial effects due to increases in aggregations of prey species. These beneficial effects have the potential to be offset by risk of entanglement in fishing gear for some marine mammal species. However, because of the uncertainty of the relative contribution of beneficial and adverse impacts on odontocetes and pinnipeds, the overall impact level determination is minor adverse. Given the uncertainty as described above, the hydrodynamic effects of offshore wind on prey in the key foraging grounds for NARWs identified in the area in and around Nantucket Shoals, the impact on foraging in resulting from the presence of structures in these areas is unknown but unlikely be distinguishable from natural variability and the significant impacts of climate change. BOEM is committed to further studying the impacts of offshore wind operations on NARW prey (BOEM 2024).

Traffic (vessel strike): The expected vessel types and amount of vessel traffic during Phase 2 is expected to remain the same as or similar to that under Phase 1. Although Phase 2 would result in an increase in regional vessel traffic above historical baseline averages, this is not expected to result in a significant increase the overall risk of vessel collisions, particularly with the proposed mitigation and vessel strike avoidance measures the proposed Project would employ (i.e., reduced vessel speeds and ships maintaining minimum distances from marine mammals). Given the implementation of Project-specific vessel strike avoidance measures, vessel strikes as a result of Phase 2 are considered unlikely. These mitigation and monitoring measures would minimize encounters that have a high risk of resulting in collision or injury by reducing both the encounter potential (e.g., trained visual observers, vessel separation distances, seasonal restrictions, avoidance of aggregations, strict adherence to NMFS Regional Viewing Guidelines for vessel strike avoidance) and severity potential (e.g., vessel speed reduction, vessel positioning parallel to animals). These mitigation and monitoring measures, plus additional strike avoidance measures (Appendix H, Table H-2), are considered effective at avoiding and minimizing collision risk. Therefore, with implementation of these known and highly effective measures, BOEM concludes that vessel strikes are unlikely to occur. As a result, there is no anticipated effect on marine mammals and collision effects due to Alternative B. Vessel strikes would, therefore, be negligible for mysticetes (including the NARW), odontocetes, and pinnipeds. Under the maximum-case scenario for the Phase 2 SCV, additional vessel traffic may shift westward, but overall impacts on marine mammals are not likely to appreciably differ from OECC cables routed through Muskeget Channel alone. Therefore, with implementation of these known and effective measures, BOEM concludes that vessel strikes are unlikely to occur for Phase 2, similar to the assessment of Phase 1. As a result, there is no anticipated effect on marine mammals and collision effects due to Phase 2. Vessel strikes would, therefore, be negligible for mysticetes (including NARW), odontocetes, and pinnipeds.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing non-offshore wind activities that may affect marine mammals include, but are not limited to, submarine cables and pipelines, tidal energy projects, dredging and port improvement, marine minerals extraction, military use (i.e., sonar, munitions training), marine transportation, research initiatives, and installation of new structures (such as artificial reefs) on the U.S.

OCS. Ongoing and planned offshore wind activities in the geographic analysis area for marine mammals include the construction, operations, and decommissioning of 28 planned offshore wind projects.

Accidental releases: In context of reasonably foreseeable environmental trends, combined impacts of accidental releases on marine mammals from ongoing and planned actions, including Alternative B, are expected to be temporary and highly localized due to the likely limited extent and duration of a release. Alternative B would contribute an undetectable increment to cumulative accidental release impacts, resulting in negligible impacts on all mysticetes (including the NARW), odontocetes, and pinnipeds that are barely measurable and with no perceptible population-level consequences.

Anchoring and gear utilization: In context of reasonably foreseeable environmental trends, Alternative B would contribute an undetectable increment to the cumulative impacts of anchoring and gear utilization. As described above, entanglement or entrapment in gear under Alternative B is not anticipated, and risk of entanglement or entrapment would predominantly result from ongoing and planned non-offshore wind projects (Section 3.7.3.1). Cumulative impacts from anchoring and gear utilization are expected to be moderate for mysticetes (except NARW) due to entanglement and bycatch associated with ongoing commercial and recreational fishing as impacts would be detectable and measurable, of medium intensity, and potential long term if the interaction leads to an injury. For NARWs, impacts would be major because entanglements in fishing gear from ongoing commercial and recreational fishing has been identified as a leading cause for mortality, and given the vulnerability of this population, the loss of even on individual would compromise the viability of this species. For odontocetes and pinnipeds, impacts from entanglement and bycatch associated with ongoing commercial and recreational fishing would be minor as the impacts are detectable and measurable, but because the documented risk of this IPF on these species is lower the risk of injury is also lower and no population-level effects are expected.

Fisheries monitoring surveys proposed under Alternative B and for ongoing offshore wind activities are not expected to contribute appreciably to the above-described entanglement or entrapment risk for marine mammals due to the implementation of project-specific monitoring and mitigation measures and the methods employed for these surveys. The potential for impacts on NARWs, mysticetes, and large odontocetes is anticipated to be negligible, while the potential for impacts on small odontocetes and pinnipeds is negligible to minor.

Cable emplacement and maintenance: In context of reasonably foreseeable environmental trends, the combined cable emplacement impacts on marine mammals from ongoing and planned actions, including Alternative B, are expected to be highly localized and temporary. Alternative B would contribute an undetectable increment to the cumulative cable emplacement impacts on mysticetes (including the NARW), odontocetes, and pinnipeds, which are expected to be barely detectable and negligible. Some non-measurable negligible impacts on mysticetes (including the NARW), odontocetes, and pinnipeds could occur if impacts occur in close temporal and spatial proximity, though these impacts would not be expected to be biologically notable and would be minimized due to the implementation of mitigation and monitoring measures. No perceptible population-level consequences are expected.

EMF: In context of reasonably foreseeable environmental trends, the combined impacts of EMF and cable heat on marine mammals from ongoing and planned actions, including Alternative B, are expected to be long term but highly localized. The incremental impact contributed by Alternative B would result in a noticeable increase in EMF in the geographic analysis area beyond that described under Alternative A. However, the cumulative impacts from EMF and cable heat would likely still be negligible and at the lowest level of detection for all mysticetes (including the NARW), odontocetes, and pinnipeds, with no perceptible population-level consequences.

Lighting: In context of reasonably foreseeable environmental trends, the combined impacts of lighting on marine mammals from ongoing and planned actions, including Alternative B, are expected to be long term but highly localized. The incremental impact contributed by Alternative B would result in an increase in artificial lighting in the geographic analysis area beyond that described under Alternative A. However, the cumulative impacts from lighting would still be negligible and at the lowest level of detection for all mysticetes (including the NARW), odontocetes, and pinnipeds, with no perceptible population-level consequences.

Noise: In context of reasonably foreseeable environmental trends, Alternative B would contribute a noticeable increment to the cumulative noise impacts in the geographic analysis area generated by other ongoing and planned activities including offshore wind. Construction-related noise impacts would occur within a limited time frame. However, long-term noise sources from operational turbines and vessels would persist. All effects on marine mammals from noise (e.g., some PTS, TTS, behavioral changes, masking) are anticipated to be the same as described under Alternative A (Section 3.7.3.1). BOEM concludes that the cumulative effects of noise on mysticetes (including NARW), odontocetes, and pinnipeds would be moderate because impacts on individuals would be detectable and measurable, though populations would maintain viability throughout their range.

Port utilization: In the context of reasonably foreseeable environmental trends, Alternative B would contribute incrementally to the combined impacts of port utilization from other ongoing and planned activities including offshore wind, which would likely be minor, as impacts on marine mammals would be detectable, but highly localized and intermittent; population-level impacts would not be expected for mysticetes (including the NARW), odontocetes, and pinnipeds. However, any future port expansion and associated increase in vessel traffic would be subject to independent NEPA analysis and regulatory approvals requiring full consideration of potential effects on marine mammals.

Presence of structures: The incremental impact contributed by Alternative B would result in a noticeable increase in the presence of structures in the geographic analysis area beyond that described under Alternative A. 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. Detectable and measurable impacts may be realized for mysticetes, odontocetes, and pinnipeds, but the viability of each species (except the NARW) is not likely to be compromised. Effects on specific species, including the 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. The potential hydrodynamic effects discussed under Alternative A may influence the availability of already limited prey resources for NARW in the proposed Project area. Although the type and magnitude of effect from changes 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. Effects on each 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. Based on available information the cumulative impacts of Alternative B would be similar to those described for ongoing activities in Section 3.7.3.1. Impacts other than potential prey impacts from hydrodynamic changes from the presence of structures from ongoing and planned activities would likely be minor for mysticetes (including NARW), odontocetes, and pinnipeds. Impacts on individuals would be detectable and measurable; however, they would not lead to population-level effects for most species. Impacts on odontocetes and pinnipeds may result in slight beneficial effects due to increases in aggregations of prey species. These beneficial effects have the potential to be offset by risk of entanglement in fishing gear for some marine mammal species. However, because of the uncertainty of the relative contribution of beneficial and adverse impacts on odontocetes and pinnipeds, the overall impact level determination is minor adverse. Given the uncertainty as described above, the hydrodynamic effects of offshore wind in some areas on prey, including key foraging grounds for NARWs such as the area in and around Nantucket Shoals, the impact on foraging in these is unknown but unlikely able to be distinguished from natural variability and the significant impacts of climate change. BOEM is committed to further studying the impacts of offshore wind operations on NARW prey (BOEM 2024).

Lighting: In context of reasonably foreseeable environmental trends, Alternative B would contribute an undetectable increment to the combined lighting impacts from other ongoing and planned activities including offshore wind, which would likely be negligible, localized, and long term for mysticetes (including the NARW), odontocetes, and pinnipeds, with no perceptible population-level consequences.

Traffic (vessel strike): In context of reasonably foreseeable environmental trends, the combined vessel traffic impacts on marine mammals from ongoing and planned actions, including Alternative B, could range from minor to major, dependent on the number of individuals exposed and population status. Alternative B would contribute a detectable increment to the cumulative traffic (vessel strike) impacts. Collision-related effects would be minor for pinnipeds, odontocetes, and non-listed mysticetes because impacts would be detectable and measurable but would not lead to population-level effects. Given the population status and estimated PBR of 0.7 for NARW, collision-related impacts are considered major for NARW because the removal of even one individual could compromise the viability of the species. Due to the population status of all other listed mysticetes, collision-related effects are considered moderate because population -level effects may be realized, but the viability of the species is not likely to be compromised.

Conclusions

Incremental Impacts of Alternative B. The incremental impact of Alternative B when compared to Alternative A is summarized here. The analysis considered an incremental impact as an impact occurring because of both Phase 1 and Phase 2 of Alternative B alone, without addition of baseline or other ongoing offshore wind and non-offshore wind activities. Noise produced by activities associated with both Phase 1 and Phase 2 of Alternative B, primarily during construction (i.e., noise produced during installation of the WTG and ESP foundations, UXO detonations), would disturb marine mammals and could potentially result in permanent impacts (i.e., PTS). The mitigation and monitoring measures included in Appendix H would minimize noise exposure, and the potential for PTS being realized for NARWs would be avoided. However, PTS is still likely to occur for all other marine mammals during either foundation installation activities or UXO detonations. Impacts from these noise sources would be of medium intensity, though only short-term impacts are expected for NARW. Thus, the incremental impact of noise produced by both Phase 1 and Phase 2 of Alternative B would **moderate** for all marine mammals. More severe impacts on marine mammals, such as mortality or serious injury from vessel strikes and entanglement, are not anticipated from either Phase 1 and Phase 2 of Alternative B due to the mitigation and monitoring measures and additional measures (Appendix H). Beneficial impacts are expected to result from the presence of both Phase 1 and Phase 2 structures as related to the artificial reef effect for pinnipeds and small odontocetes, but these may be offset by the potential risks associated with entanglement from fishing gear.

When including the baseline status (i.e., Alternative A) of marine mammals into the impact findings, the construction, operations, and decommissioning of both Phase 1 and Phase 2 of Alternative B would result in **major** impacts on NARW resulting from non-offshore wind vessel strike and entanglement risk. Due to its current stock status, population-level impacts that threaten the viability of the species could be realized if a NARW vessel strike or entanglement were to occur. As noted in Section 3.7.3.1, BOEM is requiring offshore wind project developers to implement several vessel strike avoidance measures to reduce risk to a level that should functionally avoid vessel strikes. For all other mysticetes, odontocetes, and pinnipeds BOEM expects **moderate** impacts resulting from vessel strike, entanglement risk, and PTS risk resulting from ongoing construction noise. Adverse effects for all other IPFs are expected to be negligible for mysticetes (including NARW), odontocetes, and pinnipeds. Greater than negligible adverse effects would be of medium intensity, of longer duration, and present throughout the entire geographic analysis area but would not be expected to have any long-term effects on the populations, except for

NARW. **Minor** beneficial impacts are expected from the presence of structures as related to the artificial reef effect for pinnipeds and small odontocetes but may be offset by the potential risks associated with gear entanglement from fishing gear.

Cumulative Impacts of Alternative B. In context of reasonably foreseeable environmental trends and planned actions in the geographic analysis area, impacts resulting from individual IPFs from ongoing and planned actions, including both Phase 1 and Phase 2 of Alternative B (which considers Phase 2 SCV), would be **major** for NARW, **moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds, and may potentially include **minor** beneficial impacts from reef effect associated with the presence of structures but may be offset by the potential risks associated with gear entanglement from fishing gear. The main drivers for this impact rating are foundation installation and construction noise, risk of vessel strikes due to non-offshore wind vessel traffic described under Alternative A, risks associated with gear entanglement from fishing gear, and ongoing climate change. Based on the current status of NARW, impacts on NARWs resulting from all IPFs combined from ongoing and planned actions, including Alternative B, are expected to be major because serious injury or loss of an individual would result in population-level impacts that threaten the viability of the species if a vessel strike or entanglement were to occur. Moderate impacts are expected for mysticetes (except NARW), odontocetes, and pinnipeds species, which could result in effects that are of medium intensity, of longer duration, and present throughout the entire geographic analysis area but would not be expected to have any long-term effects on the populations, except for NARW. The presence of structures could result in minor beneficial impacts on pinnipeds and delphinids, but these may be offset by the potential risks associated with entanglement from fishing gear. Alternative B would contribute to the overall impact rating primarily through noise-related IPFs.

BOEM expects cumulative impacts to be **major** for the NARW, as population-level impacts may occur, primarily due to non-offshore wind vessel traffic and entanglement risk associated with anchoring and gear utilization. BOEM further expects individual **moderate** impacts for odontocetes and pinnipeds and could include **minor** beneficial impacts, as impacts would be noticeable and measurable but would not result in population-level impacts. Adverse impacts are expected to result mainly from pile-driving noise, non-offshore wind vessel traffic, and the presence of structures related to fishing gear entanglement. Beneficial impacts for odontocetes and pinnipeds are expected to result from the presence of structures, though these impacts may be offset by increased interactions with fishing gear associated with the presence of structures.

3.7.3.5 Impacts of Alternative C – Habitat Impact Minimization Alternative on Marine Mammals

Alternatives C-1 and C-2 would reduce impacts on complex fisheries habitats compared to impacts of Alternative B through minor adjustments in the OECC route to avoid habitat for cod and other habitats. All other Project components including construction, operations, and decommissioning would align with those of Alternative B.

Since marine mammal habitat selection and use is not limited to or largely influenced by complex fisheries habitat, the changes described above for Alternative C-1 and C-2 are unlikely to result in any measurable differences in impacts on marine mammals from that assessed in Alternative B. Therefore, impacts on marine mammals from each IPF would be the same as described for Alternative B (Section 3.7.3.4).

Conclusions

Incremental Impacts of Alternatives C-1 and C-2. The incremental impact of Alternatives C-1 and C-2 when compared to Alternative A are summarized here. The analysis considered an incremental impact as an impact occurring as a result of Alternative C-1 or C-2 alone, without addition of baseline or other ongoing offshore wind and non-offshore wind activities. The incremental impacts of the construction, operations, and decommissioning of Alternatives C-1 and C-2 would be the same as described under Alternative B, as the minor adjustments in the OECC route to avoid habitat for cod and other habitats would not change the overall impact levels assessed for Alternative B. Noise produced by activities associated with Alternative B, primarily during construction (i.e., pile driving during installation of the WTG and ESP foundations, UXO detonations), would disturb marine mammals and potentially result in permanent impacts (i.e., PTS). The mitigation and monitoring measures would minimize noise exposure, and the potential for PTS being realized for NARWs would be avoided. However, PTS is still likely to occur for all other marine mammals during either foundation installation activities or during UXO detonations. Impacts from these noise sources would be of medium intensity, though only short-term impacts are expected for NARW. Thus, the incremental impact of noise produced by both Alternative C would **moderate** for all marine mammals. More severe impacts on marine mammals such as mortality or serious injury from vessel strikes and entanglement are not anticipated to occur from Alternatives C-1 and C-2 due to the mitigation and monitoring measures and additional measures that would be required as part of the environmental permitting processes, including vessel speed restrictions, required separation distances, vessel strike avoidance measures, use of a dedicated lookout (e.g., a PSO or trained crew member), and surveys for lost or discarded fishing gear around the WTG and ESP foundations (Appendix H). Beneficial impacts are expected from the presence of Project structures as related to the artificial reef effect for pinnipeds and small odontocetes, but these may be offset by the potential risks associated with gear entanglement from fishing gear.

When including the baseline status (i.e., Alternative A) of marine mammals into the impact findings, the construction, operations, and decommissioning of Alternatives C-1 and C-2 would result in individual IPFs of **major** impacts on NARW due to vessel strike and entanglement risk from the ongoing non-offshore wind activities. Due to its current stock status, population-level impacts that threaten the viability of the species could be realized if a NARW vessel strike or entanglement were to occur. As noted in Section 3.7.3.1, BOEM is requiring offshore wind project developers to implement several vessel strike avoidance measures to reduce risk to a level that should functionally avoid vessel strikes. For all other mysticetes, odontocetes, and pinnipeds BOEM expects **moderate** impacts primarily due to vessel strike, entanglement risk, and the risk of PTS from ongoing construction activity noise. Adverse effects from all other IPFs are expected to be **negligible** for mysticetes (including NARWs), odontocetes and pinnipeds. Above negligible adverse effects would be of medium intensity, of longer duration, and present throughout the entire geographic analysis area but would not be expected to have any long-term effects on the populations, except for NARW. **Minor** beneficial impacts are expected to result from the presence of structures as related to the artificial reef effect for pinnipeds and small odontocetes but may be offset by the potential risks associated with gear entanglement from fishing gear.

Cumulative Impacts of Alternatives C-1 and C-2. In context of reasonably foreseeable environmental trends and planned actions in the geographic analysis area, impacts resulting from individual IPFs from ongoing and planned actions, including Alternatives C-1 and C-2, would be **major** for NARW, **moderate** for all other mysticetes (except NARW), odontocetes, and pinnipeds, and may potentially include **minor** beneficial impacts from reef effect. The main drivers for this impact rating are pile driving and construction noise, risk of vessel strikes due to non-offshore wind vessel traffic described under Alternative A, risks associated with gear entanglement from fishing gear, and ongoing climate change. Based on the current status of NARWs, impacts on NARWs resulting from all IPFs combined from ongoing and planned actions, including Alternatives C-1 and C-2, are expected to be major because serious injury or loss of an individual would result in population-level impacts that threaten the viability of the species if a vessel strike or entanglement were to occur. **Moderate** impacts are expected for mysticetes (except NARW), odontocetes, and pinnipeds species, which could result in effects that are of medium intensity, of longer duration, and present throughout the entire geographic analysis area but would not be expected to have any long-term effects on the populations, except for NARW. The presence of structures could result in minor beneficial impacts on pinnipeds and delphinids, but these may be offset by the potential risks associated with entanglement from fishing gear. Alternatives C-1 and C-2 would contribute to the overall impact rating primarily through noise-related IPFs.

3.7.3.6 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Marine Mammals with the Western Muskeget Variant Contingency Option

Impacts on marine mammals from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B. While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential for up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would not change the potential impacts on marine mammals, as reducing the number of WTG and/or ESP foundations to be installed in the SWDA would not change proposed Project activities or impacts within the OECC.

The Preferred Alternative would result in the same level of adverse impacts as Alternative B. The incremental impacts of the Preferred Alternative would have **moderate** impacts on all marine mammals. More severe impacts on marine mammals, such as mortality or serious injury from vessel strikes and entanglement, are not anticipated under the Preferred Alternative due to the mitigation and monitoring measures and additional measures (Appendix H). Beneficial impacts are expected to result from the presence structures under the Preferred Alternative as related to the artificial reef effect for pinnipeds and small odontocetes, but these may be offset by the potential risks associated with entanglement from fishing gear.

In context of reasonably foreseeable environmental trends and planned actions in the geographic analysis area, BOEM anticipates impacts resulting from individual IPFs from ongoing and planned actions, including the Preferred Alternative, to be **major** for the NARW, as population-level impacts may occur, primarily due to non-offshore wind vessel traffic and entanglement risk associated with anchoring and gear utilization. As noted in Section 3.7.3.1, BOEM is requiring offshore wind project developers to implement several vessel strike avoidance measures to reduce risk to a level that should functionally avoid vessel strikes. BOEM further expects individual **moderate** impacts for odontocetes and pinnipeds and could include minor beneficial impacts, as impacts would be noticeable and measurable but would not result in population-level impacts. Adverse impacts are expected to result mainly from pile-driving noise, increased vessel traffic, and the presence of structures related to fishing gear entanglement. Beneficial impacts for odontocetes and pinnipeds are expected to result from the presence of structures, though these impacts may be offset by increased interactions with fishing gear associated with the presence of structures.

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3.8 Sea Turtles

3.8.1 Description of the Affected Environment

3.8.1.1 Geographic Analysis Area

This section discusses existing sea turtles in the geographic analysis area, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.8-1, namely the Northeast Shelf and Southeast Shelf LMEs, which are likely to capture the majority of the movement range within U.S. waters for most species in this group. Table G.1-5 in Appendix G, Impact-Producing Factors Tables and Assessment of Resources with Minor (or Lower) Impacts, summarizes the existing conditions and the anticipated impacts, based on IPFs assessed, of ongoing and future offshore activities other than offshore wind, which is discussed below.

3.8.1.2 Existing Conditions

Four ESA-listed species of sea turtles that occur in the U.S. northwest Atlantic Ocean may also occur in the proposed Project area: leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), and green sea turtles (*Chelonia mydas*). These sea turtle species are migratory and occur in New England waters primarily in the summer and fall. Although occasional occurrences are possible, hawksbill sea turtles (*Eretmochelys imbricata*), which are also protected under the ESA, primarily occur in warmer southern waters associated with coral reef habitats and is exceedingly rare north of Florida (NMFS and USFWS 1993; MGEL 2022). Therefore, hawksbill sea turtles are not likely to occur in the proposed Project area, and this EIS does not consider them further. The other species may use the proposed Project area for traveling and foraging (COP Volume III, Section 6.8; Epsilon 2023). Targeted surveys have been conducted for sea turtles near the proposed Project area, and the results can be found in the *Atlantic Marine Assessment Program for Protected Species* surveys (Palka et al. 2017; 2021), *Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles* (Kraus et al. 2016a), *Megafauna aerial surveys in the wind energy areas of Massachusetts and Rhode Island with emphasis on large whales: Summary Report Campaign 5, 2018-2019* (O'Brien et al. 2021a), *and Megafauna aerial surveys in the wind energy areas of Massachusetts and Rhode Island with emphasis on large whales: Interim Report Campaign 6A, 2020* (O'Brien et al. 2021b).

The combination of sightings, strandings, and bycatch data provides the best available information on sea turtle distribution in the SWDA. This section summarizes data from the most current sightings surveys of the waters around the RI/MA Lease Areas including the SWDA (Kraus et al. 2016a; O'Brien et al. 2021a, 2021b), the NMFS Sea Turtle Stranding and Salvage Network (NMFS 2021g), most recent available density estimates (COP Appendix III-M; Epsilon 2023), and historic regional data (Kenney and Vigness-Raposa 2010). Table 3.8-1 summarizes sea turtle occurrence in the SWDA surrounding waters, and additional detail is provided in Appendix B, Supplemental Information and Additional Figures and Tables. Prey items vary with species, and detailed foraging information is provided in the BA for the proposed Project (BOEM 2023b).

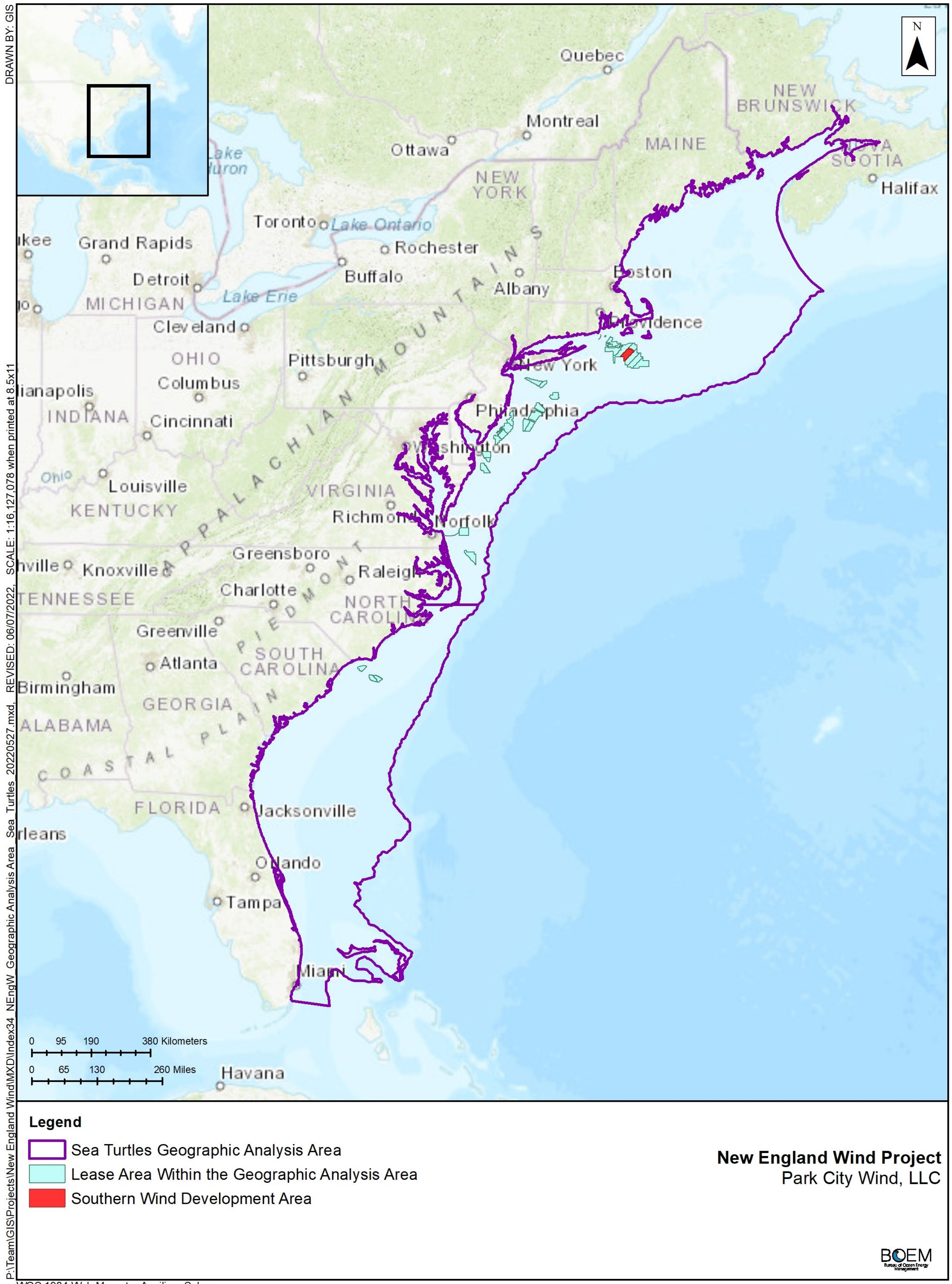


Figure 3.8-1: Geographic Analysis Area for Sea Turtles

Table 3.8-1: Summary of Sea Turtles Likely to Occur in the Coastal Waters in the Southern Wind Development Area and Surrounding Waters

Common Name	Scientific Name	DPS or Population	ESA Status (Massachusetts ESA Status)	Relative Occurrence in the SWDA and Surrounding Waters [a,b]
Green sea turtle	*Chelonia mydas*	North Atlantic DPS	Threatened (Threatened)	Rare
Hawksbill sea turtle	*Eretmochelys imbricata*	Atlantic	Endangered (Endangered)	Not expected
Kemp's ridley sea turtle	*Lepidochelys kempii*	NA	Endangered (Endangered)	Regular (heightened abundance during summer and fall)
Leatherback sea turtle	*Dermochelys coriacea*	Northwest Atlantic subpopulation	Endangered (Endangered)	Common (heightened abundance during summer and fall)
Loggerhead sea turtle	*Caretta caretta*	Northwest Atlantic DPS	Threatened (Threatened)	Common (heightened abundance during summer and fall)

Source: Adapted from COP Volume III; Epsilon 2023

DPS = distinct population segment; ESA = Endangered Species Act; NA = not applicable; SWDA = Southern Wind Development Area

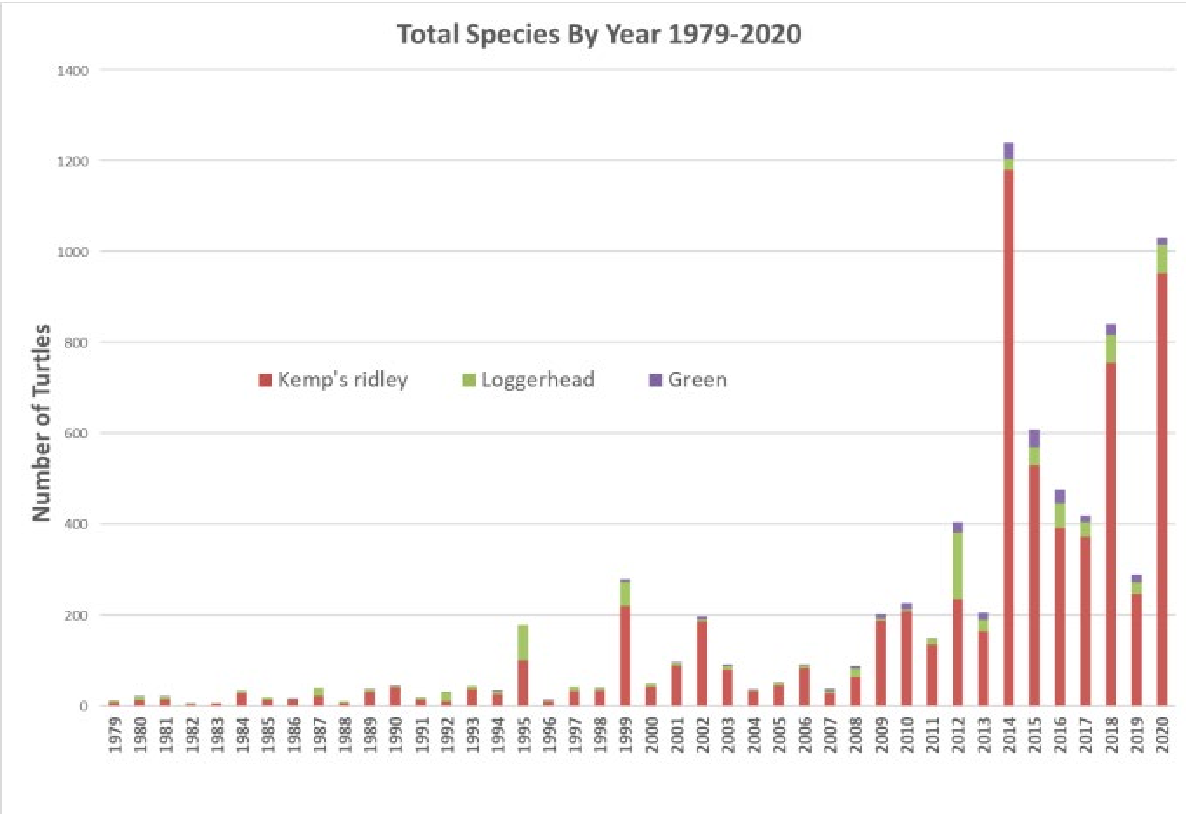
[a] Relative occurrence is categorized as follows:

Common: the species occurs consistently in moderate to large numbers.
Regular: the species occurs in low to moderate numbers on a regular basis or seasonally.
Uncommon: the species occurs in low numbers or on an irregular basis.
Rare: there are limited species records for some years; range includes the SWDA but due to habitat preferences and distribution information, species are not expected of occur in the SWDA. Records may exist for adjacent waters.
Not expected: the SWDA is beyond the species' range; the species is not expected to occur in the SWDA

[b] Seasonal occurrence is defined as follows:

Winter: December, January, February
Spring: March, April, May
Summer: June, July, August
Fall: September, October, November

Figure 3.8-2 shows strandings data for Cape Cod Bay (WBWS 2022). The Northeast Fisheries Observer Program statistical area 537 encompasses the waters from the southern shores of Martha's Vineyard and Nantucket south (including the SWDA and OECC) to the OCS waters off New York (NMFS 2022d). NMFS bycatch data in this area indicated that a total of 33 sea turtles (4 leatherback, 2 green, 21 loggerhead, and 6 unidentified hard-shelled turtles [i.e., unidentified members of Cheloniidae family]) were incidentally caught in monkfish, squid, and skate fishery gear from 2008 through 2021 (NMFS 2022d). These data under-represent the actual number of bycaught turtles due to the limited observer coverage for each fishery. The turtles were caught from June through December, with the majority in July (18 of 31) and August (5 of 31). In area 538, which includes the waters from the south shore of Cape Cod to the southern shores of Martha's Vineyard and Nantucket (and the OECC), one loggerhead turtle was incidentally caught in August 2014 (NMFS 2022d). No Kemp's ridley turtles were incidentally caught in either area from 2008 through 2021 despite the relatively high number of strandings in the area for this species. Interactions with sea turtles and fisheries gear in the SWDA are low compared to regional data.



Source: WBWS 2022

Figure 3.8-2: Sea Turtle Strandings by Year on Cape Cod reported by the Wellfleet Bay Wildlife Sanctuary from 1979 through 2020

Leatherback, loggerhead, and Kemp's ridley sea turtles have been sighted in the waters around the RI/MA Lease Areas, predominantly in the summer and fall (Kraus et al. 2016a; O'Brien et al. 2021a, 2021b). Leatherback (184 sightings) and loggerhead sea turtles (91 sightings) were the most commonly sighted species, occurring mostly during summer and fall, with a few sightings of both species in the spring (Kraus et al. 2016a; O'Brien et al. 2021a, 2021b). Kraus et al. (2016a) sighted a total of six Kemp's ridley sea turtles: one in August and five in September. Over their study period, Kraus et al. (2016a) observed 30 unidentifiable sea turtles, and O'Brien et al. (2021b) observed 1 unidentifiable sea turtle. Because of their high submergence rate and low profile at the sea surface, sea turtles can be difficult to see and identify to species during surveys, and the observed numbers in waters around the RI/MA Lease Areas are likely underestimated. There were no sightings of any species of sea turtle during the winter season. Although green sea turtles were not observed during any of the surveys, stranding records indicate the presence of green sea turtles in the area. Sightings per unit effort (SPUE) data from the Right Whale Consortium (2018) indicate similar trends in the seasonal occurrence for loggerhead, leatherback, Kemp's ridley, and unidentified sea turtles in the proposed Project area. Additional information on sea turtle occurrence in the proposed Project area is available in the BA for the proposed Project (BOEM 2023b).

There are limited density estimates for sea turtles in the SWDA. For this analysis, sea turtle densities were obtained from the U.S. Navy Operating Area Density Estimate database on the Strategic Environmental Research and Development Program Spatial Decision Support System portal (U.S. Navy 2012, 2007) and the Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles (Kraus et al. 2016a). These data are summarized seasonally (winter, spring, summer, and fall).

Because the results from Kraus et al. (2016a) use more recent data, those were used preferentially where possible. The COP (Appendix III-M; Epsilon 2023) notes that the winter densities of sea turtles in the SWDA were likely overestimated because these estimates are provided as a range of potential densities within each grid square, and the maximum density always exceeds zero. Thus, winter densities were reported, even though turtles are unlikely to be present in winter because the COP assumed maximum densities for all seasons. Details on data handling to develop these estimates are available in the COP (Appendix III-M; Epsilon 2023). These estimates suggest that leatherback sea turtles are the most likely species of sea turtle to be found in the proposed Project area followed by loggerhead sea turtles, and their densities would be highest during the summer and fall (Table 3.8-2; COP Appendix III-M; Epsilon 2023).

Table 3.8-2: Sea Turtle Densities Estimates (Animals/100 Square Kilometers [38.6 Square Miles]) for the Southern Wind Development Area

Common Name	Scientific Name	Spring	Summer	Fall	Winter
Kemp's ridley sea turtle	*Lepidochelys kempii*	0.019	0.019	0.019	0.019
Leatherback sea turtle	*Dermochelys coriacea*	0.022	0.630	0.873	0.022
Loggerhead sea turtle	*Caretta caretta*	0.103	0.206	0.633	0.103
Green sea turtle	*Chelonia mydas*	0.019	0.019	0.019	0.019

Source: COP Volume III, Appendix M; Epsilon 2023

Prey items for sea turtles within the proposed Project area vary depending on the species. Loggerhead juveniles are omnivorous, with prey that can include crab, mollusks, jellyfish, and vegetation at or near the surface; subadults and adults feed on benthic invertebrates, including mollusks and decapod crustaceans (TEWG 2009). Green sea turtles feed extensively on algae, sea grasses, and seaweed. Leatherback sea turtles feed primarily on jellyfish and other soft-bodied invertebrates like sea squirts and tunicates (Janßen et al. 2013). Foraging behavior of sea turtles is provided in greater detail in the NMFS BA (BOEM 2023b).

3.8.1.3 Trends

Sea turtles are wide-ranging and long-lived, making population estimates difficult, and methods vary depending on species (TEWG 2007; NMFS and USFWS 2013, 2015a, 2015b, 2023). Since sea turtles have large ranges and highly migratory behaviors, the current condition and trend of sea turtles are affected by factors outside the geographic analysis area (BOEM 2014c, 2021a; NMFS 2020a). Data indicate that the nesting populations of green sea turtles are generally stable or show some signs of increasing nesting trends (NMFS and USFWS 2013, 2015b; TEWG 2007). NMFS and USFWS (2020) concluded that the Northwest Atlantic population of leatherback sea turtles have a total index of nesting female abundance of 20,659 females, with a decreasing nest trend at nesting beaches with the greatest known nesting female abundance. The Northwest Atlantic DPS leatherback sea turtle faces clear and present threats that, along with a declining nest trend, which has accelerated in recent years, place its continued persistence in question. In addition, nesting populations of loggerhead and Kemp's ridley sea turtles have not reached critical benchmark recovery criterion, with reduced nesting populations that indicate the populations are not recovering (NMFS and USFWS 2015a, 2019; Ceriani et al. 2019).

3.8.2 Environmental Consequences

Definitions of potential impact levels for sea turtles are provided in Table 3.8-3.

Table 3.8-3: Impact Level Definitions for Sea Turtles

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts on sea turtles would be undetectable or barely measurable, with no consequences to individuals or populations.
	Beneficial	Impacts on sea turtles would be undetectable or barely measurable, with no consequences to individuals or populations.
Minor	Adverse	Impacts on sea turtles would be detectable and measurable, but of low intensity, highly localized, and temporary or short-term in duration. Impacts may include injury or loss of individuals, but these impacts would not result in population-level impacts.
	Beneficial	Impacts on sea turtles would be detectable and measurable, but of low intensity, highly localized, and temporary or short-term in duration. Impacts could increase survival and fitness, but would not result in population-level impacts.
Moderate	Adverse	Impacts on sea turtles would be detectable and measurable and could result in population-level impacts. Adverse impacts would likely be recoverable and would not affect population or DPS viability.
	Beneficial	Impacts on sea turtles would be detectable and measurable and could result in population-level impacts. Impacts would be measurable at the population level.
Major	Adverse	Impacts on sea turtles would be significant and extensive and long-term in duration, and could have population-level impacts that are not recoverable, even with mitigation.
	Beneficial	Impacts would be significant and extensive and contribute to population or DPS recovery.

DPS = distinct population segment

3.8.2.1 Impacts of Alternative A – No Action Alternative on Sea Turtles

When analyzing the impacts of Alternative A on sea turtles, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities on the existing conditions for sea turtles (Table G.1 5 in Appendix G). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for sea turtles would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Important IPFs for sea turtles within the geographic analysis area are generally associated with accidental releases (i.e., fuel spills and releases of trash and debris), underwater noise, vessel traffic resulting in ship strikes, anchoring and gear utilization, lighting, and ongoing climate change. IPFs may result in a range of impacts, from mortality to minor disturbance, and typically fall across a scale of risk depending on the activities and susceptibility of the species to impacts. These ongoing impacts on sea turtles are expected to continue regardless of the offshore wind industry.

The following ongoing offshore wind activities[28] within the geographic analysis area would contribute to impacts on sea turtles:

[28] Construction of the Revolution Wind Project that is expected to occur at the time of publication of this Final EIS are limited to onshore and nearshore project components (BOEM 2023c), whereas offshore construction in their respective lease areas has begun for the Vineyard Wind 1 and South Fork Wind Projects at the time of publication (BOEM 2021b, 2021c).

- Continued operations of the Block Island Wind Farm (five WTGs) installed in state waters;
- Continued operations of the CVOW-Pilot Project (two WTGs) installed in OCS-A 0497;
- Ongoing construction and eventual operations of offshore wind projects such as Vineyard Wind 1 (62 WTGs and 1 ESP) in OCS-A 0501 and other approved offshore wind projects as discussed in Appendix E; and
- Ongoing site assessment and site characterization surveys (e.g., G&G surveys, habitat monitoring surveys, fisheries monitoring surveys).

Ongoing offshore wind activities would have the same type of impacts from these IPFs as described under cumulative impacts for planned offshore wind activities, but the impacts would be of lower intensity, as there are fewer ongoing offshore wind projects relative to the planned projects (Appendix E).

IPFs associated with ongoing offshore wind and non-offshore wind activities with the potential to affect sea turtles within the geographic analysis area are discussed through the following IPFs.

Accidental releases: Marine pollution is an ongoing threat, as sea turtle ingestion of human trash and debris has been observed in all species of sea turtles (Bugoni et al. 2001; Hoarau et al. 2014; Nelms et al. 2016; Schuyler et al. 2014). Ingestion often occurs when sea turtles mistake debris for potential prey items (Gregory 2009; Hoarau et al. 2014; Tomás et al. 2002). Although the threat varies among species and life stages due to differing feeding, plastic ingestion is an issue for sea turtle species throughout all life stages (Eastman et al. 2020). Ingestion of plastics and other marine debris can result in both lethal and sublethal impacts on sea turtles, with sublethal impacts more difficult to detect (Gall and Thompson 2015; Hoarau et al. 2014; Nelms et al. 2016; Schuyler et al. 2014). Long-term sublethal impacts may include dietary dilution, chemical contamination, depressed immune system function, and poor body condition, as well as reduced growth rates, fecundity, and reproductive success. However, some of these impacts are not well understood, and clear causal links are difficult to identify (Nelms et al. 2016). Trash and debris may be released by vessels or port operations throughout the geographic analysis area. While federal regulations are in place to prevent accidental releases, it is possible that some debris could be lost overboard during ongoing offshore wind and non-offshore wind activities.

Accidental releases, bilge/ballast discharges, and fuel spills have lesser potential impacts on sea turtles due to their low probability of occurrence and relatively limited spatial extent, although impacts of large spills can be significant. However, sea turtle exposure to aquatic contaminants and inhalation of fumes from oil spills can result in mortality (Shigenaka et al. 2010, 2021) or sublethal impacts on individual fitness, including adrenal impacts, dehydration, hematological impacts, increased disease incidence, liver impacts, poor body condition, skin impacts, skeletomuscular impacts, and several other health impacts attributed to oil exposure (Bembenek-Bailey et al. 2019; Camacho et al. 2013; Mitchelmore et al. 2017; Shigenaka et al. 2010, 2021; Vargo et al. 1986). Offshore wind projects will comply with their Oil Spill Response Plan and USCG requirements for the prevention and control of oil and fuel spills, and BOEM assumes all non-offshore wind vessels would comply with laws and regulations such as those recommended by the International Convention for the Prevention of Pollution from Ships to minimize releases. Vessels are also required to adhere to existing state and federal regulations related to ballast and bilge water discharge, including USCG ballast discharge regulations (33 CFR § 151.2025) and USEPA National Pollutant Discharge Elimination System Vessel General Permit standards, both of which regulate discharge of ballast or bilge water.

Accidental releases may also affect sea turtles due to impacts on their prey species. Prey species for the sea turtles present in the geographic analysis area include benthic invertebrates, jellyfish, fish, seagrass, and algae (NMFS and USFWS 2007, 2013, 2015a, 2023). However, based on the analysis of these species provided in Section 3.6, Finfish, Invertebrates, and Essential Fish Habitat, accidental releases are unlikely to result in large-scale changes in sea turtle prey availability.

Though exposure to contaminants or ingestion of trash or debris could result in more severe impacts, BMPs and precautions that all industries follow would reduce the likelihood of exposure, and the extent of potential impacts would be localized to the area around each activity. These impacts would affect individual fitness, but mortality and sublethal impacts associated with accidental releases and discharges are not expected to have population-level impacts. Therefore, impacts from accidental releases and discharges from ongoing activities would likely be minor for sea turtles.

Anchoring and gear utilization: A primary threat to sea turtles is their unintended capture in fishing gear, which can result in drowning or cause injuries that lead to injury and mortality (e.g., swallowing hooks). For example, trawl fishing is among the greatest continuing primary threats to the loggerhead turtle (Bolten et al. 2019) and sea turtles are also caught as bycatch in other fishing gear, including longlines, gillnets, hook and line, pound nets, pot/traps, and dredge fisheries. A substantial impact of commercial fishing on sea turtles is the entrapment or entanglement that occurs with a variety of fishing gear. Anchors associated with vessels and met buoys do not pose a direct risk of entanglement or entrapment for any sea turtle species, and the relatively limited extent of seafloor disturbances due to anchoring would not result in impacts beyond those described under the cumulative impacts scenario for cable emplacement and maintenance.

Existing conditions for commercial fisheries, which contribute the greatest entanglement risk to sea turtles, is discussed and analyzed in Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing. More than 1,200 entangled sea turtles are encountered per year globally, with just over a 90 percent mortality rate (Duncan et al. 2017). Although the requirement for the use of bycatch mitigation measures, such as requirements for "turtle excluder devices" in trawl fishing gear, has reduced sea turtle bycatch, Finkbeiner et al. (2011) compiled data on sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, 4,500 of which were lethal, occurred annually since implementation of bycatch mitigation measures. A reduction of sea turtle interactions with fisheries is a priority for sea turtle recovery.

While impacts from gear utilization associated with biological resource monitoring on individual sea turtles could occur, monitoring plans would have sufficient mitigation procedures in place to reduce potential impacts so as to not result in population-level impacts. Consequently, the likelihood of interactions with sea turtles is considered extremely unlikely.

In summary, overall impacts from anchoring and gear utilization for ongoing non-offshore wind and ongoing offshore wind activities are expected to be moderate for sea turtles due to entanglement and bycatch associated with ongoing commercial fishing, as impacts would be detectable and measurable, of medium intensity, and potentially long-term if the interaction leads to an injury. Fisheries monitoring surveys for ongoing offshore wind activities are not expected to contribute appreciably to the above-described entanglement or entrapment risk for sea turtles due to the implementation of proposed Project-specific monitoring and mitigation measures. Therefore, impacts from anchoring and gear utilization for ongoing offshore wind activities are expected to be minor, as impacts on individuals would be detectable and may include injury or loss of individuals but would not result in population-level impacts.

Climate change: Global climate change is an ongoing risk to sea turtles, although the associated impact mechanisms are complex, not fully understood, and difficult to predict with certainty. Global climate change could result in population-level impacts on sea turtle species by displacement, impacts on prey species, altered population dynamics, and increased mortality. Impacts of climate change include increased storm severity and frequency; increased erosion and sediment deposition; increased disease frequency; ocean acidification; and altered habitat, prey availability, ecology, and migration patterns. Over time, climate change, in combination with coastal development, would alter existing nearshore and coastal (nesting beach) habitats and render some areas unsuitable for some species and more suitable for others. Furthermore, regarding the impacts of temperature on nesting sea turtles, termed "temperature-dependent sex determination," increased temperatures could result in skewed and even lethal incubation conditions, which would result in impacts on turtle species, hatchling success (the proportion of eggs that produce viable hatchlings), hatchling size and locomotory performance, the prevalence of scute abnormalities, and possibly infectious disease outbreaks (National Ocean Service 2023; Laloë and Hays 2023; Patrício et al. 2021). Patel et al. (2021) used global climate models to predict that the future distribution of suitable thermal habitat for loggerheads along the OCS will likely increase in northern regions. Sea turtle nesting could also shift northward on the U.S. Atlantic Coast. Because these changes may affect sea turtle reproduction, survival, and demography, the impacts of climate change resulting from ongoing non-offshore wind activities on sea turtles are expected to be moderate.

Ongoing offshore wind is expected to combat the impacts from climate change over the long-term by providing clean energy and reducing use of fossil fuels. Minor beneficial impacts on sea turtles are anticipated because planned offshore wind activities may reduce the ongoing and predicted rate of climate change.

Lighting: The impacts of coastal development affects sea turtles primarily through habitat loss from development and artificial lighting near sea turtle nesting areas, which can disorient nesting females and hatchlings. Artificial lighting on the OCS does not appear to have the same potential for impacts. In spite of increasing human population growth and associated coastal development, and negative correlation between sea turtle nest numbers and the presence of artificial light (Mazor et al. 2013), Weishampel et al. (2015) found that nighttime light levels decreased for more than two-thirds of Florida's surveyed sea turtle nesting beaches despite coastal urbanization trends. It is anticipated that there will be increasing adoption of state and local lighting ordinances in places where sea turtles nest. However, the impacts of lighting on sea turtles resulting from ongoing non-offshore wind activities would be minor because coastal development trends are likely to continue, and sea turtle nesting is also affected by light from more distant urban lighting. Impacts of lighting on sea turtles from ongoing construction and operations of offshore wind projects have been previously analyzed and were found to be negligible because construction vessel activity was unlikely to measurably alter existing vessel light levels and a lack of evidence that offshore platform illumination leads to impacts on sea turtles.

Noise: In the geographic analysis area, several anthropogenic noise sources are present and may affect sea turtles in a variety of ways. Vessel traffic, pile-driving noise, and active naval sonars are the main anthropogenic contributors to low and mid-frequency noises in oceanic waters (NMFS 2018), with vessel traffic being the dominant contributor to ambient sound levels in frequencies below 200 Hz (Veirs et al. 2016). In the sea turtle geographic analysis area, underwater noise is generated from ongoing non-offshore wind and ongoing offshore wind activities, including impulsive (e.g., impact pile driving, military training [munitions training], G&G surveys) and non-impulsive (e.g., vibratory pile driving, naval sonar, vessels, G&G surveys, aircraft, dredging) sources. The long-term impacts of multiple anthropogenic underwater noise stressors on sea turtles across their large geographical range are difficult to determine, particularly given potential interaction with other stressors. Additional information about sea turtle hearing and acoustic thresholds, as well as characteristics of underwater noise, is provided in Appendix B.

Impulsive sources such as impact pile driving and military munitions training can lead to auditory injury (i.e., PTS, TTS) impacts in sea turtles; in addition, military training activities that result in underwater detonations can also lead to non-auditory injury (i.e., physical injuries such as hemorrhage or damage to the lungs, liver, brain, ears, or gastrointestinal tract) in sea turtles.

G&G surveys in the geographic analysis area may use both impulsive and non-impulsive sources; however, the risk of PTS occurring is extremely low due to the characteristics of these sources and how they are operated, as detailed below. Non-impulsive noise sources ongoing in the sea turtle geographic analysis area include vibratory pile driving, naval sonar, vessels, aircraft, and dredging activities, which are not expected to result in PTS for any sea turtle species given the non-impulsive nature of these sources (see Appendix B for a more detailed description of the characteristics of underwater sound sources).

Impact Pile Driving

The only project activities that would require pile driving in the offshore environment that have potential to affect sea turtles are foundation installations associated with offshore wind projects. However, as discussed previously, the Revolution Wind Project will not have started installation of foundations at the time of publication of this Final EIS, and foundation installation activities for the South Fork Wind Project have been completed as of November 2023 when their construction IHA expired (NMFS 2022b). It is anticipated that foundation installation activities for Vineyard Wind 1 will continue through May 2024 based on the expiration date of in their IHA application, though actual pile-driving activities may end sooner based on the estimated 8-month pile-driving duration included in their IHA (NMFS 2023c). Responses of sea turtles to impact pile-driving noise are not well studied, so research on responses to seismic air guns (another impulsive signal) currently serve as the best available proxy, as detailed further under the cumulative impact scenario. The results of available studies on sea turtles suggest that PTS is unlikely to occur, as the most commonly reported responses to impulsive noise are short-term behavioral changes when relatively close to the sound source, but they may not be affected at lower received levels or at greater distances. Additionally, given the only ongoing pile driving is associated with Vineyard Wind 1, which is only anticipated to continue for a few months after publication of this Final EIS, noise associated with impact pile driving would only be present within the sea turtle geographic analysis area for a relatively short period of time. Therefore, impacts on sea turtles from impact pile driving would be minor, as only short-term, low-intensity behavioral responses are expected that would not result in population-level impacts.

Military Munitions Training

Military munitions training in the sea turtle geographic analysis area is anticipated to occur within the Atlantic Fleet Training and Testing study area based on the current take authorization (50 CFR Part 218); therefore, testing and training activities would be ongoing at the time of publication of this Final EIS. Activities under this authorization include active sonar and other transducers, explosives, air guns, pile driving/removal, and vessels used during transit (50 CFR Part 218). Underwater explosions like those associated with these testing and training activities generate shock waves characterized by extreme changes in pressure, both positive and negative. For a physical description of UXO detonations, see Appendix B. This shock wave can cause injury and mortality to a sea turtle, depending on how close an animal is to the blast. Duronslet et al. (1986) examined the physiological response of submerged and caged turtles placed at 750 feet, 1,200 feet, 1,800 feet, and 3,000 feet to a detonation of 50 pounds of nitromethane. The animals closest to the blast had the most severe physiological responses including dilated blood vessels (loggerhead) and an everted cloaca (Kemp's ridley), while all animals showed some degree of lost control of their vasoconstrictor control centers (sustained pink coloration on throat and flippers). Similar to impacts seen in mammals, the physical range at which injury or mortality could occur will vary based on the amount of explosive material in the detonation, the size of the turtle, and the location of the turtle relative to the explosive. Injuries may include hemorrhage or damage to the lungs, liver, brain, or ears, as well as auditory impairment such as PTS and TTS (Finneran et al. 2017; Ketten et al. 2005). Turtles that are recovering after exposure may be more vulnerable to infection and predation, so there also could be indirect increases in mortality (Popper et al. 2014). However, the proposed testing and training activities would implement mitigation and monitoring measures like pre-clearance monitoring to help reduce the risk of sea turtles being present in proximity to the underwater explosions to help reduce the risk of more severe impacts. Therefore, underwater explosions associated with these activities would result in moderate impacts on sea turtles. The underwater explosions may result in mortality in a few individuals but would not be expected to result in population-level impacts given the irregular occurrence and the relatively small area of the larger sea turtle geographic analysis area this activity covers.

Geological and Geophysical Surveys

G&G surveys in the geographic analysis area would be limited to near shore bathymetric or sand source surveys and the site assessment surveys associated with ongoing offshore wind projects. Bathymetric and sand source surveys would be conducted for storm assessments, dredging depth certification and deposition monitoring, and sand source identification primarily using side scan sonar and multibeam echosounder, which are not expected to have any acoustic impacts on marine mammals; no takes are requested or authorized for these intermittent activities. There are currently 13 active IHAs for site assessment surveys that have been issued by NMFS for the U.S. Atlantic (NMFS 2024h).

Only a subset of geophysical sources (e.g., boomers, sparkers) are likely to be audible by sea turtles given the frequency range of the sounds and the hearing range of turtles (Appendix B), but that subset may cause short-term behavioral disturbance, avoidance, or stress (NSF and USGS 2011). Many HRG sources operate at frequencies above the sea turtle hearing range and are, thus, not expected to affect them. Recently, BOEM and the U.S. Geological Survey characterized the acoustic qualities of HRG sources and their potential to affect marine animals, including sea turtles (Ruppel et al. 2022). In addition to frequency range, other characteristics of the sources like the source level, duty cycle, and beamwidth make it unlikely that these sources would result in behavioral disturbance of sea turtles, even without mitigation (Ruppel et al. 2022). Given the intensity of noise generated by this equipment (Crocker and Fratantonio 2016) and the short duration of proposed surveys, G&G activities are unlikely to result in PTS for any turtle species. Although temporary avoidance or behavioral responses may occur, these disruptions would be limited in extent and short-term in duration given the movement of the survey vessel and the mobility of the animals. Sea turtle behaviors are expected to return to normal once the survey vessel passes a turtle. BOEM has concluded that sea turtle disturbance from underwater noise generated by site characterization and site assessment activities would likely result in temporary displacement and other behavioral or non-biologically significant adverse physiological consequences (Ruppel et al. 2022), and impacts on sea turtles from G&G survey activities would, therefore, be minor.

Vibratory Pile Driving

Vibratory pile-driving activities are anticipated only for offshore wind projects during cable installation or to support foundation installation. As discussed previously, only Vineyard Wind 1 is expected to be installing foundations at the time of publication of this Final EIS, but no vibratory piling of the foundations was proposed for Vineyard Wind 1 (NMFS 2023c). However, all ongoing offshore wind projects may be conducting construction activities to support nearshore cable installation, which may require vibratory pile driving. Vibratory pile driving is a non-impulsive sound source, and the hammer produces sound continuously. Given the non-impulsive nature of this sound source, it is unlikely to result in PTS for any sea turtle species. Vibratory pile-driving noise can exceed levels associated with behavioral disturbances in sea turtles but only within short distances from the source (Denes et al. 2018; COP Appendix III-M; Epsilon 2023). Given this low exposure probability, vibratory pile-driving noise impacts on sea turtles would be negligible at the individual and population levels.

Vessel Noise

Vessel noise has the potential to result in infrequent behavioral impacts on sea turtles, including temporary startle responses and changes to submergence patterns, masking of biologically relevant sounds, and physiological stress (NSF and USGS 2011; Samuel et al. 2005). Sea turtles may respond to vessel approach, noise, or both, with a startle response (diving or swimming away) and/or a temporary stress response by increasing submergence time between breaths, increasing duration of dives, or swimming to the surface (Lenhardt 1994; NSF and USGS 2011; O'Hara and Wilcox 1990; Samuel et al. 2005). Hazel et al. (2007) demonstrated that sea turtles only appear to respond behaviorally to vessels at approximately 33 feet or closer and suggest that sea turtles' ability to detect approaching vessels is primarily vision-dependent, not acoustic. Lester et al. (2013) drew similar conclusions, as they found that an estuarine species (diamondback terrapin) did not change its behavior in response to playbacks of boat noise. The work thus far suggests that sea turtles will only respond to vessel noise within a very close range; therefore, the impacts of vessel noise are expected to be minor. No population-level impacts are expected to occur.

Aircraft Noise

Noises generated by aircraft in the geographic analysis area that are directly relevant to sea turtles include both airborne sounds for individual turtles on land (i.e., nesting) and on the sea surface, as well as underwater sounds from air-to-water transmission from passing aircraft. The dominant tones for both types of aircraft are generally below 500 Hz (Richardson et al. 1995) and are within the auditory range of all sea turtles. A description of the physical qualities of these sound sources can be found in Appendix B. Given the frequency range and sound levels produced, when aircraft travel at relatively low altitude, aircraft noise has the potential to elicit stress or behavioral responses in turtles (e.g., diving or swimming away or altered dive patterns) (BOEM 2016; NSF and USGS 2011; Samuel et al. 2005). Sea turtle sensitivity to airborne noise is not well understood, and existing studies have yielded mixed results. For example, Balazs and Ross (1974) exposed postnatal green sea turtles in a transplanted nest to short duration high intensity noise from aircraft engine testing. On numerous occasions, a sudden burst of activity was noted within the nest at the onset of engine noise and continued until the noise subsided (Balazs and Ross 1974). On the other hand, Bevan et al. (2018) observed no evidence of behavioral responses from three species of sea turtles (green, flatback [*Natator depressus*], and hawksbill turtles) exposed to drones flown directly overhead at altitudes ranging from 50 to 102 feet. Aircraft would operate at altitudes of 1,000 feet or more, except when landing or departing from service vessels. Therefore, disturbance impacts on sea turtles are likely to be negligible given the planned altitude for flights in the geographic analysis area.

Dredging

As described in Appendix E, there are nine dredging projects that are expected to occur within the geographic analysis area. Dredging produces distinct sounds during each specific phase of operation: excavation, transport, and placement of dredged material (Central Dredging Association 2011; Jiménez-Arranz et al. 2020). SPL source levels during backhoe dredge operations range from 163 to 179 dB re 1 μPa m (Nedwell et al. 2008; Reine et al. 2012). As a whole, dredging activities generally produce low-frequency sounds; with most energy below 1,000 Hz and frequency peaks typically occurring between 150 and 300 Hz (McQueen et al. 2018). Additional detail and measurements of dredging sounds can be found in Jiménez-Arranz et al. (2020), McQueen et al. (2018), Robinson et al. (2011), and Appendix B.

There is currently no information on the impacts of dredging noise on sea turtles (Popper et al. 2014). There is evidence, however, of potentially positive impacts of dredging to breeding flatback turtles, which increased their use of a dredging area and made longer and deeper resting dives during dredging operations (Whittock et al. 2017). The most likely driver for the observed behavioral response was speculated to be the absence of predators, which were displaced by the noise from dredging operations. Despite the presence of active dredge vessels (which can often pose a risk to turtles), no events of injury or mortality were recorded. This was attributed to control measures (e.g., drag head chains) in place that seemed to be effective in preventing entrainment (Whittock et al. 2017). In general, sound emitted by dredging operations is sporadic and typically short-term. The impacts of noise from dredging operations on sea turtles are likely to be negligible.

Traffic: Vessel strikes are a concern for sea turtles. The percentage of loggerhead sea turtles stranded with injuries consistent with vessel strikes increased from approximately 10 percent in the 1980s to 20.5 percent in 2004, although an unknown number may have been struck postmortem (NMFS and USFWS 2007). Sea turtle strandings showing vessel strike injuries have been reported to be as high as 25 percent in Chesapeake Bay, Virginia (Barco et al. 2016), and Foley et al. (2019) reported that roughly one-third of stranded sea turtles in Florida had injuries indicative of a vessel strike. Sea turtles are expected to be most susceptible to vessel strikes in shelf waters where they forage (Barkaszi et al. 2021). Furthermore, they cannot reliably avoid being struck by vessels traveling in excess of 2 knots (Hazel et al. 2007); typical vessel speeds in the geographic analysis area may exceed 10 knots. However, despite the potential for individual fatalities, potential impacts are localized, and no population-level impacts on sea turtles are expected. It is expected that most ongoing offshore wind vessel traffic would adhere to vessel speed restrictions, minimization measures for vessel impacts, and visual monitoring, which, while geared primarily toward marine mammals, would help reduce (though would not eliminate) the risk of a strike occurring. Impacts from vessel traffic are expected to be minor, as impacts on individuals would be detectable and may include injury or loss of individuals but would not result in population-level impacts.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind activities to affect sea turtles through the following primary IPFs.

Accidental releases: Gradually increasing non-offshore wind vessel traffic over time would increase the risk of accidental releases. Planned offshore wind activities may also increase accidental releases of fuels, fluids, and hazardous materials and trash and debris due to increased vessel traffic and installation of WTGs and other offshore structures. The risk of accidental releases is expected to be highest during construction, but accidental releases could also occur during operations and decommissioning. Refueling of primary construction vessels at sea is anticipated for planned offshore wind projects. The impacts of accidental releases of fuel/fluids/hazardous materials, and/or trash and debris on sea turtles would be the same as described for the ongoing activities scenario above, but the risk of accidental releases may increase as a result of planned activities. Section G.2.2, Water Quality, discusses potential releases.

Activities under Alternative A would carry a low risk of a leak of fuel/fluids/hazardous materials from any 1 of approximately 3,104 WTGs and ESPs in the geographic analysis area. BOEM estimates that a release of 128,000 gallons is likely to occur no more often than once per 1,000 years, and a release of 2,000 gallons or less is likely to occur every 5 to 20 years (Bejarano et al. 2013). The likelihood of a spill occurring from multiple WTGs and ESPs at the same time is very low; therefore, the potential impacts from a spill larger than 2,000 gallons are largely discountable. Based on the volumes potentially involved, the likely amount of additional releases associated with future offshore wind development would fall within the range of accidental releases that already occur on an ongoing basis from non-offshore wind activities.

BOEM assumes all vessels would comply with laws and regulations such as those recommended by the International Convention for the Prevention of Pollution from Ships to minimize releases. While precautions to prevent accidental releases would be employed by vessels and port operations associated with future offshore wind development, it is likely that some debris could be lost overboard during construction, maintenance, and routine vessel activities. An accidental trash or debris release associated with offshore wind activity would be a localized event, and the amount released would likely be miniscule compared to other existing sources. Therefore, impacts from accidental releases and discharges from ongoing and planned activities would likely be minor for sea turtles.

Anchoring and gear utilization: Ongoing and planned offshore wind activities are likely to include monitoring surveys in the offshore wind lease areas. These could include trawl and trap/pot surveys, as well as other methods of sampling the biota in the area. Sea turtles could be affected by these surveys through survey vessel traffic and interactions with survey gear. Survey vessels would produce underwater noise and increase the risk of vessel strikes. The impacts of vessel noise and increased strike risk would be similar to those discussed under the noise and traffic IPFs. In addition, offshore wind activities would result in disturbances to the seafloor during anchoring and temporarily increase suspended sediment and turbidity levels in and immediately adjacent to the anchorage area. However, the limited extent of seafloor disturbances due to anchoring would not result in impacts beyond those described below for cable emplacement and maintenance.

Impacts on sea turtles could result from interactions with mobile (e.g., trawl, dredge) or fixed (e.g., trap, hydrophone) survey gear. Offshore wind projects are expected to use trawl surveys, among other methods, for project monitoring. The capture and mortality of sea turtles in fisheries using bottom trawls are well documented (Henwood and Stuntz 1987; NMFS and USFWS 1991, 1992; NRC 1990). Although sea turtles are capable of extended dive durations, entanglement and forcible submersion in fishing gear leads to rapid oxygen consumption (Lutcavage and Lutz 1997). Based on available research, restricting tow times to 30 minutes or less is expected to prevent sea turtle morality in trawl nets (Epperly et al. 2002; Sasso and Epperly 2006). BOEM anticipates trawl surveys for offshore wind project monitoring would be limited to tow times of 20 minutes, indicating that this activity poses a very low risk of mortality. Additional mitigation measures would be expected to eliminate the risk of serious injury and mortality from forced submergence for sea turtles caught in bottom-trawl survey gear. Tows for clam dredge surveys would have a short duration of 120 seconds, and the survey vessels would be subject to mitigation measures similar to those for the trawl survey.

The vertical buoy and anchor lines associated with monitoring surveys using fixed gear, such as fish traps or baited remote underwater video, could pose a risk of entanglement for sea turtles. While there is a theoretical risk of sea turtle entanglement in trap and pot gear, particularly for leatherback sea turtles (NMFS 2016c), the likelihood of entanglement would be extremely small given the patchy distribution of sea turtles, the small number of vertical lines used in the surveys, and the relatively limited duration of each sampling event. BOEM also anticipates mitigation measures would be in place to reduce sea turtle interactions during fisheries surveys.

Sea turtle prey species (e.g., crabs, whelks, fish) may be collected as bycatch in trap gear. However, all bycatch is expected to be returned to the water and would still be available as prey for sea turtles regardless of their condition, particularly for loggerhead sea turtles, which are known to forage for live prey and scavenge dead organisms. Given the non-extractive nature of fixed-gear surveys, any impacts on sea turtles from the collection of potential sea turtle prey would be so small that it cannot be meaningfully measured.

Monitoring surveys are expected to occur at short-term, regular intervals over the duration of the monitoring program. It is expected that monitoring plans would have sufficient mitigation procedures in place to reduce potential impacts. Impacts from gear utilization from other offshore wind activities on sea turtles are, therefore, expected to be negligible, with no perceptible consequences to individuals or the population. However, the potential extent and number of animals potentially exposed cannot be determined without proposed Project-specific information.

Cable emplacement and maintenance: The impact on benthic habitat during cable-laying activities would include loss of existing habitat from cable emplacement, scour protection, and hard protection on top of cables. However, the scour protection could create a more complex habitat and increase the abundance of associated organisms like mussels and crustaceans on and around the cables (Hutchison et al. 2020a), providing a prey resource for loggerhead and Kemp's ridley sea turtles. The hard substrate may also increase the abundance of jellyfish, an important prey species for leatherback sea turtles (Janßen et al. 2013).

The impact on water quality from sediment suspension during cable-laying activities is expected to be temporary and short-term. Under Alternative A, cable emplacement would disturb approximately 70,706 acres beginning in 2023 and continuing through 2030 and beyond. Data are not available regarding impacts of suspended sediments on adult and juvenile sea turtles, although elevated suspended sediments may cause individuals to alter normal movements and behaviors. However, these changes are expected to be too small to be detected (NOAA 2021b). Sea turtles would swim through or away from sediment plumes. Elevated turbidity is most likely to temporarily affect the foraging behavior of sea turtles by attracting prey to feed on detritus or by interference with visual prey detection, but no impacts would occur due to swimming through the plume (NOAA 2021b). Turbidity associated with increased sedimentation may result in temporary, short-term impacts on some sea turtle prey species, including benthic mollusks, crustaceans, sponges, "sea pen" octocorals, and crabs. While the cable routes for future offshore wind developments are unknown at this time, the areas subject to increased suspended sediments from simultaneous activities would be limited and all impacts would be localized and temporary. Sediment plumes would be present during construction for 1 to 6 hours at a time. If multiple cable emplacement projects were to occur in close temporal or spatial proximity, this could increase the size of the sediment plumes, which would increase the risk of sea turtles encountering areas of higher turbidity. However, based on the anticipated cable emplacement activities and locations of the proposed offshore wind farm lease areas (Appendix E), it is unlikely that any project would be close enough to result in a sediment plume large enough to adversely affect any sea turtles foraging behavior for a prolonged period of time, as the plume would still be expected to disperse within a few hours.

Additional impacts related to impingement, entrainment, and capture associated with mechanical and hydraulic dredging techniques could also occur. Mechanical dredging is not expected to result in the capture, injury, or mortality of sea turtles (USACE 2020). Sea turtles are vulnerable to impingement or entrainment in hopper dredges, which can result in injury or mortality (USACE 2020). Sea turtles have been known to become entrained in TSHD or trapped beneath the draghead as it moves across the seabed. Direct impacts, especially for entrainment, typically result in severe injury or mortality (Dickerson et al. 2004; USACE 2020). Sea turtles may be crushed during placement of the draghead on the seafloor, impinged if unable to escape the draghead suction and become stuck, or entrained if sucked through the draghead. Of the three direct impacts, entrainment most often results in mortality. However, the risk of interactions between hopper dredges and individual sea turtles is expected to be lower in the open ocean areas where dredging may occur compared to nearshore navigational channels (Michel et al. 2013; USACE 2020). This may be due to the lower density of sea turtles in these areas, as well as differences in behavior and other risk factors (i.e., sea turtle avoidance movements are less constrained in open ocean areas compared to within constricted nearshore areas). Given the available information, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support other offshore wind projects would be minor, and population-level impacts are unlikely to occur.

Climate change: Climate change would continue to affect sea turtles under the planned activities scenario in the same way as described above for the ongoing activities. However, planned offshore wind is expected to combat the impacts from climate change over the long-term by providing clean energy and reducing reliance on and use of fossil fuels. Minor beneficial impacts on sea turtles are anticipated because planned offshore wind activities may reduce the ongoing and predicted rate of climate change. Therefore, impacts on sea turtles from climate change may be reduced.

EMF: Under Alternative A, export cables would be added in 26 BOEM offshore wind lease areas, with at least 6,136 miles of offshore export, inter-array, and inter-link cable added in the geographic analysis area for sea turtles in association with planned offshore wind projects based on submitted COPs to date (Appendix E).

Each cable would generate EMF potentially detectable by sea turtles in the immediate area around the cable (Klimley et al. 2021). The available evidence indicates that sea turtles are magnetosensitive and orient to the Earth's magnetic field for navigation. Although they may be able to detect magnetic fields as low as 0.05 milligauss, sea turtles are unlikely to detect magnetic fields below 50 milligauss (Normandeau et al. 2011; Snoek et al. 2016). Recent reviews by Bilinski (2021) of the impacts of EMF on marine organisms concluded that measurable, though minimal, impacts can occur for some species, but not at the relatively low EMF intensities representative of marine renewable energy projects. Electrical telecommunications cables are likely to induce a weak EMF on the order of 1 to 6.3 microvolts per meter within 3.3 feet of the cable route (Gill et al. 2005). Fiber-optic communications cables with optical repeaters would not produce EMF impacts. Transmission cables using HVAC emit ten times less magnetic field than high-voltage DC (Taormina et al. 2018); therefore, high-voltage AC cables are likely to have less EMF impacts on sea turtles. This EIS anticipates that proposed offshore energy projects would use high-voltage AC transmission, but high-voltage DC designs are possible and could occur. Additionally, potential EMF impacts would be reduced by cable shielding and burial to an appropriate depth, and new submarine cables would be installed to maintain a minimum separation of at least 331 feet from other known cables to avoid damaging existing infrastructure during installation. This separation distance would avoid additive EMF impacts from adjacent cables.

While EMF impacts on sea turtles are not well studied, current construction and mitigation methods would limit projected EMF impacts to below levels that are expected to cause measurable biological impacts. Short-term displacement of individual turtles from the proposed Project area or deviations in their migrations would, therefore, be small and would not be expected to substantially affect energy expenditure in sea turtles. Therefore, although EMF associated with offshore wind development cables could cause some deviations to sea turtle routes, these deviations would likely be small (Normandeau et al. 2011) and biologically insignificant due to the minor energy expenditure they may cause.

Heat transfer into surrounding sediment associated with buried submarine high-voltage cables is possible (Emeana et al. 2016). However, heat transfer is not expected to extend to any appreciable impact into the water column due to the use of thermal shielding, the cable's burial depth, and additional cable protection, such as scour protection or concrete mattresses for cables unable to achieve adequate burial depth. As a result, heat from submarine high-voltage cables is not expected to affect sea turtles.

Impacts from EMF and cable heat from ongoing and planned non-offshore wind activities would likely be negligible for sea turtles as it would be of the lowest level of detection; no perceptible consequences to individuals or populations are expected. Impacts from EMF from other offshore wind activities would similarly be negligible for sea turtles.

Lighting: Offshore wind development would result in additional anthropogenic light from vessels and offshore structures at night. Artificial light pollution, particularly near nesting beaches is detrimental to sea turtles because it alters critical nocturnal behaviors; namely, their choice of nesting sites, their return path to the sea after nesting, and how hatchlings find the sea after emerging from their nests (Witherington et al. 2014). Offshore anthropogenic light sources may result in short-term, low-intensity impacts, including attraction, avoidance, or other behavioral responses that are expected to be localized and temporary. Potential impacts on sea turtles due to anthropogenic light associated with offshore wind activities would be increased primarily during construction, but also during operations and decommissioning of offshore wind facilities.

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

Under Alternative A, up to 3,104 WTGs and ESPs would be constructed incrementally from 2023 through 2030 and beyond in the geographic analysis area, where few lighted structures currently exist. WTGs and ESPs would have minimal yellow flashing navigational lighting and red flashing FAA hazard lights in accordance with FAA (2020) and BOEM (2021a) lighting and marking guidelines (COP Volume I, Section 3.2.1; Epsilon 2023). Available information neither confirms nor refutes the potential for WTG and ESP lighting to generate sufficient downward illumination to affect sea turtles; however, per BOEM (2021a) guidance, direct lighting would be avoided, and indirect lighting of the water surface would be minimized to the greatest extent practicable. In laboratory experiments, captive-reared juvenile loggerhead turtles consistently oriented toward glowing lightsticks of all colors and types used by pelagic longline fisheries (Wang et al. 2019). These results indicate that WTG and ESP lighting may attract loggerhead and possibly Kemp’s ridley and green sea turtles. In a separate study, juvenile leatherback sea turtles do not appear to be attracted to light (Gless et al. 2008). In addition, most juvenile leatherbacks, in contrast to loggerheads, either failed to orient or oriented at an angle away from the lights, although older, adult turtles might show responses that differ from those of juvenile turtles (Gless et al. 2008). Gless et al. (2008) also reviewed previous studies based on fisheries logbook data and concluded that because of confounding factors, there is no convincing evidence that marine turtles are attracted to lights used in longline fisheries. Orr et al. (2013) indicated that lights on wind generators that flash intermittently for navigation or safety purposes do not present a continuous light source and, thus, do not appear to have disorientation impacts on juvenile or adult sea turtles. Although the potential impacts of offshore lighting on juvenile and adult sea turtles are uncertain, WTG lighting is not anticipated to have any detectable impacts (adverse or beneficial) on any age class of sea turtles in the offshore environment (Orr et al. 2013). Further potential impacts arising from offshore lighting could be reduced through the use of ADLS on all offshore structures associated with offshore wind development. Given the highly localized extent of artificial lighting, impacts from ongoing and planned activities would be negligible for sea turtles, of the lowest level of detection, and barely measurable, with no perceptible consequences to individuals or the population.

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

Impact Pile Driving

Noise from impact pile driving would occur during foundation installations for a total of 3,166 non-concurrent pile-driving days under the one-pile-per-day scenario or 1,522 non-concurrent pile-driving days under the two-piles-per-day scenario between 2023 and 2030 (Table 3.7-7). Sea turtles could be displaced up to 6 hours per day during monopile installation and up to 14 hours per day during jacket installation. Responses of sea turtles to impact pile-driving noise are not well studied, so research on responses to seismic air guns (another impulsive signal) currently serve as the best available proxy. Moein et al. (1994) found that caged loggerheads exposed to airguns at received levels of 175 to 179 dB re 1 µPa SPL initially avoided the sound source but appeared to habituate with repeat exposures, even when the exposures were separated by several days (Bartol and Bartol 2011). McCauley et al. (2000) approached one green and one loggerhead turtle in cages with a single airgun and observed startle response starting at received SPLs of 166 dB re 1 µPa. O'Hara and Wilcox (1990) observed nine turtles in a large enclosure within a canal and saw that turtles spent more time in the areas further from the airgun when the firing pressure was at 140 kilograms per square centimeter but not at 70 kilograms per square centimeter (received sound levels not reported).

Field studies with free-swimming animals are generally more appropriate for drawing conclusions, but the work thus far has observed variable behavioral responses. DeRuiter and Larbi Doukara (2012) observed that 57 percent of loggerhead sea turtles in the vicinity of a seismic survey exhibited a diving response after exposure to received levels between 175 and 191 dB re 1 µPa. Observations of multiple species during a 10-month seismic survey off Africa showed that the majority of turtles continued to bask at the surface as the vessel moved by (regardless of whether the airguns were actively shooting) (Weir 2007). Out of the 180 turtles that the authors were able to observe both before and after exposure, only 20 initiated response dives, with no clear difference in whether the airguns were on or off; however, data were too limited to draw firm conclusions (Weir 2007). In addition to changing behavior, exposure to anthropogenic noise may result in the displacement of individuals from important habitats used for foraging, resting, and reproducing (Reese et al. 2023). Taken together, the results of studies with sea turtles suggest that they exhibit short-term responses to impulsive noise when relatively close to the sound source but may not be affected at lower received levels or at greater distances. Overall, impacts on sea turtles from impact pile-driving noise are expected to be minor, as impacts would be temporary and limited to a relatively small range around the source.

Vibratory Pile Driving

Vibratory pile driving is expected to create nearly continuous, non-impulsive, low-frequency noise. This means that the most damaging elements of sound exposure (the rapid rise time) that are possible with impact pile driving do not pose a risk. Source levels for vibratory pile driving, expressed as SEL, have been measured between 175 to 190 dB re 1 $\mu Pa^2 m^2$ s (Hart Crowser et al. 2009; Houghton et al. 2010), which are below threshold associated with potential hearing injury in sea turtles (Finneran et al. 2017). To date, no studies have examined the impact of vibratory pile driving on sea turtles, but if animals remain within an area where vibratory piling is occurring for long enough, they may experience auditory fatigue and acoustic masking due to the continuous nature of this sound source. Reduced hearing sensitivity because of pile driving could limit the ability to detect predators, prey, or potential mates and reduce the survival and fitness of affected individuals. However, the role and importance of sound in these biological functions for sea turtles remains poorly understood (Lavender et al. 2014). Vibratory pile-driving noise can exceed levels associated with behavioral disturbances in sea turtles but only within short distances from the source (Denes et al. 2018; COP Appendix III-M; Epsilon 2023). Given this low exposure probability, vibratory pile-driving noise impacts on sea turtles would be negligible at the individual and population levels.

Drilling

There is very little information on the impacts of underwater drilling sounds on sea turtles. However, sea turtle hearing sensitivity is within the frequency range (100 to 1000 Hz) of sound produced by low-frequency sources such as marine drilling (Popper et al. 2014). It is unlikely that sounds from drilling would reach injury thresholds, unless the sea turtle is within very close proximity to the drilling activity (Dow Piniak et al. 2012; Finneran et al. 2017; McCauley et al. 2000), but it may cause temporary avoidance or displacement of sea turtles. Drilling-related noise is continuous, and source levels for drill ships have been reported to be as high as 191 dB re 1 μPa during drilling, which exceeds the behavioral disturbance threshold of SPL of 175 dB re 1 μPa. Studies of sea turtles in the proximity of platforms are not conclusive regarding whether or not the turtles may habituate to the continuous sound source. Further research is required to understand the potential impacts of marine drilling noise during wind turbine installation on sea turtles, but the impact is expected to be negligible.

Unexploded Ordnance Detonations

Planned offshore wind activities may result in encounters of UXOs on the seabed in lease areas or along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be removed by explosive detonation. There are several options for UXO removal that include stabilizing the UXO for safe relocation without detonation, low-order detonation designed to reduce the net explosive yield of a UXO compared to conventional "blow-in-place" techniques, and high-order detonation in which the full explosive weight is detonated in the place where the object is found. Potential impacts from in-situ UXO detonation would result from both low- and high-order detonation methods, with less intense pressures and noise produced from the low-order detonations. However, though low-order detonation methods would generally be preferred, they may not always fully eliminate the risk of high-order detonation, so potential impacts from in-situ UXO disposal need to be assessed assuming high-order detonations would occur. Noise generated during detonation is dependent on the size and type of UXO, amount of charge used, location, water depth, soil conditions, and burial depth of the UXO. The appropriate method of removal for each project would depend on the condition of the UXO (i.e., how stable it is for potential relocation) and surrounding environmental conditions. If high-order detonations are required for any future offshore wind project, potential impacts on sea turtles would be the same as those described for the ongoing military munitions training activities. High-order detonation methods associated with future offshore wind projects would present impacts on sea turtles. UXO detonations may result in mortality of a few individuals but would not be expected to result in population-level impacts given the irregular occurrence. Therefore, UXO detonation impacts on sea turtles would be minor.

Aircraft Noise

Future offshore wind development may use both helicopters and fixed-wing aircraft during initial site surveys, protected species monitoring prior to and during construction, facility monitoring, and crew transfers during construction. Potential impacts on sea turtles would continue to be the same as those described for the ongoing aircraft activities, but aircraft traffic may increase within the geographic analysis area associated with future offshore projects. However, as described for ongoing aircraft activities, behavioral responses in sea turtles are expected to be undetectable or barely measurable, and impacts would, therefore, be negligible.

Geological and Geophysical Surveys

G&G surveys described for the ongoing activities scenario would continue under the planned activities scenario, with the addition of geophysical surveys performed for future offshore wind projects that use a suite of active acoustic sources to map shallow geophysical features. Likewise, geotechnical surveys associated with these projects may introduce low-level, intermittent, broadband noise into the marine environment, though these sounds are unlikely to result in behavioral disturbance given their low source levels and intermittent use. The types of sources and potential impacts on sea turtles would be similar to those described for the ongoing G&G surveys, and impacts would be limited to temporary displacement and other behavioral or non-biologically significant adverse physiological consequences (Ruppel et al. 2022). Impacts on sea turtles from ongoing and future G&G surveys would, therefore, be minor.

Cable Laying and Trenching

Preparing a lease area for WTG foundation installation and cable laying may require jetting, plowing, or removal of soft sediments, as well as the excavation of rock and other material through various dredging methods. Cable installation vessels are likely to use DP systems while laying the cables. The sound associated with DP generally dominates over other sound sources present, especially compared to the sounds produced by the dredging, trenching, and cable-laying activities themselves. A description of the physical qualities of these sound sources can be found in Appendix B. Given the estimated source levels (Appendix B) and transitory nature of these sources, exceedance of PTS and TTS sound levels are not likely for sea turtles (Heinis et al. 2013), and behavioral disturbances would likely be low-intensity, localized, and result in negligible impacts on sea turtles.

Site Preparation

Mechanical and/or hydraulic dredging may be required to prepare an area for foundation installation. While the acoustic impacts of dredging on sea turtles are expected to be similar to other continuous, non-impulsive sound sources, the response thresholds for sea turtles are not well researched and are poorly understood relative to marine mammals. A description of the physical qualities of these sound sources can be found in COP Appendix III-M (Epsilon 2023). Even right at the source, sound exposure levels from dredging are not expected to exceed the recommended sea turtle cumulative sound exposure threshold for TTS or PTS (SEL: 189 and 204 dB re 1 µPa, respectively) (Finneran et al. 2017; Popper et al. 2014). Behavioral responses are possible close to the source, as suction dredging may produce sounds up to an SPL of 190 dB re 1 µPa (Robinson et al. 2011; Todd et al. 2015), which exceeds the behavioral response threshold of 175 dB re 1 µPa.

Impacts from dredging during site preparation for planned offshore wind projects would be similar to those described for ongoing dredging activities and would, therefore, be negligible, as the risk of exposure would be short-term and localized, and only barely measurable behavioral disturbances are expected.

Wind Turbine Generator Operations

Sound is generated by operating WTGs due to pressure differentials across the airfoils of moving turbine blades and from mechanical noise of bearings and the generator converting kinetic energy to electricity. Sound generated by the airfoils, like aircraft, is produced in the air and enters the water through the air-water interface. Mechanical noise associated with the operating WTG is transmitted into the water as vibration through the foundation and subsea cable. Both airfoil sound and mechanical vibration may result in long-term, continuous noise in the offshore environment. For a full description of the physical nature of operational noise, see Appendix B. The most sensitive hearing range for sea turtles is confined to low frequencies (Bartol 1999; Ridgway et al. 1969b), and sea turtles have shown behavioral avoidance to low-frequency sound (Dow Piniak et al. 2012; O'Hara and Wilcox 1990). Operational WTG underwater noise is expected to be low-frequency and may be audible to sea turtles but only at very close distances to each turbine. Elliot et al. (2019) measured SPLs below 120 dB re 1 µPa at 164 feet from operating turbines at the Block Island Wind Farm, which are below the sound level thresholds expected to cause sea turtle PTS, TTS, and behavioral disturbance (Finneran et al. 2017; NMFS 2022c). However, measured underwater sound levels in the literature are limited to geared smaller wind turbines (less than 6.15 MW), as summarized by Tougaard et al. (2020). Operational noise from larger, current-generation WTGs on the order of 10 MW would generate higher source levels than the range noted above, at around SPL of 170 dB re 1 µPa (Stöber and Thomsen 2021). However, the shift from using gear boxes to direct-drive technology is expected to reduce the sound level by around 10 dB. Although WTG operational noise would be continuous near each wind farm, behavioral impacts would be localized, and sea turtles are likely to become habituated to the sound. Therefore, acoustic impacts on sea turtles are likely to be negligible.

Vessel Noise

Due to the large number of vessels required for planned offshore wind development and the overlap in frequency between vessel noise and sea turtle hearing ranges (see Appendix B for more information on vessel noise), vessel noise could potentially result in impacts on sea turtles. BOEM anticipates that the potential impacts of noise from construction and installation vessels may elicit brief responses to the passing vessel that would dissipate once the vessel or the turtle left the area, similar to those described for ongoing vessel traffic. Therefore, the impacts of vessel noise from non-offshore wind activities would be minor, and no population-level impacts are expected to occur.

Decommissioning

Noise generated by decommissioning activities are likely similar to those outlined for construction activities. A physical description of underwater explosives and mechanical cutting, two potential methods that could be used for decommissioning, can be found in Appendix B. Decommissioning may also cause at least a short-term potential for displacement from established foraging areas or migratory routes and increased vessel noise. Therefore, noise generated by decommissioning activities may result in minor impacts on sea turtles.

Port utilization: Increases in global shipping traffic and expected increases in port activity along the U.S. East Coast from Maine to Virginia—including increased activity associated with future offshore wind projects—would require port modifications to receive the increase in shipping traffic and increased ship size. As described in Section G.2.7, Land Use and Coastal Infrastructure, numerous port and terminal expansions are planned or underway to support the offshore wind industry (including the projects that comprise Alternative A). Future channel deepening and subsequent maintenance that may be necessary to accommodate larger ships required to carry offshore WTG components and/or increased vessel traffic associated with offshore wind projects may result in increased potential high-intensity impacts including entrainment and vessel strikes, but such risk would be highly localized to nearshore habitats. Port expansions would increase the total amount of disturbed benthic habitat, potentially resulting in impacts on some sea turtle prey species. However, the expected disturbance of benthic habitat and resulting impacts on sea turtles would likely be a small percentage of available benthic habitat overall. Increased port utilization due to other offshore wind projects would lead to increases in vessel traffic, with peak vessel traffic occurring during construction activities, decreased activity during operations, and increased activity during decommissioning. In addition, any port expansion and construction activities related to the additional offshore wind projects would add to increased turbidity in the coastal waters.

Impacts from port utilization from ongoing and planned activities on sea turtles would likely be minor, with impacts that would be detectable and measurable but not lead to population-level impacts. However, any future port expansion and associated increase in vessel traffic would be subject to independent NEPA analysis and regulatory approvals requiring full consideration of potential impacts on sea turtles regionwide.

Presence of structures: The presence of offshore wind structures can lead to beneficial and adverse impacts on sea turtles through localized changes to hydrodynamic disturbance, prey aggregation and associated increase in foraging opportunities, incidental hooking from recreational fishing around foundations, entanglement in lost and discarded fishing gear, migration disturbances, and displacement. These impacts may arise from buoys, met towers, WTG foundations, ESP foundations, scour/cable protections, and transmission cable infrastructure during any stage of a project. Alternative A would include up to 3,104 foundations and 31,910 acres of new scour protection and hard protection atop cables. Projects may also install more buoys and met towers. Structures would be added intermittently beginning in 2023 and continuing through 2030 and beyond, and that they would remain until decommissioning of each facility is complete (assuming a 33-year project life).

Anthropogenic structures, especially tall vertical structures such as WTG and ESP foundations, alter local water flow at a fine scale, and could potentially result in localized impacts on sea turtle prey distribution and abundance (Section 3.8.1). Tank tests, such as the one conducted by Miles et al. (2017), conclude that mean water flow is reduced immediately downstream of a monopile foundation but returns to background levels within a distance that is dependent on the pile diameter. For WTG and ESP foundations such as those included in the proposed Project, background conditions would return approximately 328 feet away from each monopile foundation. In addition, altered hydrodynamics can increase seabed scour and sediment suspension around foundations, but BMPs would be in place to minimize scour; therefore, sediment plumes, if any, would return to existing conditions within a short distance.

The changes in fluid flow caused by the presence of an estimated 3,104 structures could also influence sea turtle prey species at a broader spatial scale. Christiansen et al. (2022) have demonstrated that wind wakes and their impacts on surrounding hydrodynamic patterns likely extend tens of kilometers outside the border of wind developments, so the cumulative oceanographic impacts caused by wind wakes may extend farther than immediately surrounding the offshore structures. The existing physical oceanographic conditions in the geographic analysis area, with a particular focus on the southern New England region, are described in Section B.1 of Appendix B. Although waters on the OCS experience considerable vertical mixing throughout much of the year, an important seasonal feature influencing sea turtle prey is the cold pool, which a mass of cold bottom water in the mid-Atlantic bight (the area offshore of the U.S. East Coast from Massachusetts to North Carolina) overlain and surrounded by warmer water. The cold pool forms in late spring and persists through summer, gradually moving southwest, shrinking, and warming due to vertical mixing and other factors (Chen et al. 2018). During summer, local upwelling and local mixing of the cold pool with surface waters provides a source of nutrients, influencing primary productivity of the ecosystem, which in turn influences finfish and invertebrates (Lentz 2017; Matte and Waldhauer 1984). While there is a high degree of uncertainty, the presence of many WTG structures could affect oceanographic and atmospheric conditions by reducing wind-forced mixing of surface waters and increasing vertical mixing of water forced by currents flowing around foundations (Carpenter et al. 2016; Schultze et al. 2020a). During times of stratification (summer), increased mixing could possibly increase pelagic primary productivity in local areas. The ultimate impacts on sea turtle prey species, and, therefore, sea turtles, are of changes to oceanographic and atmospheric conditions caused by offshore structures are not known at this time and are likely to vary seasonally and regionally.

The presence of new structures could result in increased prey items for some sea turtle species. WTG and ESP foundations could increase the mixing of surface waters and deepen the thermocline, possibly increasing pelagic productivity in local areas (English et al. 2017). Additionally, hard-bottom (scour control and rock mattresses used to bury required offshore export cables) and vertical structures (i.e., WTG and ESP foundations) in a soft-bottom habitat can create artificial reefs, thus inducing the artificial reef effect associated with higher densities and biomass of fish and decapod crustaceans (Causon and Gill 2018; Taormina et al. 2018). Invertebrate and fish assemblages may develop around these reef-like elements within the 2 years after construction (English et al. 2017). Although some studies have noted increased biomass and increased production of particulate organic matter by epifauna growing on submerged foundations, it is not clear to what extent the artificial reef effect results in increased productivity versus simply attracting and aggregating fish from the surrounding areas (Causon and Gill 2018). Recent studies have found increased biomass for benthic fish and invertebrates, and possibly for pelagic fish, sea turtles, and birds as well (Pezy et al. 2018; Raoux et al. 2017; Wang et al. 2019), indicating that offshore wind facilities can generate beneficial permanent impacts on local ecosystems, translating to increased foraging opportunities for some sea turtle species (Section 3.8.1.1). The vertical WTG structures may also result in increased primary production and zooplankton, which provide forage for sea turtles and sea turtle prey species.

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

While the anticipated artificial reef effect would result in beneficial impacts on sea turtles, some potential exists for increased exposure to high-intensity risk of interactions with fishing gear that may lead to entanglement, ingestion, injury, and death. The presence of structures may concentrate recreational fishing around foundations, both personal and for-hire, and would also increase the risk of gear loss/damage. This could cause entanglement and increase the potential for entanglement in both lines and nets leading to injury and mortality due to abrasions, loss of limbs, and increased drag leading to reduced foraging efficiency and ability to avoid predators (Berreiros and Raykov 2014; Gregory 2009; Vegter et al. 2014). Between 2016 and 2021, 186 sea turtles were documented as hooked or entangled with recreational fishing gear (Table 3.8-4). These data provided by the Sea Turtle Stranding and Salvage Network (NMFS 2021g) are collected by a network of federal, state, and permitted private partners to identify causes of morbidity and mortality of sea turtles to inform conservation, management, and recovery.

Table 3.8-4: Sea Turtle Probable Incidental Hooking and/or Entanglement with Fishing Gear from 2016 to 2021

State	Loggerhead Sea Turtle (*Caretta caretta)*	Green Sea Turtle (*Chelonia mydas)*	Leatherback Sea Turtle (*Dermochelys coriacea)*	Kemp's Ridley Sea Turtle (*Lepidochelys kempii)*	Unknown	State Total
Virginia	32	2	0	120	25	179
Delaware	1	1	0	1	0	3
New Jersey	1	0	2	0	1	4
New York	7	0	1	1	1	10
Massachusetts	0	0	20	0	0	20
Total	**41**	**3**	**23**	**122**	**27**	**216**

Source: NMFS 2021g

The artificial reef effect may attract recreational fishing effort from inshore areas, as well as sea turtles for foraging opportunities, resulting in a small increase in interactions between sea turtles and fisheries at WTG locations if both fishing and turtles are concentrated around the same foundations. Due to the large number of foundations in each wind development area within the RI/MA Lease Areas, it is likely that recreational and for-hire fisheries would avoid overcrowding structures by dispersing effort across many WTG foundations. However, the risk of entanglement and hooking or ingestion of marine debris could slightly increase as both fishers and turtles may be attracted to the same areas.

Some level of sea turtle displacement out of the lease areas into areas with a higher potential for interactions with ships or fishing gear during the construction stages of future offshore wind development may occur. Given the use of structures in the Gulf of Mexico by sea turtles, as described above, no long-term displacement is expected to occur. After construction, some commercial and recreational fishing vessels may be displaced outside of the WTG grid, and Alternative A would impact all fisheries and all gear types (Section 3.9). Bottom tending mobile gear is more likely to be displaced than fixed gear. Future offshore wind projects would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear compared to smaller fishing vessels with similar gear types that may be easier to maneuver. Shifts in fishing effort to areas adjacent to offshore wind projects (as opposed to within the projects) would not increase the risk of sea turtle interaction with fishing gear beyond current levels due to the patchy distribution of sea turtles. In addition to displacement of fishing effort Alternative A could prompt a shift in gear types from fixed to mobile, or from mobile to fixed gear. However, the impact of such gear shifts (if they occur) on sea turtles is uncertain.

Impacts from the presence of structures from ongoing and planned activities would likely be minor for sea turtles; although impacts on individuals would be detectable and measurable, they would not lead to population-level impacts for most species. Impacts on sea turtles may result in minor beneficial impacts due to increases in aggregations of prey species, though these beneficial impacts have the potential to be offset by risk of hooking or entanglement in fishing gear for sea turtles. However, because of the uncertainty of the relative contribution of beneficial and adverse impacts on sea turtles, the overall impact level determination is minor adverse.

Traffic: Planned offshore wind activities would result in increased vessel traffic due to vessels transiting to and from individual lease areas during construction, operations, and decommissioning. As discussed previously, vessel strikes are an increasing concern for sea turtles. Further, sea turtles may not be able to avoid collisions when vessel speeds exceed 2 knots (Hazel et al. 2007); average vessel speeds in the geographic analysis area may exceed 10 knots. Increased vessel traffic may result in sea turtle injury or mortality.

The relative risk of vessel strikes from wind industry vessels would depend upon the density of sea turtles within the proposed Project area, stage of project development, time of year, number of vessels, and speed of vessels. Collision risk is expected to be greatest when offshore wind vessels transit between the offshore wind lease areas and ports used by each project, as vessel speeds would be highest, and turtles are expected to be most susceptible to strike in coastal foraging areas. Offshore wind projects may also cause shifts in vessel traffic, including temporary restrictions of fishing vessels during construction due to implementation of safety zones, potential increases in vessel traffic within the offshore wind lease areas after construction due to an influx of recreational fishing vessels targeting species associated with an artificial reef effect, and likely shifts in commercial fishing vessels from the offshore wind lease areas to areas not routinely fished due to recreation vessel congestion and gear-conflict concerns. The increased collision risk associated with this incremental increase in vessel traffic may result in sublethal injury or mortality of individual sea turtles. However, despite the potential for individual fatalities, potential impacts are localized, and no population-level impacts on sea turtles are expected. It is expected that planned offshore wind projects will adhere to vessel speed restrictions, minimization measures for vessel impacts, and visual monitoring requirements (Appendix H, Mitigation and Monitoring) which, while geared primarily toward marine mammals, would help reduce the risk of a strike occurring, which results in a serious injury or mortality. With the implementation of these measures, impacts are expected to be minor; while mortality and sublethal impacts associated with vessel strikes under Alternative A may occur, these impacts are not expected to have population-level consequences.

Conclusions

Impacts of Alternative A. Under Alternative A, sea turtles would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built, ongoing activities would have continuing temporary to permanent impacts on sea turtles, primarily through pile-driving noise, presence of structures, vessel traffic, commercial and recreational fisheries gear interactions, and climate change. Impacts of ongoing activities, especially vessel traffic, commercial and recreational fishing gear interaction, and climate change would be **moderate**. The presence of structures and associated artificial reef effect could also result **minor** beneficial impacts.

Cumulative Impacts of Alternative A. In addition to ongoing activities, planned activities other than offshore wind development include increasing vessel traffic, commercial and recreational fishing, new submarine cables and pipelines, channel deepening activities, and the installation of new towers, buoys, and piers (Appendix G). The impacts of planned activities other than offshore wind would be minor. The combination of ongoing activities and planned activities other than offshore wind development to result in moderate impacts on sea turtles, driven primarily by increasing vessel traffic and commercial and recreational fishing gear interactions. The presence of structures and associated artificial reef effect could also result in **minor** beneficial impacts.

The cumulative impacts of Alternative A with other ongoing and planned activities in the geographic analysis area would result in **moderate** impacts, predominantly due to impact pile-driving noise and increased vessel traffic, as well as **minor** beneficial impacts throughout the life of the projects due to the presence of structures and associated artificial reef impacts. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures. The majority of offshore structures in the geographic analysis area for sea turtles would be attributable to the offshore wind industry. The offshore wind industry would also be responsible for a majority of the impacts associated with cable emplacement and EMF, but impacts on sea turtles resulting from these IPFs would be localized and temporary and would not be biologically significant.

3.8.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of impacts on sea turtles:

- The WTG foundation type used: The potential acoustic impacts on sea turtles differ among the WTG foundation types that the proposed Project would use either 12-meter monopile foundations or 4-meter jacket foundations during Phase 1, and either 13-meter monopile foundations or 4-meter jacket foundations during Phase 2 of the proposed Project.
- The number of WTGs and ESPs installed: The scale of potential acoustic impacts on sea turtles increases with the number of WTGs and ESPs installed.

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

3.8.2.3 Impacts of Alternative B – Proposed Action on Sea Turtles

This section identifies potential impacts of Alternative B on sea turtles. When analyzing the impacts of Alternative B on sea turtles, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for sea turtles. Except where otherwise stated, the impacts of Phase 1 decommissioning would be similar to those for Phase 1 construction for all of the IPFs described below.

Impacts of Phase 1

Construction of Phase 1 would affect sea turtles through the following primary IPFs during construction, operations, and decommissioning.

Accidental releases: Potential impacts resulting from accidental releases of hazardous materials and trash/debris during Phase 1 would be similar to those described for Alternative A; therefore, only negligible impacts, if any, on individual sea turtles would occur. The risk of any type of accidental release under Alternative B would be increased primarily during construction or decommissioning but may also occur during operations of the proposed Project. Alternative B would comply with USCG requirements for the prevention and control of oil and fuel spills and would implement proposed BMPs for waste management and mitigation, as well as marine debris awareness training for proposed Project personnel, reducing the likelihood of an accidental release (Appendix H). In the unlikely event of an accidental spill, hydrocarbons could impact sea turtles within 30 to 50 miles of the spill if no protective measures are put in place (COP Volume III, Appendix I-F; Epsilon 2023). The potential impacts of exposure would be sublethal based on the low concentration of hydrocarbons during a potential sea turtle exposure event. Oil spill modeling for Alternative B is provided in the COP (Volume III, Appendix 1-F, Attachment 11; Epsilon 2023). Additionally, adherence to the applicant's OSRP and spill response measure described in Appendix H would mitigate potential impacts from spills. Therefore, due to the unlikelihood of an oil spill, the sublethal level of impact, and the implementation of an OSRP, potential temporary impacts, if any, on sea turtles from accidental oil (or other chemical) spills would be negligible, due to the rare, brief, and highly localized nature of accidental releases.

While the significance level of impacts would remain the same, BOEM may include the following mitigation and monitoring measure to address impacts on sea turtles, as described in detail in Table H-2 of Appendix H:

- Provide proposed Project personnel with informational training on proper storage, handling, and disposal practices to reduce the likelihood of accidental discharges of hazardous materials and trash/debris.

Anchoring and gear utilization: Fisheries monitoring survey methods for Alternative B include demersal otter trawl, drop camera, ventless trap, fish pot, lobster tagging, and Neuston net sampling surveys. The monitoring plan is proposed to be 6 years in duration, including 2 years of pre-construction baseline monitoring, 1 year of monitoring during construction, and 3 years of post-construction monitoring. As described in Section 3.8.2.1, survey gear could affect sea turtles through entanglement or entrapment. The capture and mortality of sea turtles in bottom-trawl fisheries is well documented (Henwood and Stuntz 1987; NMFS and USFWS 1991, 1992, 2008; NRC 1990). NOAA has prioritized reduction of sea turtle interactions with fisheries where these species occur. Finkbeiner et al. (2011) compiled sea turtle bycatch in U.S. fisheries and found that in the Atlantic, a mean estimate of 137,700 interactions, of which 4,500 were lethal, occurred annually since the implementation of bycatch mitigation measures; however, a vast majority of the interactions (98 percent) and mortalities (80 percent) occurred in the Southeast/Gulf of Mexico shrimp trawl fishery, although sampling inconsistencies and limitations should be considered when interpreting this data (NMFS 2014). The trawl vessel and sampling equipment used for the fisheries monitoring plan would be comparable to that used by the Northeast Area Assessment and Monitoring Program. Trawl tow lengths are limited to 20 minutes, and the vessel operating the trawl (a commercial fishing vessel) would tow at 3 knots. The total effort of trawl surveys for the proposed Project is 50, 20-minute tows four times per year or 66.6 hours per year and 400 hours over a 6-year period. The relatively short tow duration is expected to minimize the potential for interactions with sea turtles, as it would reduce the overall amount of time the gear is in the water and, therefore, pose a low risk of mortality. The proposed mitigation measures would be expected to minimize the risk of serious injury and mortality from forced submergence for sea turtles caught in the bottom otter trawl survey gear. Where possible, captured turtles would be disentangled and, if injured, may be brought back to rehabilitation facilities for treatment and recovery. This helps to reduce the rate of death from entanglement. Safe release, disentanglement protocols, and rehabilitation (Appendix H) would help to reduce the severity of impacts of these interactions.

Stationary gear also poses a risk of entanglement for sea turtle species due to buoy and anchor lines. The proposed Project's ventless trap survey includes 30 stations that would be sampled twice monthly from May through December; soak times would be limited to 3 days (when feasible). In the event of a sea turtle capture, survey vessels would be required to carry adequate disentanglement equipment and crew trained in proper handling and disentanglement procedures. While there is a theoretical risk of sea turtle entanglement, particularly for leatherbacks, in trap and pot gear, the likelihood is considered very low given the implementation of mitigation measures (e.g., ropeless gear, biodegradable components; Appendix H), the small number of vertical lines used in the surveys, and the limited duration of each survey event.

Neuston sampling is conducted with a plankton net towed and slow speeds (4 knots) for short periods (10 minutes) in the top 1.6 feet of the water column. The Neuston net frame is 7.8 feet by 1,906.0 feet by 19.6 feet in size, and the net is made of a 1,320-micrometer mesh; although capture is possible, given the relatively small size of the net, the use of trained observers onboard, and the limited tow length duration, no sea turtle entanglement is expected to occur from Neuston net sampling. Drop camera sampling is conducted directly from the stern of vessel and includes continuous monitoring of the seabed. Similarly, HRG and benthic habitat monitoring surveys would not use gear that pose an entanglement risk to sea turtles.

Given the short-term, low-intensity, and localized nature of the impacts of gear utilization for Alternative B, as well as the implementation of proposed mitigation and minimization measures, impacts on sea turtles would be minor, with no population-level impacts realized.

Cable emplacement and maintenance: Sea turtles in the SWDA would likely be foraging for prey items including amphipods and other crustaceans, crabs, gastropods, and bivalves (BOEM 2014c). Phase 1's incremental contribution of up to 442 acres of seafloor disturbed by cable installation and up to 67 acres affected by dredging prior to cable installation. Dredging of sand waves along portions of the OECC may occur under Alternative B; however, it would be limited to only the extent required to achieve the desired cable burial depth during installation of the offshore export cable for both proposed Project phases (COP Section 3.3.1.3.5 and 4.3.1.3.5; Epsilon 2023). The geographic extent over which dredging would occur under Alternative B is site-specific and not extensive (i.e., up to 67 acres). This limited extent minimizes the risk for sea turtles in the proposed Project area. Dredging may be accomplished through the use of a TSHD or through jetting by controlled flow excavation. While both methods would result in seafloor disturbances, only the TSHD equipment would have the additional risk of impingement, entrainment, or capture of sea turtles. Sea turtles are most often able to escape from the oncoming draghead of a hydraulic dredge due to the very slow speed that the draghead advances. During swimming and surfacing, sea turtles are highly unlikely to interact with the draghead and are most vulnerable when foraging or resting on the seafloor. The potential capture of sea turtles in the dredging equipment could occur but is more likely in channels and areas that otherwise have high densities of sea turtles. There are no known large aggregation areas or areas where turtles would be expected to spend large amounts of time stationary on the bottom where they could be entrained in a suction dredge. Additionally, the proposed Project would employ standard USACE PSO requirements on suction/hydraulic dredges used in areas where ESA-listed sea turtles may occur (Appendix H) to help detect sea turtles around the equipment so the dredge can take action to avoid the animal, further decreasing the risk of impingement or entrainment of sea turtles during suction-dredging activities. Therefore, given the short duration of dredging where sea turtles are most vulnerable and the use of trained observers, the risk of injury or mortality of individual sea turtles resulting from dredging necessary to support proposed Project construction would be low, and population-level impacts are unlikely to occur. Therefore, only negligible impacts, if any, on individual sea turtles would occur.

Dredging would also result in turbidity impacts that could temporarily affect some sea turtle prey species, including benthic mollusks, crustaceans, sponges, sea pens, and crabs. Impacts from the emplacement of export and inter-array cabling from other projects would not overlap spatially with Phase 1 (Appendix E), and no additional impacts would occur. Suspended sediment concentrations during activities other than dredging would be within the range of natural variability in the SWDA and OECC. Any dredging necessary prior to cable installation could also generate additional water quality impacts. Construction would affect a small percentage of the available foraging habitat in the geographic analysis area. Benthic recolonization and recovery to pre-construction species assemblages are expected within 2 to 4 years (Van Dalfsen and Essink 2001) but may be as rapid as 100 days (Dernie et al. 2003) due to the similarity of nearby habitats and related species. Because impacts on foraging habitats are mostly temporary and localized, there is no critical habitat or important foraging habitat identified for any sea turtles in the SWDA and OECC, and individual sea turtles, if present, would successfully forage in nearby areas not affected by increased sedimentation, only negligible impacts, if any, on individual sea turtles would occur (NOAA 2021b).

Although construction would have the greatest impact on sea turtles, the maintenance of these cables would also result in potential impacts, specifically when cable repairs are required or cable protection is added. Cable protection would be needed where cable burial desired depth is not feasible. Methods of cable protection would include rocks, gabion rock bags, or concrete mattresses. The applicant estimates approximately 6 percent of the offshore export cables and approximately 2 percent of inter-array and inter-link cables would require cable protection due to insufficient burial depth, totaling approximately 266 acres of hard protection. Recovery rates of these disturbed surfaces would depend on the sea turtle prey species present and their recovery capabilities and would result in negligible impacts on individual sea turtles. The impacts of cable removal during Phase 1 decommissioning would be similar to construction: negligible.

EMF: Both the OECC and inter-array systems are AC cables, and the applicant would bury all cables at a depth of 5 to 8 feet or use additional cable protection (e.g., concrete mattresses) in locations where this target burial depth cannot be reached. Modeled magnetic field levels for Phase 1 indicate that the proposed Project AC would emit a maximum field intensity of 84.3 milligaus [mG] directly above the center line, which decreases to 5.6 mG at 20 feet from the centerline, and EMF levels are anticipated to be comparable if the target burial depth is not reached and cable protection is required (Gradient 2020). Comparison of these results with sensitivity levels for sea turtles suggests that sea turtles are likely magnetosensitive and orient to Earth’s magnetic field for navigation, but they are unlikely to detect magnetic fields below 50 mG (Normandeau 2011). Although desktop studies suggest that sea turtles are capable of sensing magnetic fields from submarine cables, there is little evidence that these small EMFs along a cable corridor would affect turtle navigation or orientation (Normandeau 2011; Papi et al. 2000). Additionally, no nesting beaches, critical habitat, or other biologically important habitats have been identified in the SWDA or OECC that could result in harm to sea turtles should any minor behavioral response occur and animals leave the immediate area. Therefore, the potential long-term impacts on sea turtles exposed to magnetic fields from cables installed under Phase 1 would not be measurable. While EMF associated with the proposed Project’s submerged cables would be detectable by sea turtles, negligible impacts would occur due to the localized nature of EMFs along the cables near the seafloor, the wide ranges of sea turtles, and appropriate shielding and burial depth. EMF from multiple cables would not overlap, even for multiple cables within a single OECC. As discussed previously, cable heat is not likely to result in measurable or detectable impacts on sea turtles. Therefore, EMF and cable heat are expected to result in non-measurable and negligible impacts on sea turtles. These negligible impacts would be removed following proposed Project decommissioning.

Lighting: Phase 1 would contribute lighting from up to 62 WTGs and 1 or 2 ESPs, all of which would be lit with navigational and FAA hazard lighting. Vessel lights during construction (particularly deck working lights) would be substantial, based on the number of vessels involved. Phase 1 decommissioning would be expected to produce less artificial light, as less vessels would be operating concurrently within the SWDA and OECC, and the types of vessels would produce a smaller area of light (COP Volume I, Section 3.3.3; Epsilon 2023). Artificial light in coastal environments is an established stressor for juvenile sea turtles, which use light to aid in navigation and dispersal and can become disoriented when exposed to artificial lighting sources, but the significance of artificial light in offshore environments is less clear (Gless et al. 2008). However, based on the intermittent nature of the proposed lighting during construction and decommissioning, and the relatively short duration of these activities (COP Volume I, Section 3.1.1.3; Epsilon 2023), only short-term behavioral responses for sea turtles, if any, would be expected, and potential impacts would be negligible.

Artificial lighting during operations would be present throughout the life of the proposed Project; however, lighting would only be produced from the WTGs and the small, relative to construction, volume of maintenance vessels (COP Volume I, Section 3.3.2.6; Epsilon 2023). The proposed Project would include ADLS to reduce operations nighttime lighting impacts. ADLS would only activate the red flashing required FAA aviation obstruction lights on WTGs and ESPs when aircraft enter a predefined airspace and turn off when the aircraft are no longer in proximity to the SWDA (COP Appendix III-K; Epsilon 2023). ALDS activation for Phase 1 would occur for approximately 9 minutes per year (less than 0.1 percent of annual nighttime hours) (COP Appendix III-K; Epsilon 2023). Orr et al. (2013) indicated lights on WTG flash intermittently for navigation or safety purposes and do not present a continuous light source. Limpus (2006) suggested intermittent flashing lights with a very short “on” pulse and long “off” interval are non-disruptive to sea turtle behavior, irrespective of the color. Proposed Project-related vessel lighting during operations and during vessel transits would include deck lighting, but exposure would be of shorter duration than during construction. Based on the intermittent nature of the proposed lighting and the lack of evidence that offshore platform illumination leads to impacts on sea turtles, potential long-term impacts of lighting on sea turtles, if any, would be negligible.

Noise: Studies indicate that hearing in sea turtles is generally confined to lower frequencies, below 2,000 Hz, with the range of highest sensitivity between 100 and 700 Hz (Dow Piniak et al. 2012). Table 3.8-5 summarizes current data for species-specific hearing range frequencies. These data were obtained by recording a sea turtle’s auditory evoked potential (AEP). AEP is an electrical response within the sea turtle central nervous system produced when a sound is detectable by the ear (Yost 2007; Au and Hastings 2008). By exposing a sea turtle to various sound intensities and frequencies and recording whether an AEP response occurs, researchers are able to estimate the hearing capabilities of the individuals tested.

Table 3.8-5: Sea Turtle Hearing Ranges[a]

Common Name	Scientific Name	Hearing Range (Hz)	Most Sensitive Hearing Range (Hz)	Reference
Loggerhead sea turtle	*Caretta caretta*	100–1,130 50–80[b]	200–400 (at 110 dB re 1 µPa) 100 (at 98 dB re 1 µPa)	Martin et al. 2012
Kemp’s ridley sea turtle	*Lepidochelys kempii*	100–500	100–200	Bartol and Ketten 2006
Green sea turtle	*Chelonia mydas*	50–1,600	200–400	Piniak et al. 2016
Leatherback sea turtle	*Dermochelys coriacea*	50–1,200	100–400	Dow Piniak et al. 2012

AEP = auditory evoked potential; dB re 1 µPa = decibels referenced to 1 micropascal; Hz = hertz
[a] Hearing ranges based on AEP unless otherwise noted.
[b] This is based on behavioral testing.

Foundation Installation

The WTG and ESP foundations would be installed using a combination of vibratory pile setting and impact pile driving. Sixty-three of the 132 foundations, which includes all pile types (i.e., 12-meter monopile, 13-meter monopile, and 4-meter pin pile for the jacket foundations), would be installed using impact pile driving; the remaining 69 foundations would be installed first using vibratory pile setting followed by impact pile driving. The applicant has determined it may be necessary to start pile installation using a vibratory hammer rather than using an impact hammer, a technique known as vibratory setting of piles. The vibratory method is particularly useful when seabed sediments are not sufficiently stiff to support the weight of the pile during the initial installation, increasing the risk of 'pile run' where a pile sinks rapidly through seabed sediments. The applicant conducted a seabed drivability analysis to estimate the number of foundation positions that could potentially require vibratory setting of piles. The analysis suggested that up to 50 percent of foundations (approximately 66 foundations) could require vibratory setting. An additional 6 percent conservatism is assumed (6 percent of 66 is approximately 4 additional foundations), resulting in approximately 70 total foundations (53 percent of all proposed foundations) that may require vibratory setting (JASCO 2023; COP Appendix III-M; Epsilon 2023).

Acoustic modeling of foundation installation activities was conducted and is presented in the proposed Project COP (Appendix III-M; Epsilon 2023). Additional details of the modeling can be found in Appendix B of this Final EIS, as well as the modeling report (Appendix III-M; Epsilon 2023). For the purposes of the acoustic modeling, multiple construction scenarios were assessed including two foundation types (jacket and monopile); three pile sizes (4-, 12-, and 13-meter diameter); and three levels of noise attenuation (0-, 10-, and 12-dB attenuation) (COP Appendix III-M; Epsilon 2023). Although multiple attenuation levels were evaluated, BOEM anticipates that the noise attenuation system chosen would be capable of reliably reducing source levels by 10 dB; therefore, this assumption was carried forward in this analysis for all applicable modeled activities (JASCO 2022, 2023; 88 Fed. Reg. 37606 [June 8, 2023]). For the purposes of this assessment, two pile sizes were assessed for Phase 1 (the 4-meter jacket and the 12-meter monopile foundations), and two pile sizes were assessed for Phase 2 (the 4-meter jacket and the 13-meter monopile foundations), which are described further under Phase 2. The results summarized here represent the maximum potential ranges modeled, meaning the results provided assume the highest hammer energy included in the acoustic modeling was used to assess the potential for impacts on sea turtles.

Additionally, to provide a realistic estimate of distances at which acoustic thresholds for sea turtles may be met, the COP (Appendix III-M; Epsilon 2023) modeled exposure-based ranges to PTS and behavioral thresholds (Table 3.7-7) that incorporate animal movement modeling. To determine exposure ranges, pile strikes are propagated to create an ensonified environment while simulated animals (i.e., animats) are moved about the ensonified area following expected species-specific behaviors. Modeled animats that have received sound energy that exceeds the acoustic threshold criteria are registered, and the closest point of approach recorded at any point in that animal's movement is then reported as its exposure range. This process is repeated multiple times for each animat. The exposure-based ranges comprise 95 percent of the closest points of approaches for animats that exceeded the threshold (i.e., $ER_{95\%}$). The potential for noise from vibratory pile setting to induce PTS is low relative to impact pile driving; however due to the relatively short (15-minute) period between vibratory and impact piling for each foundation, vibratory setting and impact pile driving must be considered together as part of the total received acoustic energy for the entire pile installation (JASCO 2023; COP Appendix III-M; Epsilon 2023).

Noise mitigation systems, such as those proposed by the applicant (COP Volume III, Section 6.7.4; Epsilon 2023) are often used to create a local barrier around a sound source, which acts as an impedance to noise transmission (COP Appendix III-M; Epsilon 2023). This was incorporated into the modeling in the source propagation component, whereby a broadband reduction of 10 or 12 dB was applied to the noise produced by the modeled pile strikes. As a result, this reduces the sound propagated through the water column and decreases the range over which above-threshold noise will travel (COP Appendix III-M; Epsilon 2023). However, as discussed previously, BOEM determined 10 dB to be the appropriate level of attenuation for the Project, and this level of attenuation was carried forward in the impact determinations discussed in this section.

Sightings and density data indicate that sea turtles are most susceptible to impacts from pile driving during the summer and fall, when expected abundances in the SWDA are relatively moderate to high (August through November) (Kraus et al. 2016a; COP Appendix III-M; Epsilon 2023; O'Brien et al. 2021a, 2021b). Based on the results of the acoustic and exposure modeling (COP Appendix III-M; Epsilon 2023), there is a potential risk of PTS and behavioral disturbance to sea turtles from pile driving. A summary of the modeled exposure ranges for all sea turtles and all pile types installed using impact pile driving only are provided in Table 3.8-6, and the exposure ranges for all pile types installed using vibratory pile setting followed by impact pile driving are provided in Table 3.8-7. The exposure modeling conducted for the COP is described in further detail, and results are summarized in Appendix B.

Table 3.8-6: Summary of Proposed Project 95th Percentile Exposure Ranges (Meters) for Sea Turtle Acoustic Thresholds for Impact Pile Driving of Two Monopile or Four Pin Piles per Day and 10 Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			13-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			4-Meter Pin Pile, Four Piles per Day 3,500 kJ Hammer		
	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)
Kemp's ridley sea turtle (*Lepidochelys kempii)*	0	0	940	0	0	990	0	420	1,120
Leatherback sea turtle (*Dermochelys coriacea*)	0	260	1,470	0	290	1,500	0	1,280	1,280
Loggerhead sea turtle (*Caretta caretta*)	0	0	1,410	0	0	1,320	0	480	1,290
Green sea turtle (*Chelonia mydas*)	0	0	1,250	0	10	1,470	0	240	1,200

Source: COP Appendix III-M; Epsilon 2023

μPa^2 s = micropascal squared second; dB = decibel; dB re 1 μPa = decibels referenced to 1 micropascal; kJ = kilojoule; Lpk = peak sound pressure (dB re 1 μPa); PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours (dB re 1 μPa^2 s); SPL = root-mean-square sound pressure level (dB re 1 μPa)

Table 3.8-7: Summary of Proposed Project 95th Percentile Exposure Ranges (Meters) for Sea Turtle Acoustic Thresholds for Two Monopile or Four Pin Piles per Day Installed using Vibratory Setting of Piles Followed by Impact Pile Driving and 10 Decibel Attenuation

Common Name (Scientific Name)	12-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			13-Meter Monopile, Two Piles per Day 6,000 kJ Hammer			4-Meter Pin Pile, Four Piles per Day 3,500 kJ Hammer		
	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[a]	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[a]	PTS (Lpk)	PTS (SEL_{24h})	Behavior (SPL)[a]
Kemp's ridley sea turtle (*Lepidochelys kempii)*	0	0	930	0	270	1,200	0	280	1,090
Leatherback sea turtle (*Dermochelys coriacea*)	0	390	1,520	0	410	1,510	0	1,480	1,280
Loggerhead sea turtle (*Caretta caretta*)	0	210	1,170	0	310	1,430	0	580	1,300
Green sea turtle (*Chelonia mydas*)	0	0	1,230	0	10	1,450	0	380	1,240

Source: COP Appendix III-M; Epsilon 2023

μPa^2 s = micropascal squared second; dB = decibel; dB re 1 µPa = decibels referenced to 1 micropascal; kJ = kilojoule; Lpk = peak sound pressure (dB re 1 µPa); PTS = permanent threshold shift; SEL_{24h} = sound exposure level over 24 hours (dB re 1 μPa^2 s); SPL = root-mean-square sound pressure level (dB re 1 µPa)

[a] For behavior, the SPL 175 dB re 1 µPa threshold does not account for duration and instead assumes exposure if an animal is exposed to above-threshold noise in that instant an exposure could occur. Conversely, the SEL_{24h} threshold accounts for the noise produced by both vibratory pile setting followed by impact pile driving to reach the PTS threshold, whereas the behavior threshold only considers 1 second on vibratory pile setting or a single impact piling hammer hit. Therefore, the ranges to the behavioral disturbance threshold presented in this table would only apply to either vibratory pile setting noise or impact pile-driving noise, not both. Because the ranges to the behavioral disturbance threshold for only impact pile-driving noise are presented in Table 3.8-6 of this Final EIS, the ranges to the behavioral disturbance thresholds in this table apply for only vibratory pile setting noise modeled in COP Appendix III-M (Epsilon 2023).

Results of the modeling indicate there is a risk of PTS occurring for sea turtles during foundation installation activities. Modeled exposure ranges to the PTS thresholds ranged from 0 to 4,856 feet (0 to 1,480 meters) for all foundation types installed using vibratory pile setting followed by impact pile driving (Table 3.8-7), and results of the exposure modeling indicate PTS exposures may occur for all sea turtle species except Kemp's ridley and green sea turtles (Appendix B). These two species had less than one modeled PTS exposure, so the risk for these species is extremely unlikely. There have been no documented sea turtle mortalities associated with pile driving, and sea turtle anatomy may make them resistant to percussive shock waves due to their skeletal structure and construction of their skulls, which helps to reflect or mitigate the impact of rapid increases in underwater pressure (Madin 2009). Given the relatively low densities of sea turtles in the SWDA; soft starts, which give individuals an opportunity to leave the area before injurious levels are received; and the implementation of monitoring zones and clearance zones (Appendix H), mortal injury would not occur. The proposed clearance and shutdown zones for sea turtles during all foundation installation activities are 5,249 feet (1,600 meters) and 4,921 feet (1,500 meters), respectively (Appendix H). The effective range for reliable and consistent visual detection of sea turtles from vessels can be up to 1,640 feet (500 meters) in good visibility conditions (Barkaszi and Kelly 2019; Smultea Environmental Sciences 2020; Vandeperre et al. 2019), although any reduction in visibility conditions would affect the detection range for sea turtles. While pile-driving activities would, to the extent feasible, be limited to the daytime, the modeling in the COP

(Appendix III-M; Epsilon 2023) currently assumes that some of the ESP and WTG foundations may require nighttime pile driving. If nighttime pile-driving activities are required, the proposed Project would implement additional measures, such technologies and methodologies effective for nighttime monitoring of sea turtles in their nighttime pile-driving monitoring plan, which would be developed through consultation with BOEM and NMFS (Appendix H). Implementation of these mitigation measures may reduce the risk of PTS in sea turtles but would not eliminate the risk, so PTS is still considered possible for loggerhead and leatherback sea turtles during foundation installation activities. However, results of the exposure modeling (Appendix B, Section B.6) indicate only a maximum of four leatherback sea turtles and one loggerhead sea turtle may be exposed to noise above the PTS SEL_{24h} threshold during foundation installation activities; as such, the likelihood of this level of exposure having population-level impacts is low.

Modeling results indicate the ranges to the behavioral disturbance threshold for sea turtles range from 3,051 feet (930 meters) to 0.9 miles (1.5 kilometers) for all foundation types installed using vibratory pile setting followed by impact pile driving (Table 3.8-7). Behavioral responses to pile-driving activities could range from a startle with immediate resumption of normal behaviors to complete avoidance of or displacement from the area and could also include changes in diving patterns or changes in foraging behavior (Bowles et al. 1999; DeRuiter and Doukara 2010; Lenhardt 2002; McCauley et al. 2000; Moein et al. 1994; O'Hara and Wilcox 1990; Southwood et al. 2008; Weir 2007). With 10 dB noise attenuation, the behavioral threshold for sea turtles may be met up to 3,675 to 4,232 feet (1,120 to 1,290 meters) from the jacket piles and 4,101 to 3,365 feet (1,250 to 1,940 meters) from the monopiles (Table 3.8-6 and Table 3.8-7). Sea turtles foraging or migrating within these ranges from the piles being driven are likely to temporarily alter these behaviors and/or make evasive movements (changes in diving or swimming patterns) until they are outside the area where noise is elevated above the behavioral disturbance threshold (Weir 2007; DeRuiter and Doukara 2010; Reese et al. 2023). Additionally, there is no critical habitat or important areas for foraging or nesting identified within the SWDA, so temporary avoidance of the area during pile driving is not expected to interrupt these biologically important behaviors. The most likely impact would be from temporary behavioral disturbance associated with foundation installation activities, and implementation of the mitigation and monitoring measures such as trained observers, soft start, and shutdowns described previously for PTS (Appendix H) would further minimize the risk of biologically significant behavioral impacts, as it would reduce the overall amount of time noise exceeding the behavioral threshold for sea turtles is present within the geographic analysis area. Overall, BOEM considers impacts from foundation installation activities to be moderate for sea turtles, given the risk of PTS occurring, but due to the low number of individuals likely to be exposed (Appendix B), no population-level impacts are expected. It is also likely behavioral disturbances would occur, but these are expected to be short-term and would dissipate once the pile driving has ceased. No population-level impacts are expected.

Foundation Drilling

Foundation drilling may be used on a portion of the piles to reduce the risk of pile run and ensure the pile can be installed to the target depth (JASCO 2023). While foundation drilling was not modeled for sea turtles, the information provided in the proposed Project's LOA (JASCO 2023) enables a qualitative assessment of vibratory pile setting using published data of potential received noise levels that may be produced during proposed Project vibratory pile setting. Assuming the unweighted SPL levels at 2,461 feet (750 meters) were approximately 136 dB re 1 µPa during the summer (JASCO 2023), it was estimated that the SPL source level back-calculated to 3.3 feet (1 meter) using spherical spreading loss was 193 dB re 1 µPa m. The estimated source level for this activity is below the PTS-onset SEL_{24h} threshold of 220 dB re μPa^2 s for sea turtles in response to non-impulsive sources, so PTS is not likely to occur during foundation drilling activities. Additionally, the sea turtle SPL behavioral threshold of 175 dB re 1 µPa may be met or exceeded only within approximately 26 feet (8 meters) during foundation drilling using a practical spreading loss equation. Given that not all foundations would require drilling activities and that these ranges are well within the mitigation zones identified for foundation installation (Appendix H), the likelihood of behavioral disturbances that would affect foraging, migrating, or mating behaviors is considered extremely low. Impacts from foundation drilling may, therefore, result in minor impacts on sea turtle species in the geographic analysis area.

Unexploded Ordnance Detonations

Potential UXO detonations would also present a risk of impact on sea turtles. Preliminary survey data for the SWDA indicates there is a risk of UXOs that cannot be avoided or removed through non-explosive methods. The analysis in the Letter of Authorization application (JASCO 2022) estimated up to 10 UXO may be detonated over a 2-year period during construction. Underwater detonations of UXO present the risk of non-auditory injury for sea turtles such as lung or gastrointestinal injuries; PTS; and behavioral disturbances represented by TTS (U.S. Navy 2017). A quantitative analysis of ranges to non-auditory injury, PTS, and TTS ranges was not included for sea turtles (JASCO 2022); however, based on the thresholds from Finneran et al. (2017), the result of the analysis for marine mammals (Section 3.7, Marine Mammals), and the proposed mitigation and monitoring measures for UXO detonations (Appendix H), non-auditory injury and mortality are not expected to occur, and the most likely impacts on sea turtles would result from PTS and TTS. The proposed Project would implement mitigation measures including 10 dB noise attenuation during the detonations, a 60-minute pre-clearance period before any detonations to ensure sea turtles are not present within the 5,249-foot clearance zone would reduce the risk of sea turtles being exposed to noise above, non-auditory injury, PTS- and TTS-onset thresholds. Impacts from potential UXO detonations would, therefore, be expected to result in moderate impacts on sea turtles.

Aircraft Noise

Helicopters transiting to the SWDA would fly too high for their noise to cause behavioral responses from sea turtles, except when flying low to inspect WTGs or when taking off and landing on the SOV. While helicopter traffic may cause some short-term behavioral reactions in sea turtles (BOEM 2017a; NSF and USGS 2011; Samuel et al. 2005), these brief responses would dissipate once the aircraft has left the area. These impacts would be temporary, short-term, and negligible, resulting in minimal energy expenditure.

Geological and Geophysical Surveys

Offshore and nearshore HRG surveys would be conducted just prior to construction, during, and post-construction for various activities including cable and foundation installation (JASCO 2022). Equipment that operates under 180 kHz included in the proposed Project includes the Applied Acoustics AA251 boomer and GeoMarine's Geo Spark 2000 (400 tip) sparker system. It was assumed that HRG surveys would be conducted for 24 hours per day for up to 25 days each year (totaling 125 days over the 5-year ITA period) beginning in the first year of foundation installation and extending 2 years beyond the 3-year foundation installation schedule (JASCO 2022).

Noise from G&G surveys associated with the pre-construction site investigation used to aide installation of proposed Project cables and foundations may affect sea turtles. The G&G surveys would use only electromechanical sources such as boomer, sparker, and chirp sub-bottom profilers; side-scan sonar; and multi-beam depth sounders. Acoustic signals from electromechanical sources other than the boomer and sparker are not likely to be detectable by sea turtles. Boomers and sparkers have an operating frequency range of 200 Hz to 16 kHz and could be audible to sea turtles; however, these sources have very short pulse lengths (120, 150, or 180 microseconds) and a very low source level. No injurious impacts are expected for sea turtles from any G&G survey equipment (Ruppel et al. 2022). G&G equipment operating at the highest power setting could cause behavioral disturbances up to 295 feet from impulsive sources and up to 6.6 feet from non-impulsive sources (Baker and Howsen 2021). Additionally, the proposed

Project will implement monitoring and mitigation measures including the use of trained observers to monitor for the presence of sea turtles around the equipment and a 328-foot clearance and shutdown zone for sea turtles (Appendix H). As such, BOEM believes that injury is unlikely due to the narrow radius of impact and the brief duration of the acoustic impacts. Because the potential for injury is small and potential behavioral responses would be brief, temporary, and result in no long-lasting impacts, minor impacts on sea turtles from G&G survey noise would occur.

Cable Laying and Trenching

During Phase 1 construction, all cables would be installed by simultaneous laying and burying using jetting techniques or mechanical plow, depending on bottom type/conditions, water depth, and contractor preference. As described in Section 3.8.2.1, these activities may result in behavioral disturbances for some sea turtles, though these are expected to be low-intensity and localized (Heinis et al. 2013). Additionally, because activities associated with the proposed Project are expected to be short-term and localized, and impacts on all sea turtles from dredging or trenching activities during cable laying are expected to be negligible.

Vessel Noise

Underwater noise levels produced by construction and maintenance vessels throughout the life of the proposed Project are not expected to exceed PTS thresholds for sea turtles. The main frequency range of vessels (10 to 1,000 Hz) overlaps with the frequency range of sea turtle hearing (100 to 1,200 Hz) (Bartol and Ketten 2006; Lavender et al. 2014); sea turtles can detect vessel noise and could respond with a startle or temporary stress response (NSF and USGS 2011). However, sea turtles may also habituate to vessel traffic associated with the proposed Project as they inhabit areas that experience regular marine traffic (Hazel et al. 2007). A conservative assumption is that proposed Project construction and support vessels could elicit behavioral changes in individual sea turtles present in the proposed Project area during vessel operations, but these changes would be limited to evasive maneuvers such as diving, changes in swimming direction, or changes in swimming speed. These changes are not expected to be biologically notable, and impacts on sea turtles from vessel noise associated with Phase 1 would, therefore, be minor.

Construction Noise Summary

As outlined above, no serious injury or mortality is expected to occur as a result of foundation installation activities or UXO detonations. The applicant has committed to using noise-reduction technologies during all foundation installation and UXO detonation activities to ensure a minimum attenuation of 10 dB would reduce the area impacted by noise during construction. The specific technologies have not yet been selected; potential options include a noise mitigation system, hydro-sound damper, noise abatement system, a bubble curtain, or similar (COP Appendix III-M; Epsilon 2023). The applicant would use PSO during foundation installation, foundation drilling, UXO detonation, and G&G survey activities to reduce the potential noise impacts by establishing and maintaining exclusion zones to minimize sea turtle exposure to injurious levels of noise. The detectability of sea turtles is dependent upon metrological conditions, PSO training, PSO fatigue, and animal behavior. PSO training and shift requirements, as detailed in Appendix H, would increase the ability of PSOs to detect listed species. The applicant would also submit an alternative monitoring plan to ensure the ability to maintain exclusions zones during adverse monitoring conditions.

While the significance level of impacts would remain the same, BOEM may include the following mitigation and monitoring measures to address impacts on sea turtles, as described in detail in Table H-2 of Appendix H:

- Monitor foundation installation noise to comply with required noise reductions identified through consultations with NMFS (Appendix A, Required Environmental Permits and Consultations; Appendix H);
- Refine exclusion zones based on field measurements;
- Perform daily surveys prior to starting any foundation installation activities to ensure that sea turtles are not present in the area at the start of installation;
- Implement additional mitigation measures for foundation installation activities conduced at night to ensure that all clearance zones are maintained; and
- Report—daily and weekly—sea turtles observed, if any, during foundation installation operations.

The combined impacts on sea turtles due to various anthropogenic noise sources on sea turtles from construction of Phase 1 are expected to range from negligible to moderate. The moderate and temporary impacts that would result from UXO detonations would cease once the detonations had stopped, at which point sea turtle behavior would return to normal. Although permanent hearing impairment could occur, there is evidence that sea turtles rely upon other senses including magnetic orientation (Avens and Lohmann 2003; Light et al. 1993; Putman et al. 2015) and vision (Avens and Lohmann 2003; Narazaki et al. 2013) Affected individuals may not have to adjust their life history strategies in response to auditory injury, but the consequences of hearing impairment in sea turtles are difficult to study and are not well understood. However, as discussed above, non-auditory injuries and PTS are not expected to occur during any proposed activity as a result of Phase 1.

Operational Noise Summary

The only noise present during operations would be from G&G surveys, vessel noise, and WTG operations. A detailed description of the source characteristics for each of these activities is provided in Appendix B. Noise from G&G surveys during Phase 1 operations would be the same as described for construction. As described in Section 3.8.2.1, sea turtles would likely be able to hear the continuous underwater noise of WTGs aerodynamics and mechanical vibration throughout the life of the proposed Project. However, based on the results in Kraus et al. (2016a) and Tougaard et al. (2020), the received SPLs generated by the WTGs are expected to be at or below ambient levels at relatively short distances from the foundations, and noise from vessel traffic is expected generally to exceed noise from operational WTGs. Elliot et al. (2019) measured SPLs below 120 dB re 1 μPa at 164 feet from operating turbines at the Block Island Wind Farm, which are below the sound level thresholds expected to cause sea turtle PTS, TTS, and behavioral disturbance (Finneran et al. 2017). Although WTG operational noise would be continuous near each wind farm, behavioral impacts would be localized, and sea turtles are likely to become habituated to the sound.

Vessel traffic would continue to be present throughout the operational life of the proposed Project. The types of vessels present during operations would consist primarily of smaller supply or crew vessels, and the larger transport vessels used during construction would not be used, which would lower the risk of severe injury occurring. However, because vessel activities associated with the proposed Project operations would be present through the life of the proposed Project and the same mitigation measure described for construction would be implemented for operational vessels, the potential impacts on sea turtles are expected to be the same as what was described for construction. Impacts from noise during Phase 1 operations would, therefore, be minor.

Decommissioning

Decommissioning impacts would include noise emitted from underwater acetylene cutting torches, mechanical cutting, high-pressure water jets, and vacuum pumps. SPLs are not available for these types of equipment but are not expected to be higher than construction vessel noise (i.e., generally between 177 and 200 dB re 1 μPa m [Erbe et al. 2019]). In addition, the applicant would conduct G&G and ROV surveys for site clearance activities, which would have similar impacts as those described for similar activities during construction and operations. Overall, potential impacts from noise on sea turtles during decommissioning are expected to be negligible.

Port utilization: A number of existing ports would be used by proposed Project vessels throughout the duration of Phase 1 construction and operations activities. However, Phase 1 of the proposed Project does not include implementing any port upgrades or modifications (COP Volume I, Section 3.2.2.5; Epsilon 2023). As no port expansion activities are considered, Phase 1 would not impact sea turtle populations. Impacts on sea turtles would, therefore, be negligible.

Presence of structures: The various types of impacts on sea turtles that could result from the presence of structures, such as entanglement and gear loss/damage, fish aggregation and habitat conversion, and avoidance/displacement, are similar to those described in Section 3.8.2.1 but would be expected over a smaller scale given the number of turbines included under Alternative B. Phase 1 would result in a conversion of soft-bottom habitat to hard-bottom due to scour protection. Based on the assumptions in Appendix E, future offshore wind development would result in up to approximately 32,188,468 acres of structures and associated scour protection, as well as new hard protection for cables. Of this area, only 108 acres would result from Phase 1, and the remainder would result from other offshore wind projects in the geographic analysis area. Phase 1 would contribute up to 64 of the estimated 3,104 WTGs and ESPs in the geographic analysis area. The structures and scour/cable protection, and the potential consequential impacts, would remain at least until decommissioning of each facility is complete (assuming a 33-year project life).

The spacing and size of the offshore wind structures are not expected to pose barriers to movement of sea turtles. Further, sea turtles are well documented around similar offshore structures in the Gulf of Mexico, California, and other parts of the world (Barnette 2017; NRC 1996; Gitschlag 1990; Gitschlag and Herczeg 1994), so it is unlikely that the presence of proposed Project structures would result in any significant barriers or changes to sea turtle movement or behaviors within the SWDA. Hydrodynamic changes in prey aggregations would primarily affect the leatherback sea turtle that feed on planktonic prey (NMFS and USFWS 2020) that have limited independent movement beyond the ocean currents, as opposed to green sea turtles, loggerhead sea turtles, and Kemp's ridley sea turtles whose diets include organisms that are sessile or can actively swim against ocean currents (NMFS and USFWS 2007, 2015a, 2023). The abundance and distribution of jellyfish are influenced by a number of factors rather than just currents, including sea surface temperature and prey (zooplankton) availability (Gibbons and Richardson 2008). Leatherback turtle prey, such as jellyfish, may be affected by changes in nutrient cycling and currents as a result of changes in oceanographic and hydrological changes due to the presence of proposed Project structures. However, these changes would be highly localized (Floeter et al. 2017; Miles et al. 2017; Schultze et al. 2020a), and no localized or large-scale changes in jellyfish biomass are expected from Alternative B. Additionally given their widespread range (NMFS and USFWS 2020), foraging resources for leatherback sea turtles would be available outside of the proposed Project area if any alterations to jellyfish abundances were to occur as a result of the proposed Project. The impacts on sea turtle prey availability resulting from changes in oceanographic and hydrological conditions due to presence of structures, if any, would be so small that they could not be meaningfully evaluated.

However, presence of these structures is also expected to attract fishing activity, which may increase the risk of accidental releases of trash and debris or entanglement in fishing gear. Interactions with lost fishing gear, such as hook and line or gill net gear around WTG foundations, is another potential long-term risk and may result in hooking, entanglement, ingestion, injury, and death of individual turtles (Gregory 2009; Vegter et al. 2014). Given sea turtle proclivity for using anthropogenic structures and documented impacts of discarded fishing gear on sea turtles (Barnette 2017), secondary entanglement resulting in serious injury or mortality may occur. The risk of increased interactions with active or abandoned fishing gear would result in minor impacts on sea turtles, as impacts on or loss of individuals may occur, but no population-level impacts are expected. These impacts would be removed following proposed Project decommissioning.

Christiansen et al. (2022) developed a model to assess the wake-related wind speed deficits that occur in the lee of a wind farm. The study focused on the sea surface interference of single wake effects due to the recent upsurge in offshore wind energy production and resulting larger-scale disturbances in hydrodynamics and thermodynamics in the southern and central North Sea. The results of the modeling effort indicated a reduction in sea surface currents and potentially a reduction in the temperature and salinity distribution and stratification within areas of wind farm operations, potentially extending kilometers away from offshore wind developments. Changing wind directions were shown to inhibit severe local impact surrounding individual wind farms, but a potential cascading impact could occur in areas with clustered wind farms, as proposed for the southern New England subregion. The potential change in surface water mixing could result in changes to biological productivity of the southern New England region. However, Christiansen et al. (2022) did not identify an overwhelming impact on the biological productivity of the German Bight. In comparison, other studies have concluded that wind farms could also increase the mixing of surface waters and deepen the thermocline, possibly increasing pelagic productivity in local areas (English et al. 2017; Daewel et al. 2022). Daewel et al. (2022) found that the depth of the mixed layer is predicted to be 1 or 2 meters shallower around the turbines and that the residual current past the turbine was reduced by 15 percent. Net primary productivity both decreased and increased depending on the spatial layout considered, with an overall change in the phytoplankton biomass of less than 1 percent (Daewel et al. 2022). Christiansen et al. (2022) showed that even though variability occurred in temperature and salinity, the changes were indistinguishable from interannual variability. European wind farm facilities differ, as they are in shallower waters with weak seasonal stratification, in sheltered areas along the coasts and are arranged with tight spacing of turbines (Lentz 2017; Hogan et al. 2023). Therefore, caution should be taken when making direct comparisons of the potential impacts of hydrodynamic changes to the waters within the RI/MA Lease Areas. A field survey of a Dutch wind energy facility found no wind energy facility impacts on bivalve recruitment (Bergman et al. 2010). Considering that potential impacts on the pelagic environment are likely to be non-measurable and localized, impacts of pelagic changes would be negligible.

While the significance level of impacts would remain the same, BOEM may include the following mitigation and monitoring measure to address impacts on sea turtles, as described in detail in Table H-2 of Appendix H:

- Conduct annual remotely operated underwater vehicle surveys, reporting, and monofilament and other fishing gear cleanup around WTG foundations.

Though the abandoned fishing gear would be removed, the potential for entanglement and/or hooking associated with active commercial or recreational fishing gear would still exist but be greatly reduced over the lifetime of the proposed Project. Overall, the presence of structures associated with Phase 1 would result in minor impacts on sea turtles, as well as potential minor beneficial impacts resulting from increased foraging and sheltering opportunities. Beneficial impacts, however, may be offset given the increased risk of hooking and entanglement due to derelict fishing gear on the structures.

Traffic: Propeller and collision injuries from boats and ships are common for sea turtles. Sea turtles are likely to be most susceptible to vessel collision in coastal waters, where they forage, when vessels transit from ports. Vessel speed may exceed 10 knots during such transits. Vessels traveling at greater than 10 knots pose the greatest threat to sea turtles (Sapp 2010; Foley et al. 2008), and evidence suggests that they cannot reliably avoid being struck by vessels exceeding 2 knots (Hazel et al. 2007). The increased risk of vessel strike would be greatest during construction or decommissioning when the largest number of vessels are operating but may also occur during operations of the proposed Project. Construction vessels would range in size from 66 to 98 feet to 394 to 732 feet, with operational speeds from 10 to 25 knots. During the most active construction period, the applicant estimates an average of 22 proposed Project-related vessels operating within the SWDA or along the OECC at any given time and up to approximately 56 proposed Project-related vessels operating concurrently within the SWDA during high-traffic periods (COP Volume I, Section 3.3.1.12.1; Epsilon 2023). In an extreme case, all 22 of these vessels could need to travel to or from New Bedford Harbor or a secondary port in the same day; however, the applicant estimates that activities during Phase 1's most active period would typically generate a maximum of 15 vessel trips per day to or from ports. The maximum number of vessels involved in Phase 1 at any one time is highly dependent on the proposed Project's final schedule, the final design of the proposed Project's components, and the logistics solution used to achieve compliance with the Jones Act (COP Appendix III-I; Epsilon 2023). Vessel traffic associated with Phase 1 poses a high frequency, high exposure collision risk to sea turtles in coastal waters, particularly during operations at night and/or during periods of poor visibility and high sea states. Based upon the existing traffic conditions described in the proposed Project's Navigation Safety Risk Assessment (COP Appendix III-I; Epsilon 2023), the contribution of the number of vessel trips under the proposed Project (COP Volume I, Section 3.2; Epsilon 2023) compared to current levels would be moderate to high during construction and operations.

Approximately 3,200 total vessel round trips are expected to occur during offshore construction of Phase 1, which equates to an approximate average of six vessel round trips per day under an 18-month offshore construction schedule (COP Volume I, Section 3.3.1.12.1; Epsilon 2023). These estimates are based upon the installation of up to 64 foundations (including up to 2 ESPs, with the remainder for WTGs) during Phase 1 and represent the maximum-case scenario. The applicant anticipates that WTG and ESP components, as well as offshore export cables, would be shipped from Canadian and European ports, either directly to the SWDA or through a U.S. port. It is expected that these vessels would follow the major navigation routes and would be making similar trips to U.S. ports in the absence of Phase 1 (Michael Clayton, Pers. Comm., July 23, 2020). During operations, approximately 250 vessel round trips are estimated to take place annually for Phase 1 operations, equating to less than one round-trip transit per day (COP Volume I; Epsilon 2023).

Based on the sea turtle densities estimates for the SWDA and OECC for spring through fall (COP Appendix III-M; Epsilon 2023), densities range from relatively moderate for leatherback and loggerhead sea turtles to low for Kemp's ridley and green sea turtles, which can correspond with relative risk of interacting with proposed Project vessels. Leatherback sea turtle density estimates have a high of 0.0087 animals per square kilometer in the fall and a low of 0.0002 animal per square kilometer in winter and spring. This equates to up to four leatherback sea turtles within the 175-square-mile (453-square kilometer) SWDA during their period of expected maximum abundance in the fall. Kemp's ridley sea turtle density estimates are 0.00017 animal per square kilometer for spring through winter. This equates to up to less than one Kemp's ridley sea turtle within the 175-square-mile (453-square kilometer) SWDA year-round. Green sea turtle density estimates are 0.00017 animal per square kilometer for spring through winter. This equates to up to less than one green sea turtle within the 175-square-mile (453-square kilometer) SWDA year-round. Loggerhead sea turtle density estimates have a high of 0.0063 animals per square kilometer in the fall and a low of 0.0010 animals per square kilometer in winter and spring. This equates to up to three leatherback sea turtles within the 175-square-mile (453-square kilometer) SWDA during their period of expected maximum abundance in the fall.

There are limited measures that have been proven to be effective at reducing collisions between sea turtles and vessels (Schoeman et al. 2020). Also, the relatively small size of turtles and the significant time spent at or just below the surface makes their observation by vessel operators extremely difficult, thus reducing the effectiveness of PSOs to mitigate vessel strike risk on sea turtles. Nevertheless, BOEM may include the following mitigation and monitoring measures to address impacts on sea turtles, as described in detail in Table H-2 of Appendix H. These measures are designed to reduce the amount and extent of ESA-listed species take related to pile-driving noise and vessel strike:

- Require vessel strike avoidance procedures and protected species reporting to ensure vigilance by vessel crews during transit;
- Require vessel observers to monitor a vessel strike avoidance zone around proposed Project vessels; and
- Use AIS to monitor the number of proposed Project vessels, traffic patterns, and proposed Project vessel compliance with required speed restrictions.

The increase in vessel round trips from Alternative B construction and operations is likely to increase the relative risk of vessel strike for sea turtles, particularly during nighttime and periods of reduced visibility. Based on this analysis, proposed Project vessel traffic leading to collisions with sea turtles cannot be discounted given the incremental increase in vessel traffic and the difficulty in detecting sea turtles during transits, even with relatively low total abundances expected for all species. Periods where construction vessel traffic associated with Phase 1 would be the highest are limited during the winter months and, therefore, not likely to lower the risk to sea turtles in a substantial way, as the seasonal differences in construction activities are largely driven by the presence of NARW (Section 3.7). The mitigation and monitoring measures described above would reduce the overall encounter potential. The deployment of trained observers on all vessels along with operable and effective monitoring equipment would additionally serve to minimize the collision risk with sea turtles. As a result of these measures, the probability of a vessel strike between proposed Project vessels and sea turtles throughout all Project stages would be reduced but not eliminated. Therefore, impacts on individual sea turtles due to vessel strikes would likely be minor, and no population-level impacts would occur.

Impacts of Phase 2

Impact levels from IPFs during Phase 2 are expected to be similar to those of Phase 1 with similar construction, operations, and decommissioning methods and techniques. However, if each phase is fully built using the maximum design scenario for each, impacts on sea turtles would be nominally greater during Phase 2 than Phase 1 due to the larger number of foundations. If the applicant includes the SCV as part of the final proposed Project design, some or all of the impacts on sea turtles from the Phase 2 OECC through Muskeget Channel would not occur. BOEM will provide a more detailed analysis of the impacts of the SCV on sea turtles in a supplemental NEPA analysis, if the SCV is selected.

Phase 2 operations would require routine, preventative maintenance, and equipment inspections equivalent to Phase 1 (COP Volume III, Section 4.3.2; Epsilon 2023). The maximum-case scenario for Phase 2 includes 400 nautical miles (460 miles) of offshore export, inter-array, and inter-link cables (Appendix III-T; Epsilon 2023), which represents an increase of 159 nautical miles (182 miles) of cable compared to Phase 1. However, impacts on sea turtles during Phase 2 operations are not anticipated to be appreciably different from Phase 1 and, therefore, would be the same as for the Phase 1 operations. Under the maximum-case scenario for the Phase 2 SCV, routine maintenance, preventative maintenance, and equipment inspections would still occur, but overall impacts on sea turtles are not likely to appreciably differ from OECC cables routed through Muskeget Channel alone.

Phase 2 decommissioning is anticipated to be the same sequence and timeframe but in reverse of construction and would require the removal of all proposed Project components, including foundations, cables, fluids, and chemicals (COP Volume III, Section 4.3.3; Epsilon 2023). The process is expected to be equivalent to Phase 1 decommissioning. Impacts on sea turtles during Phase 2 decommissioning, including the SCV, are not anticipated to be appreciably different from Phase 1 and would be the same as for Phase 1 decommissioning. The impact determinations for IPFs associated with Phase 2 decommissioning, inclusive of the SCV, would not change or would be greatly reduced for sea turtles compared to Phase 2 construction.

Accidental releases: The incremental impacts of Phase 2 from accidental releases of hazardous materials and trash/debris would be the same as Phase 1. Because Phase 1 would be operational during construction of Phase 2, impacts of accidental releases during Phase 2, including the SCV, would have the same impacts as Phase 1 and would remain negligible.

Anchoring and gear utilization: The incremental impacts of Phase 2 from anchoring and gear utilization would be the same as Phase 1. Impacts of anchoring and gear utilization during Phase 2, including the SCV, would have the same impacts as Phase 1 and would, therefore, remain negligible.

Cable emplacement and maintenance: The maximum design scenario for Phase 1 states that 442 acres of seafloor would be disturbed as a result of cable installation and dredging prior to cable installation in the SWDA and OECC (COP Appendix III-T; Epsilon 2023). Under the maximum-case scenario for Phase 2, 732 acres of seafloor would be disturbed, or 290 more acres than Phase 1. Under the maximum-case scenario for the Phase 2 SCV, up to 629 acres of bottom disturbance would occur within federal waters in addition to Phase 2 OECC routed through Muskeget Channel (Epsilon 2023). However, the overall impacts of cable emplacement and maintenance from Phase 2 would be similar to those described for Phase 1; temporary increases in turbidity and risk of impingement or entrainment in dredging. Though Phase 2 would disturb a larger area, dredging using TSHD equipment would still be limited to a relatively small area if any sand wave removal activities are required, as described for Phase 1, and the same mitigation would be applied during these activities as described for Phase 1 (Appendix H). As a result, cable emplacement and maintenance from Phase 2 would have the same impacts as Phase 1 and would remain negligible.

EMF: The maximum-case scenario for Phase 2 includes 400 nautical miles (460 miles) of offshore export, inter-array, and inter-link cables (Appendix III-T; Epsilon 2023), which represents an increase of 159 nautical miles (182 miles) of cable compared to Phase 1. However, impacts on sea turtles from Phase 2 are not expected to differ appreciably from that of Phase 1. Therefore, the incremental impacts of Phase 2 from EMF and cable heat would be the same as Phase 1. Impacts of EMF and cable heat during Phase 2, including the SCV, would remain negligible.

Lighting: The incremental impacts of Phase 2 from lighting would be the same as Phase 1 and would, therefore, remain negligible. While Phase 1 would be operational during construction of Phase 2, impacts of lighting during Phase 2, including the SCV, would have the same impacts as Phase 1 and would, thus, remain negligible.

Noise: Noise generated during Phase 2 (inclusive of the Phase 2 OECC SCV option) from construction, vibratory pile setting and impact pile driving of the foundations, drilling, potential UXO detonations, G&G survey activities, aircraft, cable laying, operations, and vessel traffic could contribute to impacts on sea turtles similar to the potential impacts discussed for Phase 1. The SCV option would shift the location of noise-producing activities but is not expected to have a different impact on sea turtles. During construction of Phase 2, which is anticipated to start after construction of Phase 1 is completed (COP Volume I, Section 4.1.1.3; Epsilon 2023), up to 89 foundations (of which up to 3 would be ESPs, with the remainder for WTGs) would be installed during Phase 2 using a combination of vibratory pile setting followed by impact pile driving and impact pile driving only methods, which could include three foundation types: monopiles, jackets, or bottom-frame foundations. The Phase 2 PDE also includes the

12-meter and 13-meter monopile and 4-meter jacket pile foundation types used for Phase 1. A bottom-frame foundation may also be used during Phase 2, which would have the same 4-meter maximum pile diameter as the jacket foundation but with shallower penetration. Although the bottom-frame foundation was not modeled separately, it is assumed that the potential acoustic impact would be equivalent to or less than that predicted for the jacket foundation (COP Appendix III-M; Epsilon 2023).

Due to the temporary, localized nature of noise produced by foundation installation activities under Phase 2, and the implementation of extensive mitigation and monitoring measures described for Phase 1 (Appendix H), risk of exposure to above-threshold noise levels is expected to be minimized. The impacts of installation of a bottom-frame foundations would be similar to those described for jacket foundations (COP Appendix III-M; Epsilon 2023). The impact on sea turtles from noise exposure is not expected to differ if the applicant includes the SCV as part of the final proposed Project design. Construction of Phase 2 would occur after construction of Phase 1 has been completed rather than occurring concurrently, so it would also not be expected to result in any additive risk to sea turtles species. Additionally, the modeling results presented for Phase 1 use the maximum modeling scenarios for all pile types assessed, and the exposure in Appendix B considers the full construction schedule inclusive of Phase 1 and Phase 2, so the previous assessment is considered applicable for both phases. Therefore, impacts from Phase 2 would be the same as under Phase 1 and would remain moderate overall due to foundation installation given the risk of PTS occurring during this activity. Vessel noise, G&G survey noise, and WTG operational noise is expected to remain minor. Similar to Phase 1, no population-level impacts are expected.

Port utilization: A number of existing ports would be used by proposed Project vessels throughout the duration of Phase 2 construction and operations activities (COP Volume I, Section 4.2.2.5; Epsilon 2023). Port utilization during construction of Phase 2 is expected to remain the same as under Phase 1; therefore, impacts on sea turtles would remain negligible. If the applicant includes the SCV as part of the final proposed Project design, different ports may be used, but impacts on sea turtles are not likely to differ.

Presence of structures: Phase 2 would add up to 89 foundations (of which up to 3 would be for ESPs, with the remainder for WTGs) in the SWDA. The number of foundations would be the same if the Phase 2 SCV is implemented. Phase 1 structures would exist in the area where Phase 2 structures would be added, which would increase the total space occupied by structures. As such, impacts on sea turtles would be greater for Phase 2 compared to Phase 1, though this potential increase in risk is not anticipated to increase the IPF impact rating. As discussed for Phase 1, the primary impact on sea turtles associated with the presence of structures is due to entanglement risk resulting from an increased interaction with active or abandoned fishing gear. Long-term intermittent impacts on foraging, migratory movements, or other important behaviors may also occur as a result of Phase 2, though they are unlikely to have population-level impacts on sea turtles given their proclivity for aggregating around offshore structures around the world (Barnette 2017; NRC 1996; Gitschlag 1990; Gitschlag and Herczeg 1994). Overall, impacts from the presence of structures, which would be localized and long-term, would likely be minor for sea turtles, as impacts would be detectable and measurable but not expected to lead to population-level impacts. Minor beneficial impacts would still result due to the reef effect and potential increase in foraging opportunity. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures.

Traffic: The expected vessel types and amount of vessel traffic during Phase 2 is expected to remain the same as or similar to that under Phase 1. Although Phase 2 would result in an increase in regional vessel traffic above historical baseline averages, this is not expected to result in a significant increase in the overall risk of vessel collisions, particularly with the proposed mitigation and vessel strike avoidance measures the proposed Project would employ (i.e., reduced vessel speeds and ships maintaining minimum distances from sea turtles; Appendix H). Given the implementation of proposed Project-specific vessel strike avoidance measures, vessel strikes as a result of Phase 2 are considered unlikely. The impact of

Phase 2 vessel traffic is, therefore, considered minor for sea turtles because impacts would be detectable but not lead to population-level consequences. Under the maximum-case scenario for the Phase 2 SCV, additional vessel traffic may shift westward, but overall impacts on sea turtles are not likely to appreciably differ from OECC cables routed through Muskeget Channel alone.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-5 in Appendix G would contribute to impacts on sea turtles through the primary IPFs of noise and the presence of structures. These impacts would primarily occur through pile driving and other sources of noise during construction, as well as change in habitat due to the presence of offshore structures. The cumulative impacts of all IPFs from ongoing and planned activities, including Alternative B, would be **moderate** and may include **minor** beneficial impacts due to the presence of structures. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures.

Conclusions

Impacts of Alternative B. Alternative B would have **moderate** impacts on sea turtles within the geographic analysis area based on all IPFs, as well as **minor** beneficial impacts from the presence of structures. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures. Construction, operations, and decommissioning of Alternative B would introduce potential accidental releases, anchoring and gear utilization, cable emplacement and maintenance, lighting, noise, EMF, port utilization, vessel traffic, new structures, and climate change to the geographic analysis area. The presence of structures would result in habitat conversion. These IPFs could impact sea turtles to varying degrees depending on the location, timing, and species affected by an activity. Impacts from proposed Project operations would occur at lower levels than those produced during construction and decommissioning. The impacts resulting from Alternative B would be moderate due to noise produced during foundation installation, potential UXO detonations, and vessel traffic and may also result in minor beneficial impacts due to the anticipated artificial reef effect from the presence of structures. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures. Therefore, the overall impact on sea turtles from Alternative B would be **moderate** because the impact would be small, and the resource would recover completely if remedial or mitigating action were taken. The applicant may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above, but doing so would not likely result in different impact ratings than those described above.

Cumulative Impacts of Alternative B. Cumulative impacts on sea turtles within the geographic analysis area would be **moderate**, with **minor** beneficial impacts from the presence of structures due to the reef effect. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures. The impacts from ongoing and planned activities, including Phase 1 and 2, would result in moderate impacts on sea turtles in the geographic analysis area, with moderate beneficial impacts. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures. The main drivers for this impact rating are foundation installation activities, the presence of structures, ongoing climate change, ongoing vessel traffic, and the risk of entanglement in lost fishing gear. Alternative B would contribute to the overall impact rating primarily through the temporary disturbance due to foundation installation, vessel traffic, and permanent impacts from the presence of structures. Therefore, the overall impacts on sea turtles would likely qualify as **moderate** because a notable and measurable impact is anticipated, but the resource would likely recover completely when the IPFs are removed and/or remedial or mitigating actions are taken.

While the significance level of impacts would remain the same, BOEM may include the following mitigation and monitoring measures to address impacts on sea turtles, as described in detail in Table H-2 of Appendix H. These measures are designed to reduce the amount and extent of ESA-listed species take related to foundation installation noise and vessel strike:

- Provide proposed Project personnel with informational training on proper storage and disposal practices to reduce the likelihood of accidental discharges;
- Minimize the amount of vessel lighting and navigation lighting on WTG and ESP foundations to reduce potential attraction to proposed Project vessels, WTGs, and ESPs;
- Implement pile-driving noise reduction technologies to achieve a reduction of noise impacts;
- Monitor pile-driving noise to ensure compliance with required noise reductions;
- Refine exclusion zones based on field measurements;
- Perform daily pre-construction surveys to ensure that sea turtles are not present in the area during pile driving;
- Use PSOs to establish clearance zones prior to commencing pile-driving activities;
- Use pile-driving time of day restrictions to ensure that all clearance zones are maintained;
- Implement soft-start procedures to reduce the risk of noise impacts;
- Report—daily and weekly—sea turtles observed, if any, during pile-driving operations;
- Require annual remotely operated underwater vehicle surveys, reporting, and monofilament and other fishing gear cleanup around WTG foundations;
- Require vessel strike avoidance procedures and injured/dead protected species reporting to ensure vigilance by vessel crews during transit;
- Require vessel to designate a crew person to monitor for sea turtles to avoid vessel strikes; and
- Use AIS to monitor proposed Project vessel compliance with required speed restrictions.

3.8.2.4 Impacts of Alternative C – Fisheries Habitat Impact Minimization Alternative on Sea Turtles

When analyzing the impacts of Alternative C on sea turtles, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for sea turtles. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of inter-array, inter-link, and export cables installed for the proposed Project and could, thus, affect the exact length of cable installed and area of ocean floor disturbed. However, the number of vessels anticipated for use under Alternative C and the number of foundations installed under Alternative C would not change from what was described for Alternative B. Therefore, the changes in the proposed Project design under Alternatives C-1 and C-2 would predominantly change the impacts of cable emplacement and maintenance on sea turtles, but given the low risk of notable impacts on sea turtles from this IPF, changing the location of cable installation and maintenance activities would not be expected to alter impacts on sea turtles, and the impacts would remain negligible. All other IPFs would not be expected to be meaningfully different in the scope or impact magnitudes compared to Alternative B, and so the impacts on sea turtles for all other IPFs would remain the same as described for Alternative B. Therefore, the overall impacts of Alternatives C-1 and C-2 on sea turtles would be the same as those of Alternative B: **moderate**, with **minor** beneficial impacts from the presence of structures. Beneficial impacts, however, may be offset given the increased risk of entanglement due to derelict fishing gear on the structures. The cumulative impacts of Alternative C on sea turtles would be **moderate** and **minor** beneficial.

3.8.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Sea Turtles with the Western Muskeget Variant Contingency Option

Impacts on sea turtles from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B (Scenario 2 for Phase 2). While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPS at up to two locations, resulting in 130 WT or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce the potential impacts on sea turtles by a negligible increment for both Phase 1 (3.2 acres if a foundation is eliminated or 3.9 acres if a ESP foundation is eliminated) and Phase 2 (4.5 acres if a WTG foundation is eliminated or 7.6 acres if a ESP foundation is eliminated) as a result of one less foundation and associated scour protection and required construction vessel impacts (COP Volume III, Appendix III-T; Epsilon 2023). Additionally, the impacts would be slightly less, as less pile driving would be required.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on sea turtles relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **moderate** impacts on sea turtles, as well as **minor** beneficial impacts from the presence of structures. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **moderate** and **minor** beneficial.

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3.9 Commercial Fisheries and For-Hire Recreational Fishing

3.9.1 Description of the Affected Environment

3.9.1.1 Geographic Analysis Area

This section discusses existing commercial and for-hire recreational fishing in the geographic analysis area for commercial fisheries and for-hire recreational fishing, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.9-1. Specifically, this includes the boundaries of the management area of the New England Fishery Management Council and of the Mid-Atlantic Fishery Management Council for all federal fisheries within the U.S. Exclusive Economic Zone—from 3 to 200 nautical miles (3.5 to 230 miles) from the coastline—through Cape Hatteras, North Carolina, plus state waters—from 0 to 3 nautical miles (0 to 3.5 miles) from the coastline. Section B.2 in Appendix B, Supplemental Information and Additional Figures and Tables, includes detailed fisheries data compiled for Vineyard Wind 1 (BOEM 2021b). These data broadly characterize and support the analysis of the proposed Project's impacts on commercial fisheries and for-hire recreational fishing.

3.9.1.2 Commercial Fishing Activities

Commercial fisheries refer to fishing activities that sell catch for profits. The regional setting extends primarily over fishing ports and waters in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, although vessels from other ports may operate in the area. Commercial vessels active in the RI/MA Lease Areas may be homeported and/or may land product in ports in those or other states.

Commercial fisheries in the northeast United States are known for the large landings of herring, menhaden, clam, squid, scallop, skate, and lobster, as well as for being a notable source of profit from scallop, lobster, clam, squid, and other species (NOAA 2019a). The fisheries resources in federal waters off New England provide a significant amount of revenue; commercial fisheries obtain the greatest concentration of revenue from around the 164-foot depth contour off Long Island and Georges Bank (NOAA 2019a). NMFS has many regulated fishing areas across the geographic analysis area, such as the exclusion of mobile gear fishing in parts of Georges Bank for fish stock rebuilding. Overall, there is moderate revenue from commercial fishing within and in the vicinity of the SWDA (Figure 3.9-2).

New Bedford, Massachusetts, has been the highest value-producing U.S. fishing port for more than 20 consecutive years, with a landings value of $570 million in 2021(NMFS 2023d). In 2019, commercial fisheries harvested more than 1.1 billion pounds of fish and shellfish in the Middle Atlantic and New England regions, for a total landed value of over $1.9 billion (NOAA 2021c). Of that, 234 million pounds of fish and shellfish were from Massachusetts ports in 2019, for a total landed value of over $679 million (NOAA 2021c). The two most valuable Massachusetts fisheries are the sea scallop and lobster fisheries. Since 2010, the sea scallop fishery has landed an average of 31.1 million pounds per year, worth approximately $320.2 million. Over the same period, the lobster fishery landed an average of 15.6 million pounds per year, worth approximately $70.8 million (COP Volume III, Section 7.6.1.1; Epsilon 2023). Other important shellfish fisheries in nearshore areas of Massachusetts include a propagation program in the Town of Barnstable for northern quahogs, eastern oysters, soft shell clams, and bay scallops (COP Volume III, Section 7.6.1; Epsilon 2023).

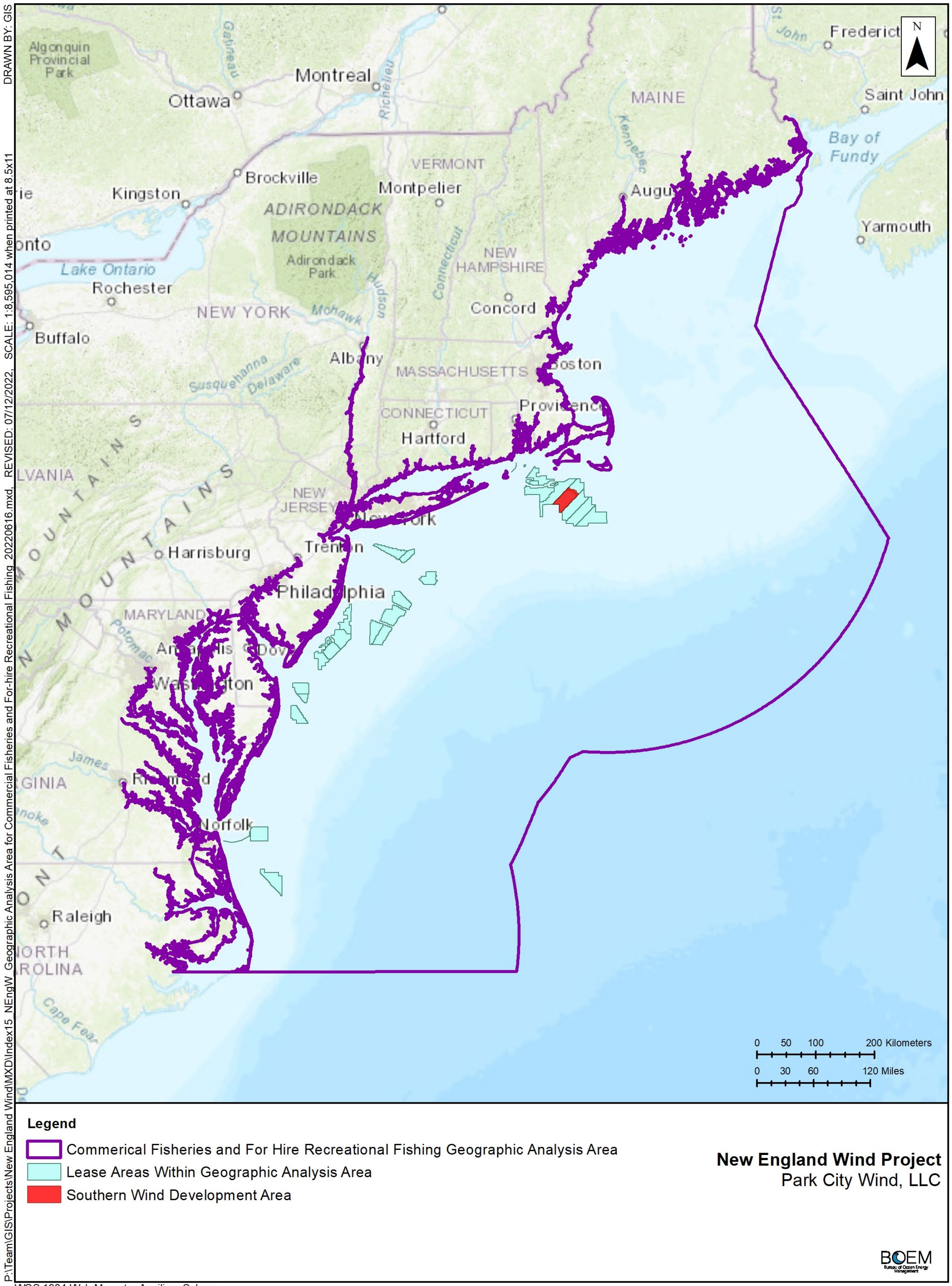
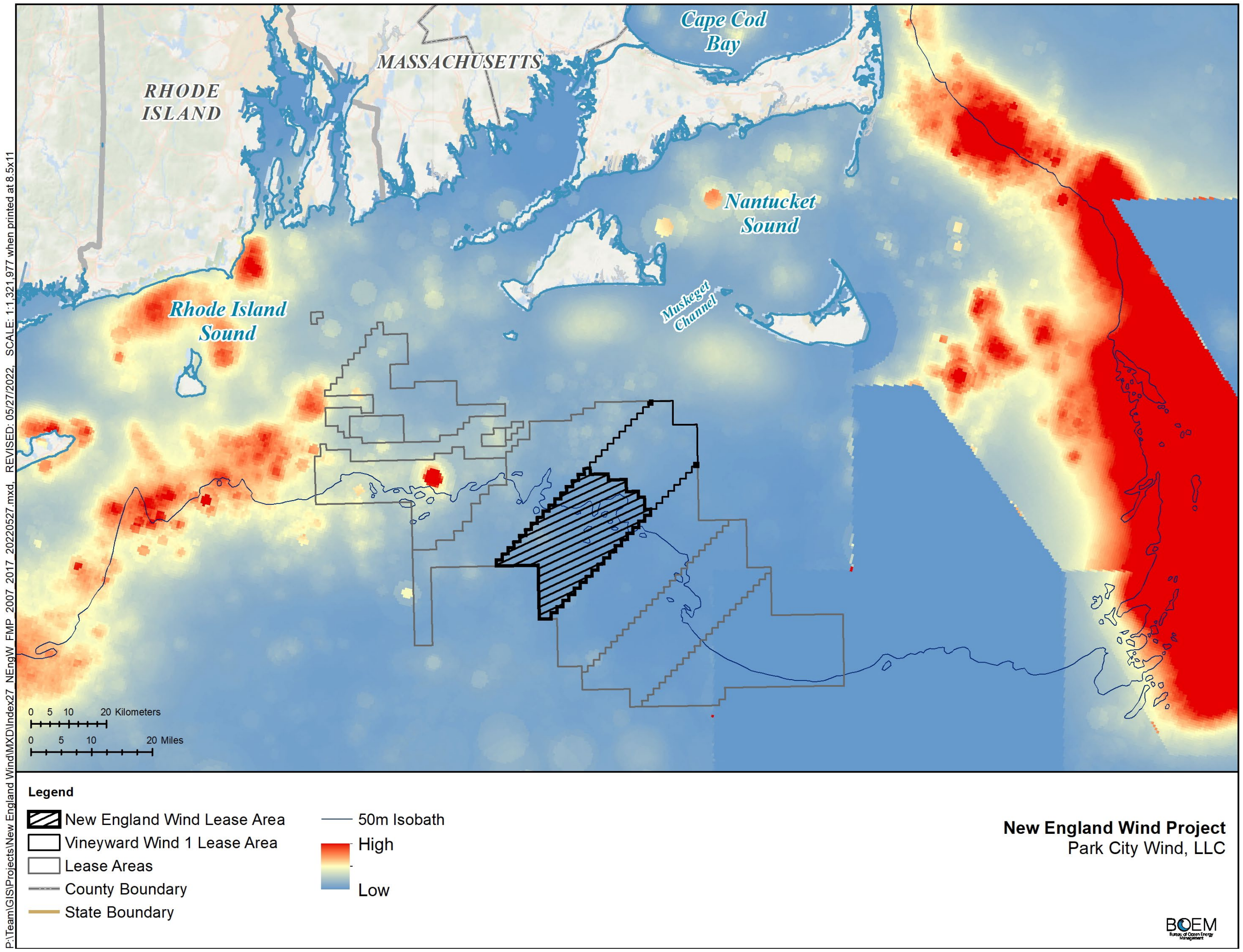


Figure 3.9-1: Geographic Analysis Area for Commercial Fisheries and For-Hire Recreational Fishing



NEFSC = Northeast Fisheries Science Center; VTR = vessel trip report
This is based on federally reported VTRs and conversion by NEFSC (G. DePiper, Pers. Comm., June 4, 2019). The top 5 percent of revenue was clipped to lessen high-value scallop revenue skew of regional revenue. Without clipping, the top 5 percent areas important to lesser value fisheries would not appear. Removing the top 5 percent does not remove any areas that are not already represented in the red (high) end of the color ramp.

Figure 3.9-2: Fishing Intensity Based on Average Annual Revenue for Federally Managed Fisheries (2007–2017)

Other important commercial fisheries in states neighboring the offshore development region (i.e., Rhode Island, Connecticut, New York, and New Jersey) include the squid, summer flounder, and Jonah crab fisheries in Rhode Island; sea scallop, squid, lobster, and whiting fisheries in Connecticut; northern quahog, squid, eastern oyster, and golden tilefish fisheries in New York; and the sea scallop, menhaden, and surf clam fisheries in New Jersey (COP Volume III, Section 7.6.1; Epsilon 2023).

In Rhode Island, the three major commercial fishing ports are Port Judith, Newport, and North Kingstown. The busiest port is Port Judith, which typically lands squid (the highest revenue species in Rhode Island), mackerel, and butterfish (BOEM 2021b). For all species, landings in Rhode Island in 2021 totaled more than 72 million pounds, for a total value of $109.8 million (NMFS 2023d). The major commercial fishing ports in Connecticut are New London and Stonington, with the highest revenue producing fishery being the sea scallop. New London is the largest port statewide by pounds landed and value, with total landings in 2021 of 1.9 million pounds valued at $2.3 million (NMFS 2023d). In New York, the highest revenue-producing species is the northern quahog. Two ports (Hampton Bays/Shinnecock and Montauk) are the major commercial landing sites, but commercial fishing and landings also occur at other smaller ports. Montauk is the largest New York port by pounds landed and value (all species). Statewide, total landings in 2021 were 9.7 million pounds valued at $16.7 million (NMFS 2023d). New Jersey contains the commercial fishing ports of Atlantic City, Cape May/Wildwood, Barnegat/Long Beach, and Point Pleasant, but commercial fishing vessels also operate and land catches at other New Jersey ports. New Jersey's most important fishery is the sea scallop. Cape May/Wildwood is the largest commercial fishing port in New Jersey and was the 13th most valuable port in the United States in 2021, with landings of 113.5 million pounds valued at more than $147 million in 2021 (NMFS 2023d). Statewide, landings totaled more than 160 million pounds valued at more than $220 million in 2021 (NMFS 2023d).

NMFS (2023k) prepared a planning-level assessment that describes selected fishery landings and estimates of commercial revenue from the SWDA. These reports modeled results using vessel trip reports (VTR) and vessel logbook data to estimate catch and landings based on the percentage of a trip that overlapped with each lease area. However, not all vessels are required to provide federal VTRs.

NMFS (2023k) described the most impacted FMPs, with "most impacted" meaning the FMP that provided the most revenue during the 14-year period from 2008 to 2021. The most impacted FMPs for the SWDA are listed in Table 3.9-1 by landings (pounds) and revenue (2021 U.S. dollars). The mackerel, squid, and butterfish FMP had the highest landings from 2008 to 2021 with 1,460,000 pounds (Table 3.9-1). Atlantic States Marine Fisheries Commission FMP includes American lobster, cobia, Atlantic croaker, black drum, red drum, menhaden, NK sea bass, NK seatrout, spot, striped bass, tautog, Jonah cab, and Pandalid shrimp. NMFS (2021b) estimated that up to 63 species may be caught in the SWDA that are not regulated under an FMP.

Table 3.9-1: Commercial Fishing Landings and Revenue of the Most Impacted Fisheries Management Plans from 2008 to 2021 for the Southern Wind Development Area

FMP	14-Year Landings (2008 to 2021; pounds)	14-Year Revenue (2021 U.S. Dollars)
Mackerel, Squid, and Butterfish	1,460,000	$1,879,000
Small-mesh multispecies	1,130,000	$781,000
Summer flounder, scup, black sea bass	741,000	$950,000
Atlantic States Marine Fisheries Commission	718,000	$1,045,000
Monkfish	415,000	$700,000

FMP = Fishery Management Plan

NMFS (2023k) further analyzed the most impacted species in the SWDA and separated them from combined FMPs. Table 3.9-2 presents cumulative landings and revenue for the most impacted species from 2008 to 2021. Landings by weight (1,297,000 pounds), as well as revenue ($1,786,000), were highest for longfin squid, over the 14-year period from 2008 to 2021. Overall, the SWDA had ten species that produced more than $374,000 in revenue from 2008 to 2021.

Table 3.9-2: Commercial Fishing Landings and Revenue of the Most Impacted Species from 2008 to 2021 for the Southern Wind Development Area

Species	14-Year Landings (2008 to 2021; pounds)	14-Year Revenue (2021 U.S. Dollars)
Longfin squid	1,297,000	$1,786,000
Skates	1,168,000	$545,000
Silver hake	1,004,000	$735,000
All other	906,000	$743,000
Jonah crab	625,000	$576,000
Scup	588,000	$447,000
Monkfish	415,000	$700,000
Summer flounder	142,000	$462,000
American lobster	90,000	$466,000
Sea scallop	34,000	$374,000

NMFS (2023k) also analyzed fishing gear types and their associated revenue for commercial fishing occurring in the SWDA. From 2008 to 2021, landings (4,022,000 pounds) and revenue were highest for bottom trawls ($4,026,000), The category "all others" refers to landings of species of less than three federal permits or dealers impacted to protect data confidentiality. A total of ten individual gear types totaled more than 7,390,000 pounds of total landings from 2008 to 2021 (Table 3.9-3).

Table 3.9-3: Commercial Fishing Landings by Gear Type and Revenue of the Most Impacted Species from 2008 to 2021 for the Southern Wind Development Area

Gear Type	14-Year Landings (2008 to 2021; pounds)	14-Year Revenue (2021 U.S. Dollars)
Bottom trawl	4,022,000	$4,026,000
Gillnet-sink	1,151,000	$1,109,000
Lobster pot	757,000	$1,068,000
Clam dredge	586,000	$471,000
Midwater trawl	465,000	$48,000
All others	341,000	$325,000
Scallop dredge	32,000	$342,000
Other pot	27,000	$32,000
Bottom longline	9,000	$35,000
Handline	<500	<$500

3.9.1.3 For-Hire Recreational Fishing Activities

For-hire fishing boats sell recreational fishing trips to anglers, as opposed to commercial fishing activities where boat operators sell their catch to processing houses for profit. For-hire recreational fishing is a common and economically important activity throughout the geographic analysis area, including the SWDA and the OECC. NOAA's Marine Recreational Information Program noted that in 2020, the largest catches in Massachusetts from charter fishing vessels were striped bass and Atlantic mackerel. A total of 32,197 for-hire angler trips occurred in state and federal waters offshore Massachusetts in 2020, a large decrease from 114,702 trips in 2019 (NOAA MRIP 2021). The decrease is likely a result of the coronavirus disease 2019 (COVID-19) pandemic. From 2010 to 2020, there were an average of 100,157 charter boat fishing trips out of Massachusetts and 22,893 out of Rhode Island. It is acknowledged that it is likely that most of these charter boat fishing trips do not occur in the SWDA, and the lack of spatially precise locations of charter boat fishing trips introduces uncertainty into the analysis of potential impacts on for-hire recreational fishing.

For-hire recreational fishing in the Atlantic provides opportunities for recreational fishing of HMS such as tuna, billfish, swordfish, and sharks. Tuna and sharks are found in the SWDA where they feed on squid, mackerel, and butterfish found in the area. Tuna and sharks are targeted in the SWDA by for-hire fishing boats. HMS such as tuna and shark are relatively costly to pursue for private anglers, as they require large vessels.

Popular recreational fishing areas across the entire RI/MA Lease Areas include "The Dump," where recreational vessels harvest yellowfin tuna, albacore tuna, and mahi-mahi, as well as "The Owl" and "The Star." "31 Fathom Hole" and the northeast corner of The Dump are the only named recreational fishing locations within the SWDA (Figure 3.9-3). Species caught by recreational vessels in these areas include bluefin tuna, mako and thresher sharks, white marlin, and yellowfin tuna. Along the OECC, harvested species often include striped bass, bluefish, bonito, and false albacore, as well as summer flounder, black sea bass, and scup (COP Volume III, Section 7.6.4; Epsilon 2023).

The greatest amount of recreational fishing effort for HMS occurred west of the SWDA in the waters south and east of Montauk Point and Block Island. Within the RI/MA Lease Areas, a large amount of fishing effort for all HMS occurred in "The Dump," "Coxes Ledge," "The Fingers," and "The Claw" (Kneebone and Capizzano 2020).

3.9.1.4 Trends

Commercial fisheries and for-hire recreational fishing in the geographic analysis area are subject to pressure from ongoing activities, including presence of structures, vessel traffic, and climate change. Fisheries management impacts commercial fisheries and for-hire recreational fishing in the region through measures such as fishing seasons, quotas, and closed areas, which constrain how the fisheries are able to operate and adapt to change. These management actions can reduce or increase the size of available landings to commercial and for-hire recreational fisheries. Reasonably foreseeable fishery management actions include measures to reduce the risk of interactions between fishing gear and the North Atlantic right whale by 60 percent (McCreary and Brooks 2019). This, along with Area 3 trap cap reductions, will likely have considerable impact on fishing effort in the lobster and Jonah crab fisheries in the geographic analysis area.

Climate change is also predicted to affect northeast U.S. fishery species (Hare et al. 2016), which will impact commercial and for-hire fisheries differently; some stocks may use increased habitat, and some may see habitat reduced, depending on the targeted species and the ability of fishing regulations to adapt. Changing environmental and ocean conditions (currents, water temperature, etc.), increased storm magnitude or frequency, and shoreline changes can impact fish distribution, populations, and availability to commercial and for-hire recreational fisheries. Impacts from other ongoing activities, including structures such as existing cables and pipelines, have been largely mitigated through burial of the infrastructure.

Overall trends in the status of commercial fisheries and for-hire recreational fisheries in the geographic analysis area are difficult to determine, for a variety of reasons. Commercial fisheries landings are often volatile from year to year, even when fishing activity is sustainable. The COVID-19 pandemic in 2020 and 2021 in particular has had vast implications on commercial and recreational fishing effort and landings. Year-to-year variation in available catch, fishing effort, as well as quotas set for commercial and recreational fisheries to protect stocks and prevent overfishing can have significant fluctuations in how much is landed every year from within the SWDA, the Massachusetts Lease Areas, and other locations. As a result, it is challenging to predict future commercial fishing revenue from specific fishing areas, such as the RI/MA Lease Areas. However, landings and catch values have generally remained consistent between 2014 and 2018 at selected northeast U.S. ports in the offshore development region, with some ports showing increases in recent years (e.g., Cape May/Wildwood, New Jersey [101.2 million pounds in 2018 versus 49.9 million pounds in 2014]), and others showing decreases (e.g., New Bedford and Fairhaven, Massachusetts [116.7 million pounds in 2018 versus 146.4 million pounds in 2014]) (COP Volume III, Section 7.6.1; Epsilon 2023). For the purposes of this analysis, it is assumed that the activity and value of fisheries in these recent years are expected to be indicative of future conditions and trends.

Although it is difficult to predict future trends in the overall status of commercial fisheries and for-hire recreational fishing in the geographic analysis area, it is expected that fisheries management regulations will continue to be assessed and modified as required to maintain the maximum sustainable yield catches.

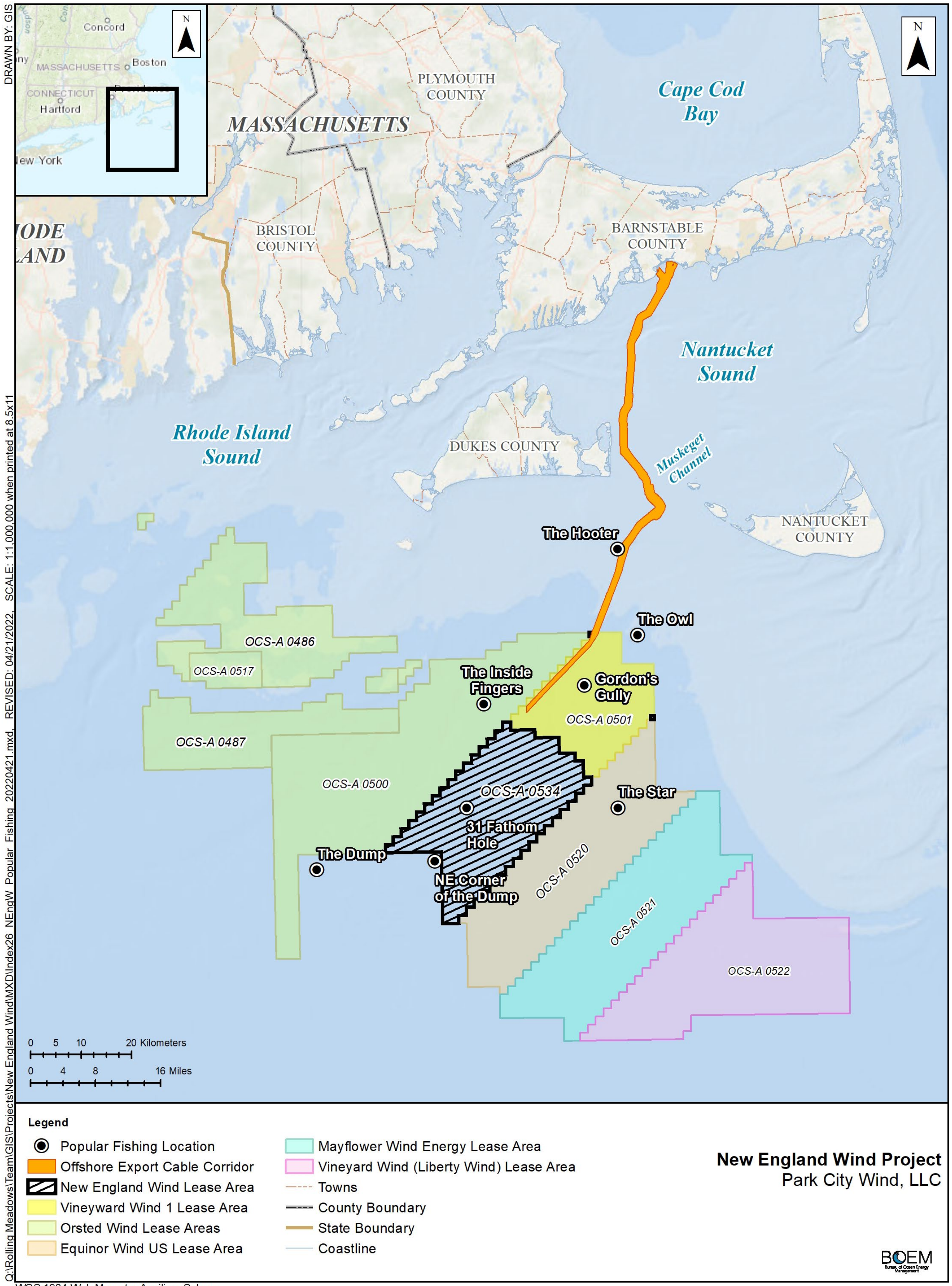


Figure 3.9-3: Popular Recreational Fishing Spots

3.9.2 Environmental Consequences

Definitions of potential impact levels for commercial fisheries and for-hire recreational fishing are provided in Table 3.9-4.

Table 3.9-4: Impact Level Definitions for Commercial Fisheries and For-Hire Recreational Fishing

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

3.9.2.1 Impacts of Alternative A – No Action Alternative on Commercial Fisheries and For-Hire Recreational Fishing

When analyzing the impacts of Alternative A on commercial fisheries and for-hire recreational fishing, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for commercial fisheries and for-hire recreational fishing (Table G.1.6 in Appendix G, Impact Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for commercial fisheries and for-hire recreational fishing described in Section 3.9.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on commercial fisheries and for-hire recreational fishing include regional fishing and fishery trends. The state demand for additional electricity that the proposed Project would have provided could be met by other offshore wind projects that could affect the same geographic analysis area for commercial fisheries and for-hire recreational fishing. Therefore, impacts from ongoing, future offshore wind activities, as well as future non-offshore wind activities would still occur. The impacts on commercial fisheries and for-hire recreational fishing would be similar, but the exact impact would not be the same due to temporal and geographical differences. The following analysis addresses planned offshore wind projects that fall within the geographic analysis area and considers the assumptions included in Appendix E.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind development activities would affect commercial fisheries and for-hire recreational fishing through the following primary IPFs.

Anchoring and gear utilization: Anchoring could pose a localized (within a few hundred feet of anchored vessels), temporary (hours to days) navigational hazard to fishing vessels. Alternative A would increase vessel anchoring during survey activities and during the construction of offshore components as a result of future offshore wind project construction from 2023 through 2030. The location and level of these impacts would depend on specific locations and duration of activities, which would not be continuous but rather intermittent based on the construction schedule of each project. BOEM assumes that anchoring disturbance for offshore wind projects would affect up to 7,404 acres of seafloor (Appendix E), out of nearly 200 million acres within the geographic analysis area. DP vessels, if used for offshore wind project construction, would reduce these impacts. In addition, the installation of met towers or buoys could increase anchoring activity. Anchoring impacts on finfish, invertebrates, and EFH are discussed in Section 3.6, and impacts on navigation and vessel traffic are discussed in Section 3.13, Navigation and Vessel Traffic.

Cable emplacement and maintenance: Cable emplacement could cause localized, short-term impacts including disrupting fishing activities during active installation and maintenance or when transmission cables are exposed on the seabed prior to burial (if simultaneous lay and burial techniques are not used). Fishing vessels may not have access to impacted areas, which could lead to reduced revenue and/or increased conflict over other fishing grounds. Assuming future projects use installation procedures similar to those of the proposed Project, the duration (1 day to several months) and extent (several feet to more than 1,600 feet during active procedures) of impacts would include temporary displacement of fishing vessels and disruption of fishing activities. Offshore, inter-array, and inter-link cable emplacement in the geographic analysis area would affect approximately 61,128 acres of seafloor (out of more than 200 million total acres); however, only a portion of that amount would be off limits to fishing vessels during Alternative A construction between 2023 and 2030. A maximum of six offshore wind projects (excluding the proposed Project) could be under construction simultaneously in 2025 (Appendix E). The impacts from a project that would overlap in cable-laying activities with a previously approved project would be assessed in additional project-specific NEPA analysis.

While simultaneous cable-laying activities may disrupt fishing activities over a larger area than if activities occurred sequentially, the total time of disruption would be less than if each project were to conduct cable-laying activities sequentially. Overall, cable-laying activities would not restrict large areas, and navigational impacts would be on the scale of hours, primarily because only a fraction of the total cable emplacement area would be affected at any time. BOEM does not anticipate differential impacts on fishery resources based on whether cable-laying activities occur sequentially or concurrently. However, both fishing and fishery resources may be differentially impacted based on the season in which the activities occur. Most construction activities would likely take place in the summer due to more favorable weather conditions. Thus, fisheries and fishery resources most active in the summer, such as the longfin squid fishery, would likely be impacted more than those that are most active in winter.

Climate change: Climate change affects commercial fisheries and for-hire recreational fishing, primarily through increased sea surface and bottom temperature. Warming of ocean waters has been shown to impact fish distribution in the northeast United States through the action of several species shifting the center of biomass either northward or to deeper waters. These movements have changed, and will continue to change, the distribution of commercial fishing effort, impacting commercial and recreational fishing participants and coastal communities (Hare et al. 2016; Rogers et al. 2019). Additional impacts on commercial fisheries and for-hire recreational fishing can result from climate change impacts such as increased storm magnitude or frequency and shoreline changes. Implementation of offshore wind projects would likely result in a net decrease in GHGs through displacement of energy generated by fossil fuel-type facilities. This reduction in GHG emissions from offshore wind operations would substantially outweigh any small increase in GHG emissions from offshore wind project construction. Overall, an offshore wind project alone would likely not influence climate change enough to modify its impacts on commercial fisheries and for-hire recreational fishing. Assessing climate change impacts on the marine ecosystem is a challenge because the future end-state of the ecosystem and animals' abilities to adapt are not completely known. Renewable energy, including offshore wind, may reduce some of these impacts over time.

Noise: Noise from construction, site assessment G&G survey activities, operations, pile driving, trenching, and vessels could cause localized, temporary impacts on commercial fisheries and for-hire recreational fishing. Section 3.6 discusses noise impacts on finfish, invertebrates, and EFH in further detail.

Noise from G&G surveys of cable routes and other site characterization surveys for offshore wind facilities could affect finfish, invertebrates, and EFH but is not anticipated to rise to fishery-level impacts because survey noise would be temporary and occur intermittently during Alternative A construction between 2023 and 2030. As described in Section 3.6, Finfish, Invertebrates, and Essential Fish Habitat, G&G noise from offshore wind site characterization surveys is less intense than G&G noise from seismic surveys used in oil and gas exploration. Noise from offshore wind G&G surveys, construction, trenching, vessel activity, and WTG operations is expected to occur but would have less of an impact on finfish, invertebrates, and EFH than acoustically sensitive marine mammals (Section 3.6). This noise is expected to cause behavioral changes for commercial fish species that could impact the catch efficiency of some gear (hook and line); however, the noise from these sources is not anticipated to impact reproduction and recruitment of commercial fish stocks and would not have fishery-level impacts.

Pile driving would have the greatest noise impacts on commercial fisheries and for-hire recreational fishing. Noise from pile driving would occur during installation of foundations for offshore structures. Based on assumptions for the proposed Project, this noise would be produced intermittently during construction of each project for approximately 2 to 3 hours per foundation or 4 to 6 hours per day for the installation of two foundations per day. One or more projects may install more than one foundation per day, either sequentially or simultaneously during Alternative A construction between 2023 and 2030. Noise transmitted through water and/or through the seabed can cause injury and/or mortality to finfish, invertebrates, and EFH in a limited space around each pile and can cause short-term stress and behavioral changes to individuals over a greater space (Section 3.6). Pile-driving noise can disrupt spawning behavior even after the noise has ended, especially for species with complex spawning behavior such as cod and longfin squid. The extent of impacts on fish and invertebrate species depends on pile size, hammer energy, and local acoustic conditions; behavioral impacts would likely extend radially up to 8.7 miles around each pile without attenuation, and the radius for injury is estimated to extend up to 515 feet from each pile (COP Appendix III-M, Section 4.5; Epsilon 2023).

In areas where commercially harvested finfish and invertebrates experience behavioral impacts, it is anticipated that some fishing activities may experience less catch due to movement of fish away from sound sources and/or reduced catch efficiency in hook and line fisheries (Skalski et al. 1992). These impacts on fish could affect fishing activities if vessels need to temporarily relocate to other fishing locations to avoid or reduce impacts on revenue. This could lead to increased conflict in those locations, increased operating costs for vessels (e.g., additional fuel costs), and lower revenue (e.g., less productive area; less valuable species). Due to the relatively small footprint of injurious sound and the ability for most fish to swim away from noise sources, it is not anticipated that injurious sound would have stock-level impacts on commercial fish species. As noted above, the area of behavioral impacts is much larger than injurious impacts. If pile-driving noise were to adversely affect spawning behavior, then reduced reproductive success in one or more spawning seasons could result. This could potentially result in long-term impacts on populations and harvest levels if 1 or more years suffer suppressed recruitment. However, the risk of reduced stock recruitment from pile-driving noise is considered low because the behavioral impacts on commercial fish species would only be present for the intermittent duration of the noise. After the cessation of pile-driving activity, fish behavior is expected to return to pre-construction levels (Jones et al. 2020; Shelledy et al. 2018).

Future offshore wind projects could result in simultaneous noise-producing activities. While simultaneous pile driving and other noise-producing activities may disrupt fishing activities over a larger area than if activities occurred sequentially, the total time of disruption would be less than if each project were to conduct pile driving or other noise-producing activities sequentially. BOEM does not anticipate differential injurious levels of impact on fishery resources based on whether pile-driving activities occur sequentially or concurrently because the areas of injurious sounds would not overlap. The chance of exposure to behavioral levels of impact on fish populations is highly likely for concurrent projects in adjacent leases. Both fishing and fishery resources may be differentially impacted based on the season in which the activities occur. Most construction activities would likely take place in the summer due to more favorable weather conditions. Thus, fisheries and fishery resources most active in the summer would likely be impacted more than those that occur in the winter.

Port utilization: Ports are largely privately owned or managed businesses that are expected to compete against each other for offshore wind business. Major northeast fishing ports are discussed in the proposed Project COP (Volume III, Section 7.6.1; Epsilon 2023). Of those major fishing ports, New Bedford, Hampton Roads, Atlantic City, Ocean City, and Montauk have been identified as possible ports capable of supporting offshore wind energy construction and/or operations. Other non-major fishing ports could also be used for operations support. Port expansions would likely happen during Alternative A construction between 2023 and 2030, and the increase in port utilization would increase vessel traffic, peaking during construction activities, decreasing during operations, and increasing again during decommissioning. An increase in vessel traffic could result in delays or restrictions in access to ports for commercial and for-hire fishing vessels. As ports expand, maintenance dredging of shipping channels could increase (including increased frequency of dredging to maintain existing authorized depths and projects to increase channel depth, as described in Section 3.13) and may cause restrictions and delays for fishing vessels trying to access port facilities. The risk of restrictions and delays to access port facilities due to dredging would only increase when actual dredging activities occur, which would be infrequent. Port expansion and modification could have local, temporary impacts on commercial and for-hire fishing vessels in ports used for both fishing and offshore wind and other projects.

Presence of structures: The presence of structures can lead to impacts on commercial fisheries and for-hire recreational fishing through allisions, entanglement or gear loss/damage, fish aggregation, habitat conversion, navigation hazards (including transmission cable infrastructure), and space use conflicts. These impacts may arise from buoys, met towers, foundations, scour/cable protection, and transmission cable infrastructure.

Structures may alter the availability of targeted fish species in the immediate vicinity of the structures. For example, stocks of structure-oriented fish such as black sea bass, striped bass, lobster, and cod may increase in areas where there was no structure (natural or artificial) previously. HMS species may also be attracted to the wind turbine foundations. Flatfish, clams, and squid species are likely to remain in open soft-bottom sandy areas. Furthermore, altered community composition could change natural mortality of certain species due to predation (decrease) or refuge (increase), and increase competition between species, which could have beneficial or adverse impacts, depending on the species. These impacts are not anticipated to result in stock-level impacts that would in turn impact fisheries. As discussed in Section 3.6, estimates of the linear extent of the reef effect range from 52.5 feet (Stanley 1994) to

1,968.5 feet (Kang et al. 2011) from a structure, and Rosemond et al. (2018) have suggested assuming a distance of 98 to 197 feet as a first approximation. These impacts could lead to increased opportunities for for-hire recreational fisheries and private recreational anglers targeting structure-oriented species, which could lead to space conflicts with commercial fisheries. There would be no impact in areas that already contain natural or artificial structures. Section 3.6 includes a more detailed discussion on finfish aggregation and habitat alteration.

Future offshore wind structures are anticipated to provide forage and refuge for some migratory species, including finfish, invertebrates, and EFH (e.g., summer flounder, monkfish, black sea bass, and lobster). While these behavioral impacts may impact individual fish, they are not anticipated to result in broad changes in migration patterns that would in turn impact fisheries. Other physical oceanographic conditions such as temperature and salinity are a larger driver of seasonal migration (Fabrizio et al. 2014; Moser and Shepherd 2009; Secor et al. 2018). Therefore, fishery-level impacts are not anticipated. Section 3.6 includes more details about the impacts of the presence of structures on finfish.

The presence of structures (including submarine cable infrastructure) would have long-term impacts on commercial fisheries and for-hire fishing by increasing the risk of allisions, entanglement or gear loss/damage, and navigational hazards. The presence of WTGs could also lead to long-term changes to fishing vessel transit routes during operations, which could affect travel time and trip costs. With respect to the risk of fishing gear snares and maneuverability restrictions (including risk of allisions) within individual project wind development areas, commercial fishing operators have expressed specific concerns about fishing vessels operating trawl gear that may not be able to safely deploy and operate in a wind development area given the size of the gear, the spacing between the WTGs, and the space required to safely navigate, especially with other vessels present and during poor weather conditions. Trawl and dredge vessel operators have commented that less than 1-nautical-mile (1.9-kilometer, 1.15-mile) spacing between WTGs may not be enough to operate safely due to maneuverability of fishing gear and gear not directly following in line with vessel orientation. Clam industry representatives state that their operations require a minimum distance of 2 nautical miles (2.3 miles) between WTGs, in alignment with the bottom contours, for safe operations (Wallace 2019). Due to mobile gear being actively pulled by a vessel over the seafloor, the chance of snagging mobile gear on proposed Project infrastructure is much greater than if—as in the case of fixed gear—the gear was set on the infrastructure or waves, or if currents pushed the gear into the infrastructure. The risk of damage or loss of deployed gear as a result of offshore wind development could impact mobile and fixed-gear commercial fisheries and for-hire recreational fishing.

Inter-array and export cables would be buried below the seabed approximately 5 to 8 feet; however, BOEM assumes that up to 10 percent of the cables may not achieve the proper burial depth and would require cable protection in the form of rock placement, concrete mattresses, and/or half-shell. Mobile bottom-tending gear (trawl and dredge gear) could become hung up on these cable protection measures, and the cost of these impacts would vary depending on the extent of damage to the fishing gear. Lastly, comments from the fishing industry have included concerns that fishing vessel insurance companies may increase premiums or not cover claims for incidents within a wind energy facility if incidents/claims were to increase as a result of facility construction. At this time, it is not possible to assess the potential number of insurance claims or future decisions by private insurance companies that could result in increased premiums or loss of coverage.

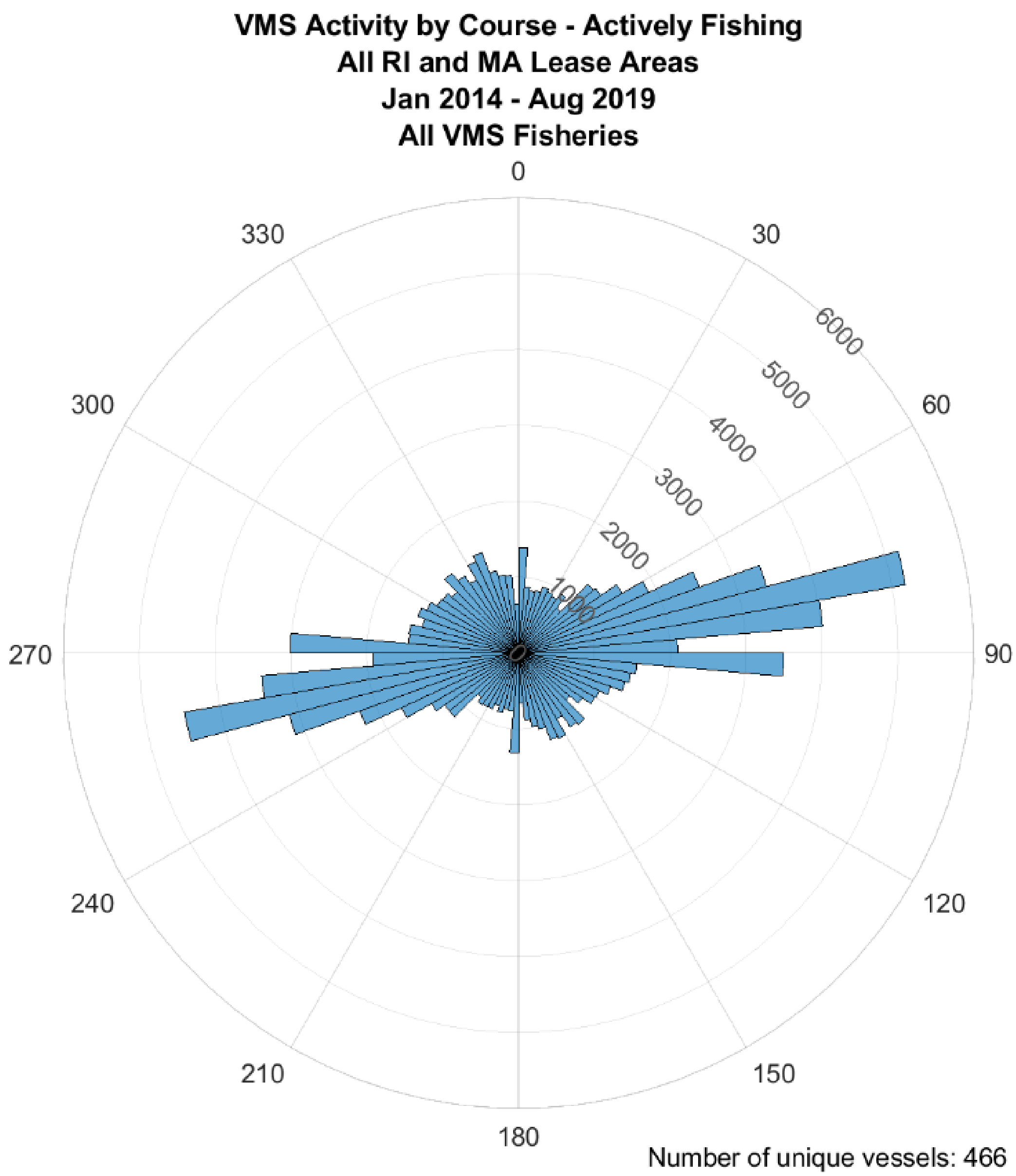
Maneuverability within wind development areas would vary depending on many factors, including vessel size, fishing gear or method used, and weather conditions. Navigating through the wind development areas would not be as problematic for for-hire recreational fishing vessels, which tend to be smaller than commercial vessels and do not use large external fishing gear (other than hook and line), which makes maneuverability difficult. However, trolling for HMS (bluefin tuna, swordfish) may involve deploying many feet of lines and hooks behind the vessel, and then following large pelagic fish once they are hooked, which pose additional navigational and maneuverability challenges around WTGs. The orientation of vessels transiting and fishing within the southern New England lease areas varies by activity, fishery, and area. Figures 3.9-4 through 3.9-10 show the directionality of vessel monitoring system (VMS)-enabled fishing vessels. While these figures are from the Vineyard Wind 1 Final EIS (BOEM 2021b), they represent long-term trends applicable to the projects proposed under Alternative A. This analysis uses the information conveyed in each individual position report (ping), which includes all fishing vessels, parsed into two speed categories representing transiting (speeds greater than or equal to 5 knots) and fishing activity (speeds less than 5 knots).

The histograms on Figures 3.9-4 through 3.9-10 demonstrate how the orientation of vessels varies by activity, fishery, and area. The polar histograms are generated from all position reports broadcast within the RI/MA Lease Areas, including the Vineyard Wind 1 wind development area (Lease Area OCS-A 0501), and represent most fishing and transit activity for fisheries with VMS requirements. Each bar includes every ping reporting a course within a 5-degree compass window (e.g., 180 to 185 degrees are represented by one bar). The longer bars represent a greater number of position reports (pings) showing fishing vessels moving in a certain direction within the RI/MA Lease Areas or the Vineyard Wind 1 wind development area. Overall, the plots show variability among activity type, fishery, and between a single project (i.e., Vineyard Wind 1 wind development area) versus the planned activities scenario across the entire RI/MA Lease Areas. Figures 3.9-4 and 3.9-5 show the directionality of all VMS fishing vessels across the RI/MA Lease Areas. Figure 3.9-4 shows a majority of the 466 unique fishing vessels moving in a direction 10 to 15 degrees off due east-to-west throughout the RI/MA Lease Areas. This direction is generally consistent with the former Loran lines. Figure 3.9-5 shows a majority of the 668 unique vessels transiting in a northwest-to-southeast direction through the southern New England lease areas. Figure 3.9-6 shows that the volume of actively transiting position reports (430) created within the Vineyard Wind 1 wind development area greatly exceeds the volume of actively fishing position reports (175), indicating a stronger northwest-to-southeast direction signal. The figures demonstrate a predominantly northwest-to-southeast transit pattern and slightly northeast-to-southwest fishing pattern in the Vineyard Wind 1 wind development area.

NMFS (2023j) prepared a summary of fishery landings and vessel revenue from the Vineyard Wind 1 wind development area, including a description of the number of fishing vessels operating in the SWDA region. In 2021, there were 217 fishing vessels operating in the Vineyard Wind 1 wind development area. Of these 217 vessels, the most targeted FMP included summer flounder, scup, and black sea bass (targeted by species) summer flounder (targeted by 66 percent of vessels), monkfish (targeted by 54 percent of vessels), and mackerel, squid, and butterfish (targeted by 56 percent of vessels) (NMFS 2023d). Individual vessels often target more than one species.

The USCG Final MARIPARS evaluated the need for establishing vessel routing measures, and recommended all surface structures be aligned in a 1-nautical-mile (1.15-mile) × 1-nautical-mile (1.15-mile) grid, such that vessels anywhere in the RI/MA Lease Areas would pass a WTG on either side every 1 nautical mile (1.15 miles) when traveling north-to-south or east-to-west, and every 0.6 nautical mile (0.69 mile) to 0.8 nautical mile (0.92 mile) when traveling northwest-to-southeast or northeast-to-southwest (USCG 2020). The final MARIPARS did not recommend implementation of any formal routing measures.

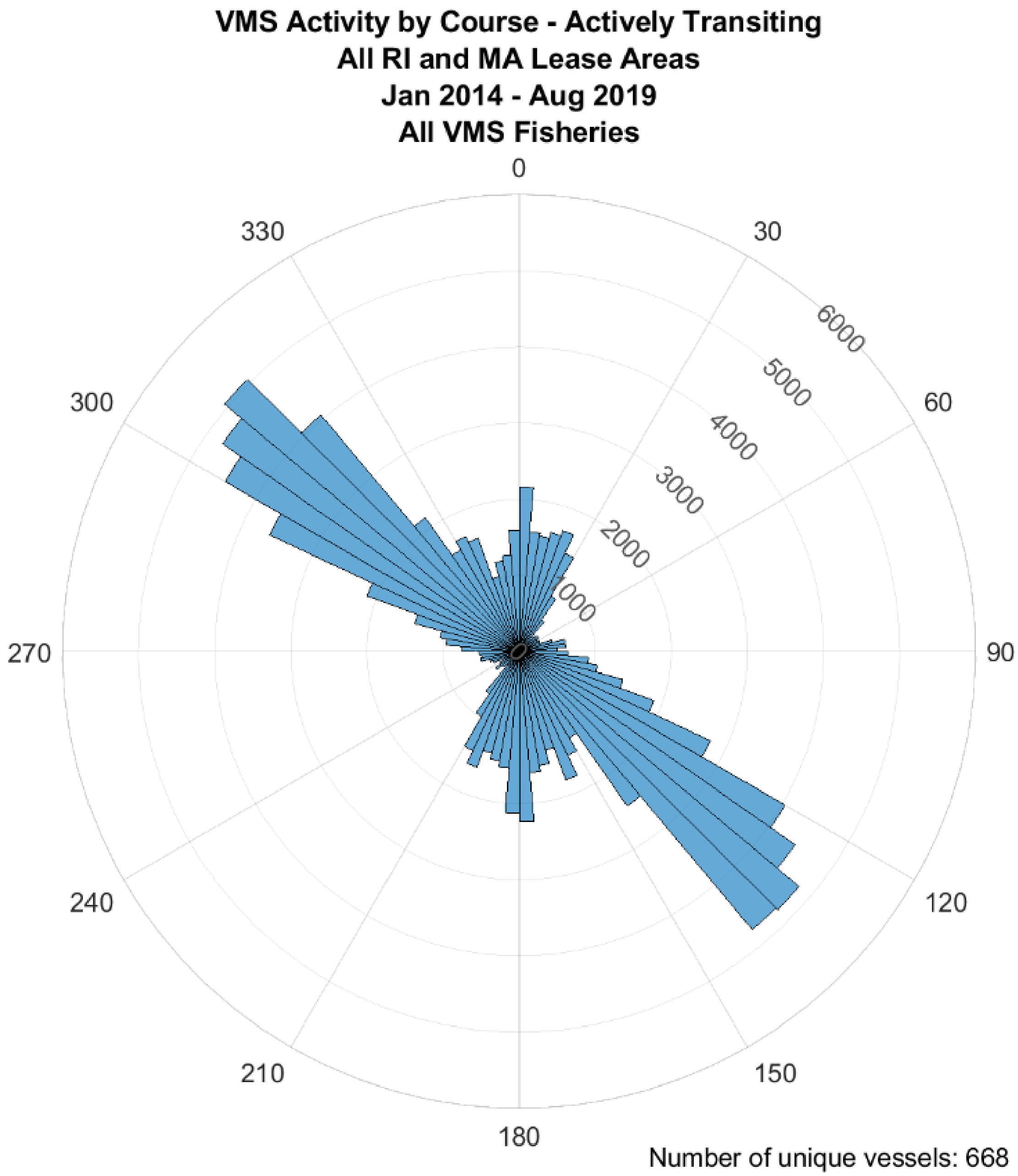
Installation of offshore cables for each offshore wind energy facility would require temporary re-routing of all vessels, including commercial and for-hire recreational fishing vessels, away from areas of active construction. During operations, periodic cable maintenance and repair could have similar impacts, although these activities would be less frequent and extensive than installation.



Source: BOEM 2021b

RI and MA Lease Areas = Rhode Island and Massachusetts Lease Areas; VMS = vessel monitoring system

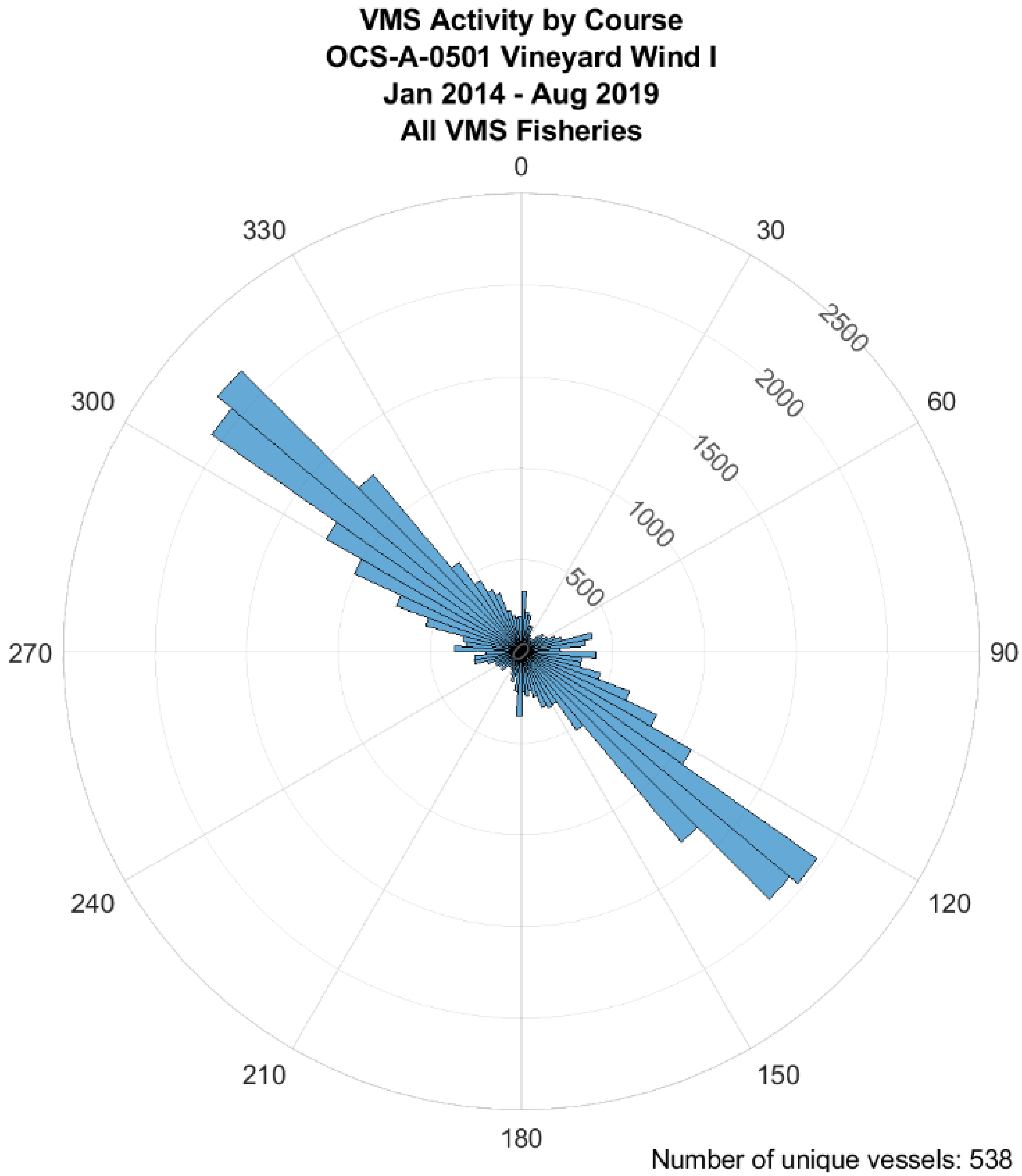
Figure 3.9-4: All Vessel Monitoring Service Fisheries in the Rhode Island/Massachusetts Lease Areas, Fishing



Source: BOEM 2021b

RI and MA Lease Areas = Rhode Island and Massachusetts Lease Areas; VMS = vessel monitoring system

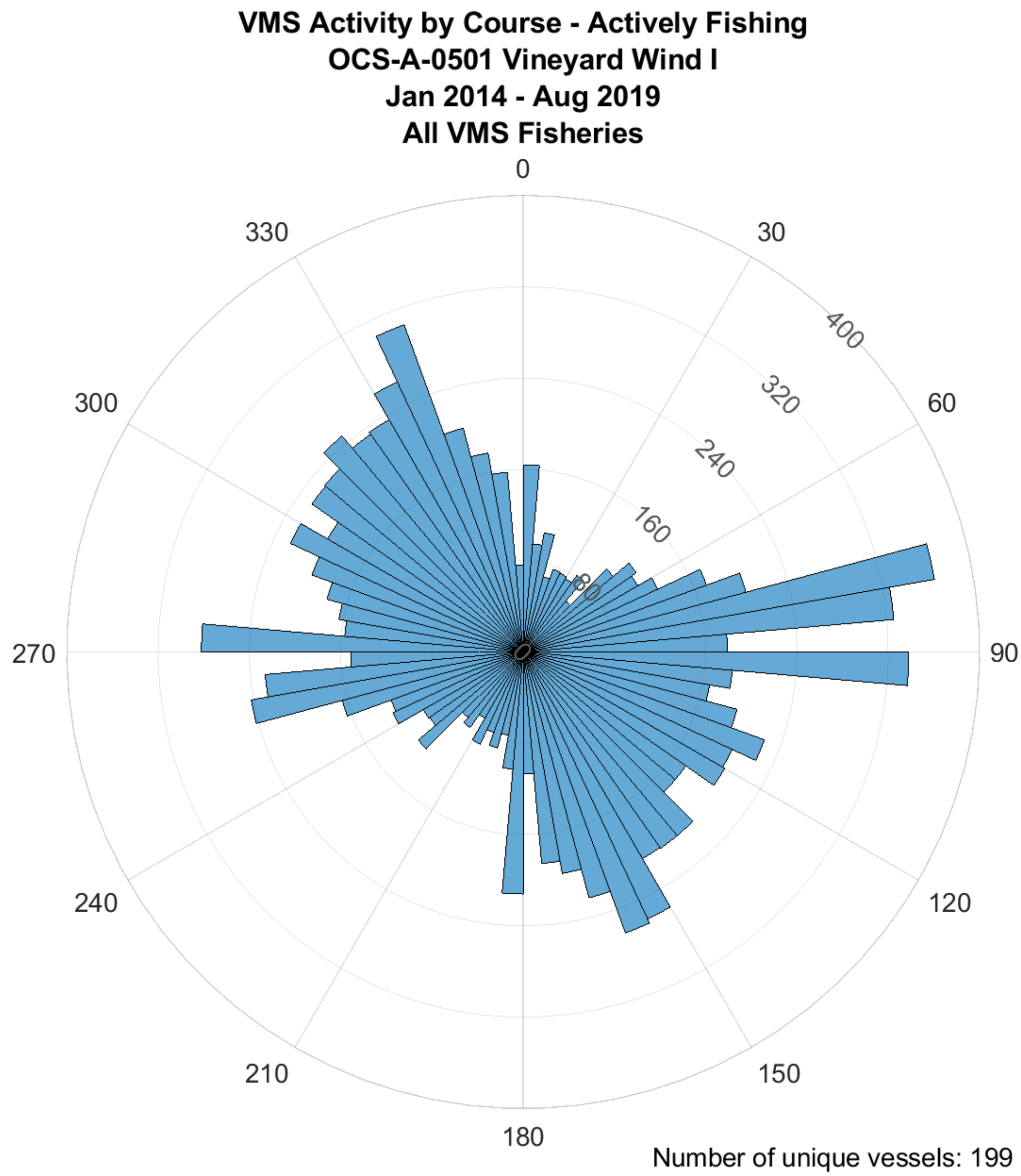
Figure 3.9-5: All Vessel Monitoring Service Fisheries in Rhode Island/Massachusetts Lease Areas, Transiting



Source: BOEM 2021b

VMS = vessel monitoring system

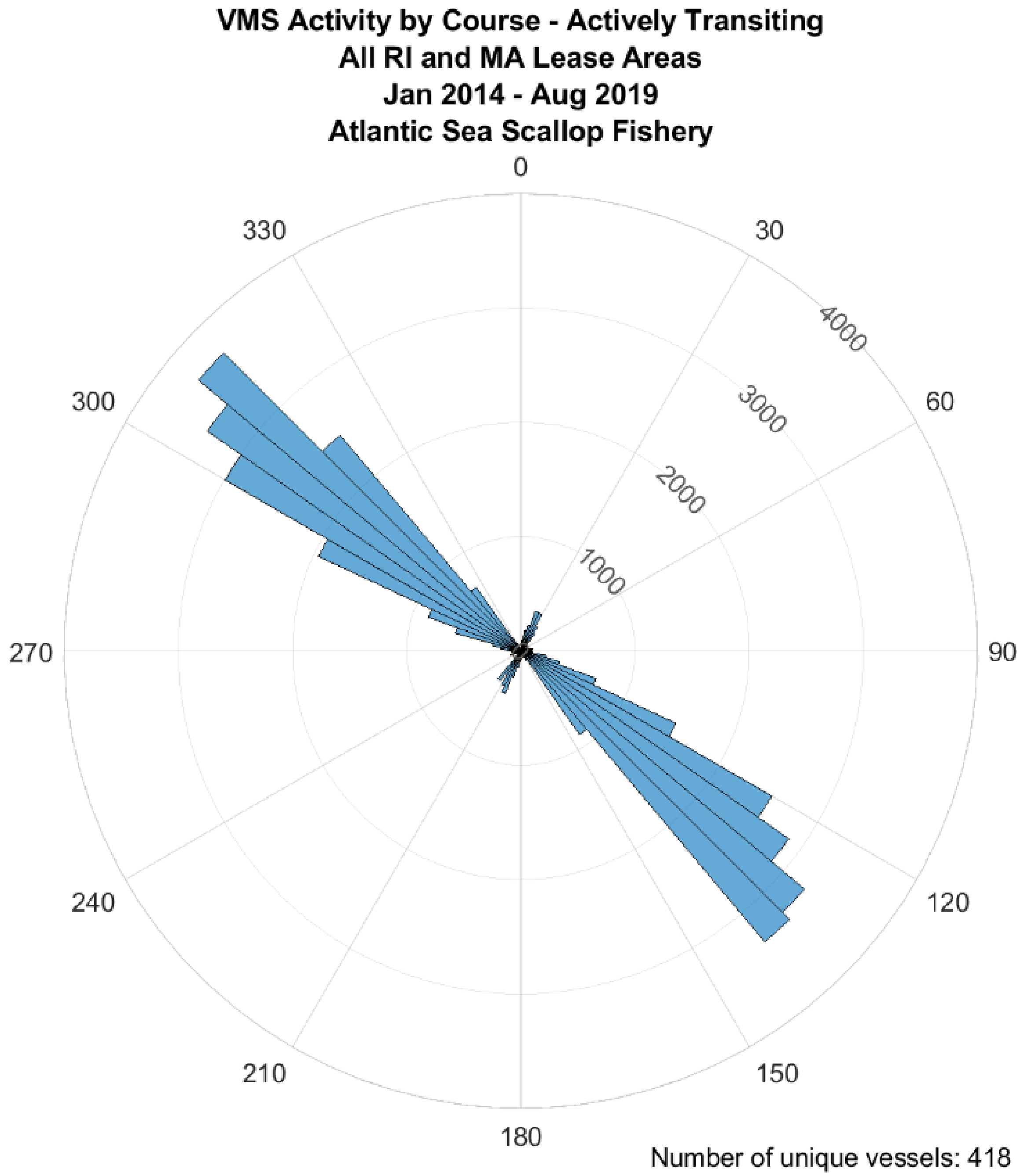
Figure 3.9-6: All Vessel Monitoring Service Fisheries in the Vineyard Wind 1 Wind Development Area, Fishing and Transiting



Source: BOEM 2021b

VMS = vessel monitoring system

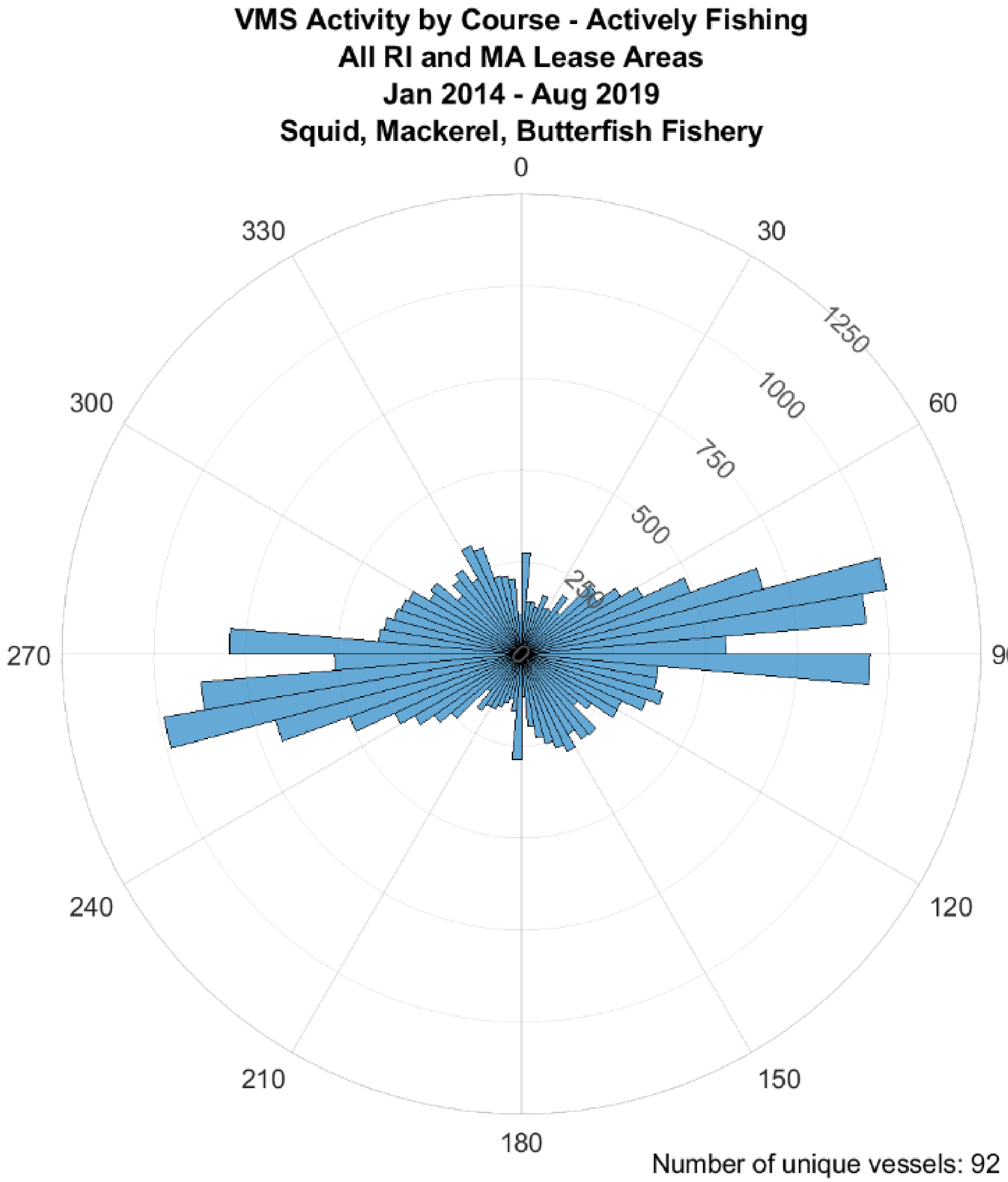
Figure 3.9-7: All Vessel Monitoring Service Fisheries in the Vineyard Wind 1 Wind Development Area, Fishing



Source: BOEM 2021b

RI and MA Lease Areas = Rhode Island and Massachusetts Lease Areas; VMS = vessel monitoring system

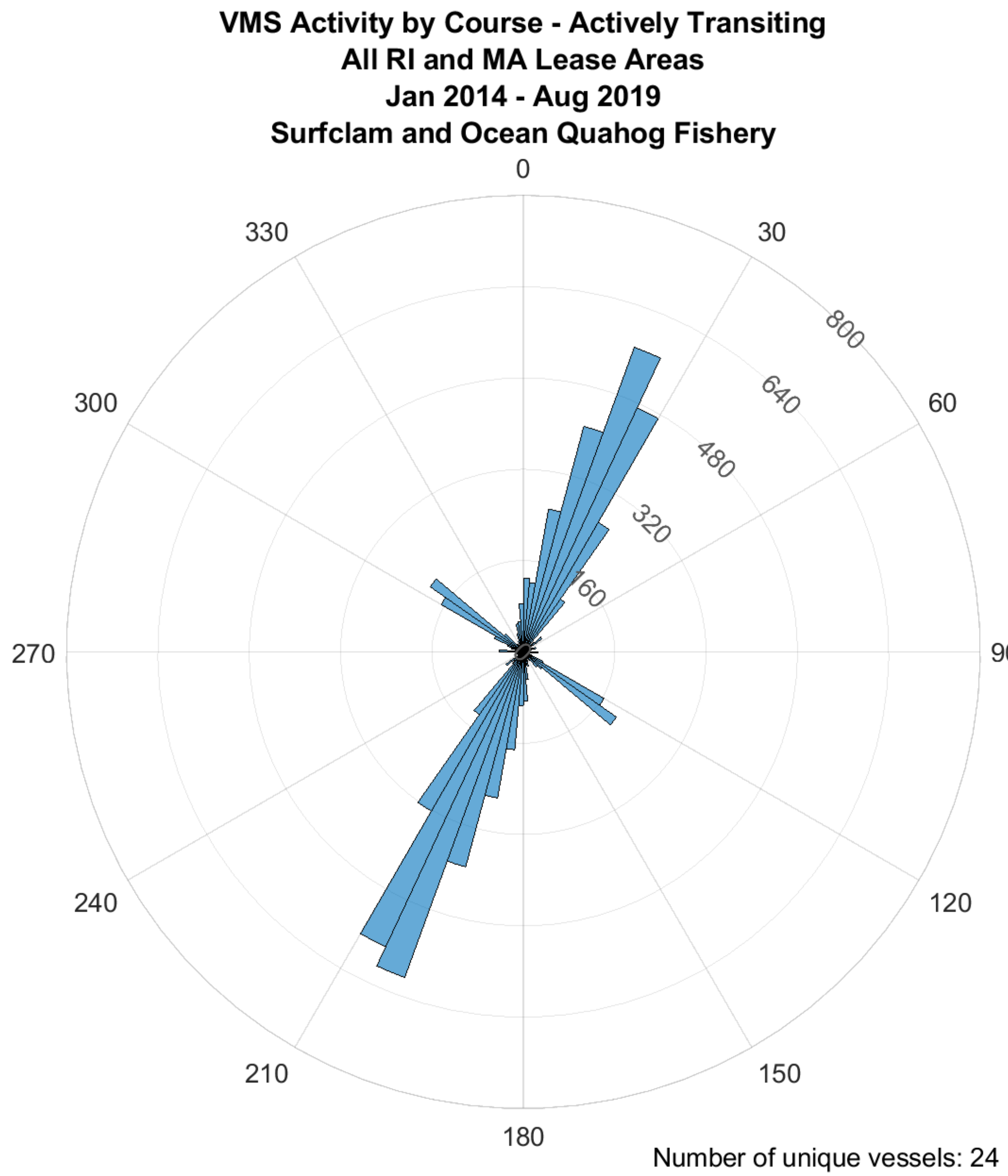
Figure 3.9-8: Sea Scallop Fishery in Rhode Island/Massachusetts Lease Areas, Transiting



Source: BOEM 2021b

RI and MA Lease Areas = Rhode Island and Massachusetts Lease Areas; VMS = vessel monitoring system

Figure 3.9-9: Squid, Mackerel, Butterfish Fishery in the Rhode Island/Massachusetts Lease Areas, Fishing



Source: BOEM 2021b

RI and MA Lease Areas = Rhode Island and Massachusetts Lease Areas; VMS = vessel monitoring system

Figure 3.9-10: Surf Clam and Ocean Quahog Fishery in the Rhode Island/Massachusetts Lease Areas, Transiting

The location of proposed offshore wind energy structures could affect the accessibility and/or availability of fish for commercial and for-hire fisheries. Potential displacement of fishing vessels and increased competition on fishing grounds could have long-term impacts on commercial fisheries and for-hire recreational fishing. In 2017, there were 4,300 federally permitted vessels operating in the northeast across all fisheries (NOAA 2019b). Alternative A would impact all fisheries and all gear types. Bottom tending mobile gear is more likely to be displaced than fixed gear. The future offshore wind projects would be more likely to displace larger fishing vessels with small mesh bottom-trawl gear and mid-water trawl gear compared to smaller fishing vessels with similar gear types that may be easier to maneuver.

Space use conflicts could cause a temporary or permanent reduction in fishing activities and fishing revenue because some displaced fishing vessels may not opt to, or may not be able to, fish in alternative fishing grounds. There could be increased gear conflicts as commercial fisheries and for-hire recreational fishing compete for space between turbines, especially if there is an increase in recreational fishing for structure-affiliated species attracted to the foundations (e.g., black sea bass). Commercial fishing vessels have well-established and mutually recognized traditional fishing locations or may be restricted on where they can fish due to fishery regulations. The relocation of fishing activity outside wind development areas could increase conflict among commercial fishing interests as other areas are encroached. The competition is expected to be higher for less mobile species such as lobster, crab, surf clam/ocean quahog, and sea scallop.

Revenue exposure, which quantifies the dockside value of fish reported as being caught in individual wind development areas, is one lens for understanding the level of commercial fishing activity that could be impacted. It is a starting point to understanding potential economic impact of future offshore wind project development if a harvester opts to no longer fish in the area and cannot recapture that income in a different location. Revenue exposure measures should not be interpreted as a measure of economic impact or loss. Actual economic impact would depend upon many factors—foremost, the potential for continued fishing to occur within the footprint of a wind development area, as well as the availability of target species within the wind development areas. Economic impacts also depend on a vessel's ability to adapt by changing where it fishes. For example, if alternative fishing grounds are available nearby, or if alternative fishing methods are implemented, the economic impact would be lower. Thus, when aggregating across all fisheries (mobile and fixed gear) and all years, the revenue exposure estimate is a very conservative estimate of actual impacts.

Projected revenue exposure measures are based on the entire area or footprint of a given lease area and the year that future projects are assumed to be constructed. Table 3.9-5 was included in the Ocean Wind 1 Draft EIS (BOEM 2022c) and is applicable to the proposed Project. Using the assumed construction schedule, Table 3.9--5 shows the projected annual total northeast fishery revenue exposed, by fishery management plan for 2021 through 2030.

Table 3.9--6 shows the cumulative port revenue from the SWDA (from 2008 to 2021) of the ports that are anticipated to be impacted (by revenue) from the planned activities scenario. The four landing port groups with the highest average annual revenue from the SWDA are Point Judith, Rhode Island; New Bedford, Massachusetts; Montauk, New York; and Fairhaven, Massachusetts. The highest revenue by dollar and percent exposure is Point Judith, Rhode Island. This is driven primarily by squid landings from leased areas offshore Massachusetts and Rhode Island.

Table 3.9-5: Annual Commercial Fishing Revenue in the Mid-Atlantic and New England Regions Exposed to Offshore Wind Energy (Excluding Proposed Project) Development by Fisheries Management Plan, 2021–2030 (thousands)

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

Sources: Adapted from BOEM 2022c

FMP = Fisheries Management Plan; HMS = highly migratory species; VTR = vessel trip report
[a] This column represents the total average revenue exposed in 2030 in order to give a value reference for the percentage of revenue exposed in 2030.
[b] This includes revenues from all species not assigned to an FMP including American lobster and Jonah crab fisheries.
Revenue is in nominal dollars using the monthly, not seasonally, adjusted Producer Price Index by Industry for Fresh and Frozen Seafood Processing provided by the U.S. Bureau of Labor Statistics. The data represent the revenue-intensity raster developed using fishery-dependent landings' data. To produce the data set, VTR information was merged with data collected by at-sea fisheries observers, and a cumulative distribution function was estimated to present the distance between VTR points and observed haul locations. Resolution of the data allows estimates to be made on a small enough scale to differentiate impacts along wind farm export cable corridors. Therefore, estimates only pertain to individual offshore wind lease areas. This provided a spatial footprint of fishing activities by FMPs. The percentages are expected to continue after 2030 until facilities are decommissioned. Slight differences in totals are due to rounding.
"$0" indicates the value is positive but less than $100.

Table 3.9-6: Average Annual Revenue from the Southern Wind Development Area for Most Impacted Ports, 2008–2021

State Landed	Port Landed	Average Annual Revenue from the SWDA
Rhode Island	Point Judith	$2,587,000
Massachusetts	New Bedford	$2,227,000
New York	Montauk	$462,000
Massachusetts	Fairhaven	$354,000
Massachusetts	Chatham	$293,000
Rhode Island	Little Compton	$246,000
Connecticut	New London	$169,000
Rhode Island	Newport	$164,000
Massachusetts	Westport	$159,000
North Carolina	Beaufort	$81,000

Source: Adapted from NMFS 2023e

SWDA = Southern Wind Development Area

The results in Table 3.9-5 show increased revenue exposure as more offshore wind energy facilities are developed in the Mid-Atlantic and New England regions by FMP fishery from 2021 through 2030. The largest annual impacts in terms of exposed revenue are expected to be in the sea scallop, mackerel/squid/butterfish, and surf clam/ocean quahog FMP fisheries. The fishery with the largest combined percent exposure and dollar value is the sea scallop fishery, which has an estimated landing value of approximately $22.4 million. This analysis includes the SWDA and all lease areas within the expanded planned activities analysis. While all federally managed fisheries are required to submit a VTR, some fisheries like American lobster and Jonah crab do not have that requirement unless they are also landing a federally managed species. Thus, lobster and Jonah crab landings are captured in the "None: Unmanaged" row. According to NMFS, VTRs capture between 31 percent (Connecticut) and 100 percent (Virginia and Maryland) of lobster landings between 2014 and 2019. Massachusetts and Rhode Island averaged 60 and 70 percent, respectively, over the same period. Similarly, VTR required vessels landed between 18 and 100 percent of Jonah crabs in New England and the MidAtlantic (B. Galuardi, Pers. Comm., March 18, 2020).

Another aspect of commercial fishing within the RI/MA Lease Areas is the proportion of small business operations compared to large businesses. To characterize the amount of fishing revenue from the RI/MA Lease Areas that is generated by small businesses, NMFS conducted a small business analysis. The analysis defined a small business as a business that is independently owned and operated, is not dominant in its field of operation (including its affiliates), and has combined annual receipts not in excess of $11 million for all its affiliated operations worldwide. The analysis was conducted upon unique business interests, which can represent multiple vessel permits. Both within the northeast region, as well as the RI/MA Lease Areas, there are more small businesses operating than large businesses. The number of small and large businesses engaged in federally managed fishing and the revenue of those businesses from 2019 through 2021 is summarized for the geographic analysis area in Table 3.9-7 and the RI/MA Lease Areas in Table 3.9-8. During this 3-year time period, an annual average of 1,166 businesses fished in the geographic analysis area, of which 1,155 (99 percent) were small businesses and 11 (1 percent) were large businesses. Businesses engaged in fishing in the geographic analysis area generated an annual average revenue of more than $1 billion, of which over $777 million (77 percent) wase attributed to small businesses and $232 million (23 percent) was attributed to large businesses. During this time period, an annual average of 166 businesses were fishing in the RI/MA Lease Areas, of which 157 (94 percent) were small businesses and 8 (5 percent) were large businesses. Businesses generated an annual average revenue of $421,000 in the RI/MA Lease Areas, of which $396,000(94 percent) was attributed to small businesses and $25,000 (6 percent) was attributed to large businesses. Small businesses that fished inside the RI/MA Lease Areas generated 0.20 percent of their total revenue from the lease areas, while large businesses that fished inside the RI/MA Lease Areas generated 0.02 percent of their total revenue from the lease areas, demonstrating that small businesses were more reliant on revenue generated from the lease areas.

Table 3.9-7: Number and Revenue of Small and Large Businesses Engaged in Federally Managed Fishing within the Geographic Analysis Area, 2019–2021

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

Source: Developed using data from NMFS 2023e
[a] Revenue values have been delated to 2021 dollars and rounded to the nearest thousand.

Table 3.9-8: Number and Revenue of Small and Large Businesses Inside the Rhode Island/Massachusetts Lease Areas Compared to the Total Revenue of those Businesses, 2019–2021

Year	Business Type	Number of Entities	Revenue from RI/MA Lease Areas (thousands of dollars)[a]	Total Revenue (thousands of dollars)[a]	Percentage of Revenue from RI/MA Lease Areas
2019	Large business	7	$20	$137,872	0.01%
	Small business	144	$385	$199,838	0.19%
2020	Large business	9	$20	$156,177	0.01%
	Small business	161	$274	$200,707	0.14%
2021	Large business	9	$35	$185,939	0.02%
	Small business	167	$528	$196,143	0.27%
Annual Average	**Large business**	**8**	**$25**	**$159,996**	**0.02%**
	Small business	**157**	**$396**	**$198,896**	**0.20%**

RI/MA Lease Areas = Rhode Island/Massachusetts Lease Areas
Source: Developed using data from NMFS 2023e
[a] Revenue values have been delated to 2021 dollars and rounded to the nearest thousand.

Regulated fishing effort refers to fishery management measures necessary to maintain maximum sustainable yield under the MSA. This includes quota and effort allocation management measures. The structures installed as part of offshore wind development could influence regulated fishing effort by changing fishing behavior to such an extent that overall harvest levels are not as predicted, and by impacting fisheries scientific surveys on which management measures are based (Section 3.14, Other Uses [National Security and Military Use, Aviation and Air Traffic, Offshore Cables and Pipelines, Radar Systems, Scientific Research and Surveys, and Marine Minerals]). If scientific survey methodologies are not adapted to sample within wind energy facilities, then there could be increased uncertainty in scientific survey results, which would increase uncertainty in stock assessments and quota setting processes. Future spatial management measures may change in response to changes in fishing behavior due to the presence of structures. Impacts on management processes would in turn have short-term or long-term impacts on commercial and for-hire recreational fisheries operations.

Traffic: Increased vessel traffic associated with future offshore wind development could increase congestion, delays at ports, and the risk for collisions with fishing vessels. In 2019, 180 fishing vessels reported trips from the SWDA, down from a maximum of 241 in 2017 (NMFS 2020). As stated in Section 3.13, future offshore wind projects would result in a small incremental increase in vessel traffic, with a peak during surveys and construction for Alternative A between 2023 and 2030, particularly when future offshore wind project construction activities overlap. The presence of construction vessels could restrict harvesting activities in wind development areas and along cable routes during installation and maintenance activities.

Conclusions

Impacts of Alternative A. Under Alternative A, commercial fisheries and for-hire recreational fishing would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under Alternative A, ongoing activities would have continuing temporary to permanent impacts on commercial fisheries and for-hire recreational fishing, primarily through cable emplacement and maintenance, pile-driving noise, the presence of structures, and ongoing climate change. The extent of impacts on commercial fisheries and for-hire recreational fishing would vary by fishery due to different target species, gear type, and location of activity. The impacts of ongoing activities would be **major** and **minor** beneficial from the presence of structures.

Cumulative Impacts of Alternative A. In addition to ongoing activities, planned activities may also contribute to impacts on commercial fisheries and for-hire fishing. Planned activities other than offshore wind include increasing vessel traffic, new submarine cables and pipelines, marine surveys, marine minerals extraction, and port expansion activities. The combination of ongoing activities and planned activities other than offshore wind would result in major impacts on commercial fisheries and for-hire recreational fishing, primarily driven by the ongoing factors of presence of structures and climate change.

Overall impacts of Alternative A would result in **major** impacts on commercial fisheries and for-hire recreational fishing due to the presence of structures (gear loss, navigational hazard, and space use conflicts). The presence of structures and their potential reef effect could also result in **minor** beneficial impacts. The majority of future offshore structures in the geographic analysis area would be attributable to the offshore wind industry. The future offshore wind industry would also be responsible for the majority of impacts related to cable emplacement and maintenance and pile-driving noise. However, ongoing impacts resulting from the presence of structures—including changes to stock levels due to ongoing fishing mortality—climate change, and other factors, would continue to be one of the most impactful IPFs controlling the sustainability of commercial and for-hire fisheries in the geographic analysis area.

3.9.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on commercial and for-hire recreational fisheries:

- The number and type/size of foundation used for the WTGs and ESPs. The applicant could construct a maximum of 130 WTGs using monopile foundations (maximum 39 feet diameter) and 5 ESPs using 3 to 12 piles.
- The export cable landfall has the potential to interfere with nearshore fishing grounds during construction.
- The route of the inter-array cables and the offshore export cable, including the ability to reach target burial depth or use cable protection measures when burial is insufficient. The applicant anticipates that up to 2 percent of the inter-array and inter-link cables and up to 6 percent of the offshore export cables within the OECC could require cable protection that could change fish habitat (soft-bottom habitat to hard-bottom habitat) and could also damage fishing gear and equipment, which in turn could cause a potential safety hazard should gear snag or hook seabed structures.
- The total amount of long-term habitat alteration from scour protection for the foundations.

- The number and types of vessels used during installation, operations, and decommissioning.
- Installation methods chosen, the amount of dredging (if any), and the duration of installation.
- The time of year during which construction occurs. For-hire recreational fisheries are most active when the weather is more favorable, while commercial fishing is active year-round with many species harvested throughout the year. However, certain fisheries have peak times. Construction activities can affect access to fishing areas and availability of fish in the area, thereby reducing catch and fishing revenue.

3.9.2.3 Impacts of Alternative B – Proposed Action on Commercial Fisheries and For-Hire Recreational Fishing

This section identifies the potential impacts of Alternative B on commercial fisheries and for-hire recreational fishing. When analyzing the impacts of Alternative B on commercial fisheries and for-hire recreational fishing, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for commercial fisheries and for-hire recreational fishing.

Impacts of Phase 1

Phase 1 would affect commercial fisheries and for-hire recreational fishing through the following primary IPFs during construction, operations, and decommissioning. The impacts of Phase 1 operations would be the same as (or less than, but with the same impact magnitudes) as Phase 1 construction, except where specifically discussed below. Except where discussed for the presence of structures IPF below, the impacts of Phase 1 decommissioning would be similar to Phase 1 construction.

Anchoring and gear utilization: Vessel anchoring would cause temporary impacts on fishing vessels and fishing activities. Anchoring vessels (including jack-up and grounding) used in the course of Phase 1 would pose a navigational hazard to fishing vessels and disturb approximately up to 178 acres (COP Appendix III-T, Tables 2 and 5; Epsilon 2023). All impacts would be localized, and potential navigation hazards would be temporary (hours to days). The impacts on commercial fisheries and for-hire recreational fishing of anchoring under Phase 1 would be moderate. Anchoring impacts on finfish, invertebrates, and EFH are discussed in Section 3.6.

Cable emplacement and maintenance: For export cable installation, the applicant would use a cable-laying vessel or barge to transport and install the export cable. The applicant would use a pre-lay grapnel run to locate and clear obstructions prior to cable laying. The applicant might also dredge to remove sand waves along the OECC, and a boulder plow and grab may be required to remove large boulders along the cable corridor. These activities would require communications with fixed-gear fisheries to ensure no gear is deployed in the installation path. The bottom-trawl fishery provides the highest revenue from the SWDA, followed by fixed-gear fisheries including gillnet and pot (COP Volume III, Tables 7.6-9 and 7.6-12; Epsilon 2023). Fishing revenue from gillnet and pots from the SWDA is estimated at $1,946,174 for the period of 2008 to 2019, with 7,426,706 landed pounds from the area (an average of $569,360 and 618,892 pounds per year) (COP Volume III, Section 7.6.2.3; Epsilon 2023). During the construction activities, it may not be possible to deploy fixed gear in parts of the SWDA, which may result in the loss of revenue if alternative fishing locations are not available. In addition, temporary limitations to fishing activities for all gear types could occur along the OECC while the site is being prepared and cables laid. The applicant would communicate where and when activities would occur in the OECC to avoid conflicts with fishing activities. The applicant considers cable burial a priority and would use iterative analyses of survey data, advanced burial techniques, and micro-routing to maximize burial and minimize the need for cable protection (Epsilon 2018). The applicant may also engage with the fishing industry to determine which form of cable armoring (i.e., rock placement, concrete mattresses, and/or halfshell) would be the least likely to create new hangs for mobile gear.

In response to a request from the Massachusetts Division of Marine Fisheries, the applicant has agreed to avoid cable laying activities in the spring season (April through June) within Nantucket Sound waters in light of high concentrations of fishing activities (squid, whelk, and flounder fisheries) and natural resource events (spawning and egg laying). Thus, the applicant would conduct cable laying of nearshore segments from early September to late October (from the landfall site to the northeast portion of Martha's Vineyard) using simultaneous lay and bury.

Phase 1 would disturb up to 442 acres of the seafloor through cable installation and up to 52 acres from dredging (COP Appendix III-T, Tables 2 and 5; Epsilon 2023). Construction of Phase 1 could prevent deployment of fixed and mobile fishing gear in limited parts of the SWDA from 1 day up to several months (if simultaneous lay and burial techniques are not used), which may result in the loss of revenue if alternative fishing locations are not available. Phase 1 would result in localized, temporary, and moderate impacts.

Section 2.3 describes the non-routine cable maintenance activities associated with Phase 1. These activities, if they were to occur, would generally require temporary activity to address emergency conditions. To perform maintenance and inspections, an SOV would be used to provide offshore accommodations and workspace for workers. CTVs would be used to transport crew to and from shore. If an SOV is not used, which is less likely, several CTVs and helicopters would be used for crew transportation.

The offshore export cables and inter-array cables would be monitored through distributed temperature sensing equipment. The distributed temperature sensing system would be able to provide real-time monitoring of temperature along the OECC, alerting the applicant should the temperature change, which could be the result of scouring of material and cable exposure. If cable repairs are needed, support vessels such as a jack-up vessel may be used. As such, only cable repairs (if required) under this IPF would temporarily impact commercially important fish and invertebrate species, and only in a localized area immediately adjacent to the repair. Commercial and for-hire recreational fishing vessels would be temporarily excluded from the area undergoing repair. Assuming repairs would be infrequent and would affect only small segments of the cables, impacts on commercial fisheries and for-hire recreational fishing from cable repairs would be negligible.

Climate change: Climate change, influenced in part by GHG emissions, is expected to continue to contribute to a gradual warming of ocean waters and shifting species distributions, influencing the distributions of commercial and for-hire recreational fisheries. Ocean acidification has impacts on the settlement and survival of shellfish (PMEL 2020) and would contribute to potential alterations in finfish migration patterns or reductions in invertebrate populations for species with calcareous shells. These impacts could lead to changes in migratory patterns, timing, available fisheries resources, and prey abundance and distribution. The intensity of impacts resulting from climate change are uncertain but are likely to be minor to moderate.

Noise: Noise from G&G surveys, pile driving related to WTG and ESP installations, cable burial or trenching, and from vessels may occur during Phase 1. Noise can temporarily disturb finfish and invertebrates in the vicinity of the source, causing a temporary behavior change, including leaving the area affected by the sound source and reducing foraging activity (biting hooks). Pile-driving noise could result in behavioral impacts up to 8.7 miles around each pile without attenuation, depending on the pile size, hammer energy, and local acoustic conditions (COP Appendix III-M; Section 4.5; Epsilon 2023). Impacts on commercial fisheries and for-hire recreational fishing would depend on the duration of the noise-producing activity (i.e., up to 6 hours per day, intermittently, for up to 78 days between May and

December [COP Appendix III-M; Epsilon 2023]) and corresponding impacts on fish species, coinciding with fishing, and would be negligible to moderate from Phase 1. Noise impacts on finfish, invertebrates, and EFH are discussed in Section 3.6.

To reduce noise impacts during construction, the applicant would use noise reduction technologies during all pile-driving activities to achieve a required minimum attenuation (reduction) of 6 dB re 1 μPa. The applicant would also use PAM to monitor and record marine mammal vocalizations and monitor Phase 1 noise including vessel noise, pile driving, and WTG operation (Appendix H, Mitigation and Monitoring).

Port utilization: Phase 1 construction would use numerous ports in Massachusetts, Rhode Island, Connecticut, and beyond (Section G.2.7, Land Use and Coastal Infrastructure), but the applicant has not funded or otherwise prompted any specific expansions. Phase 1 vessel activity would add to existing activity in existing ports and waterways. An increase in vessel traffic could result in delays or restrictions in access to ports for commercial and for-hire fishing vessels. As ports expand, maintenance dredging of shipping channels could increase (including increased frequency of dredging to maintain existing authorized depths and projects to increase channel depth, as described in Section 3.13) and may cause restrictions and delays for fishing vessels trying to access port facilities. Therefore, port utilization during Phase 1 construction would have minor to moderate impacts on commercial fisheries and for-hire recreational fishing.

Presence of structures: The type and likelihood of impacts on commercial fisheries and for-hire recreational fisheries during Phase 1 construction would be similar to the impacts described for construction of Vineyard Wind 1. Analysis from the Vineyard Wind 1 Final EIS (BOEM 2021b) is summarized here, as updated to reflect details of the proposed Project. Some structures would be present during Phase 1 construction activities as WTGs and ESPs are installed. This IPF is discussed in detail below.

Commercial and recreational regulations for finfish and shellfish, implemented and enforced by NMFS and coastal states, affect how commercial and for-hire recreational fisheries operate. FMPs are established to manage fisheries to avoid overfishing through catch quotas, special management areas, and closed area regulations. These can reduce or increase the size of available landings to commercial and for-hire recreational fisheries. During construction, this IPF would contribute to short-term and long-term moderate impacts on commercial fisheries and for-hire recreational fisheries operations, as described in detail in Section 3.9.2.1.

The presence of structures can lead to impacts on commercial and for-hire recreational fisheries through navigation hazards and allisions, entanglement and gear loss/damage, fish aggregation, habitat conversion, migration disturbances, space use conflicts, and effort displacement. The total area of construction seafloor disturbance from structures, scour protection, and cable installations for Phase 1 is 551 acres, including 35 acres of cable protection, and temporary deployment of one or more meteorological oceanographic (metocean) buoys in up to 50 locations within the SWDA and OECC (COP Appendix III-T, Tables 2 and 5; Epsilon 2023).

An allision occurs when a moving vessel strikes a stationary object, such as a WTG, ESP, or metocean buoy. The addition of Phase 1 WTGs, ESPs, and met buoys would increase navigational complexity, the risk of navigation hazards, and the potential for collisions and allisions for vessels transiting through the SWDA. Fishing vessels that choose to operate within the SWDA would have increased risk of allisions due to reduced maneuverability when fishing gear is deployed. Maneuverability within the SWDA would vary depending on many factors (e.g., vessel size, gear or method used, environmental conditions). Larger commercial fishing vessels with mobile gear are the most at risk for an allision, as they are the most limited in maneuverability.

Fishing in the SWDA would not be as problematic for for-hire recreational fishing vessels that bottom-fish with hook and line gear because these vessels generally operate over a fixed location or under a controlled drift. However, fishing for HMS may involve troll gear using many feet of lines and hooks behind the vessel, and in turn following large pelagic fish once they are hooked; these activities pose additional maneuverability challenges when structures are present. The risk of allisions would be mitigated through navigational lighting requirements and AIS transponders on foundations. The potential changes in fishing vessel transit routes or availability of fishing grounds due to the presence of structures could have long-term and moderate impacts on commercial fisheries and for-hire recreational fishing due to increased navigation time, increased fuel costs, and/or displacement from prime or preferred fishing grounds.

Commercial and recreational fishing gear is periodically lost due to entanglement with buoys, pilings, hard protection, and other structures. The lost gear, moved by currents, can disturb habitats and potentially harm individuals, creating small, localized, temporary impacts on fish, invertebrates, and habitat but likely no impacts at a fishery level. The proposed new structures would increase the risk of gear loss/damage by entanglement and could affect fishing vessels differently depending on the size of the vessel and the fishing gear. The extent of the impacts would depend on the vessel size, the fishing gear, and foundation or cable protection locations. Larger vessels with mobile gear are the most at risk for entanglement, as they are the most limited in maneuverability and are towing large gear (trawl nets). Vessels towing bottom-trawl gear, a common technique for squid fisheries, would also be vulnerable to areas of cable protection (Section B.2 in Appendix B). Gear loss and damage would have a moderate impact on commercial fisheries and a minor impact on for-hire recreational fishing, as the impacts would be localized to known/charted infrastructure. However, the risk of impacts would persist for as long as the structures remain.

Structures, including tower foundations, scour protection around foundations, and various means of hard protection atop cables create uncommon vertical relief that aggregates structure-oriented fishes. These impacts are localized and can be temporary to permanent (as long as structures are in place). Fish aggregation may be considered adverse, beneficial, or neutral. Commercial and for-hire recreational fishing can occur near these structures. However, commercial mobile fishing gear risks snagging on the structures while trying to take advantage of this aggregation. The proposed new infrastructure would modify existing soft-bottom habitat and to a lesser extent hard-bottom habitat. Structure-oriented species would benefit (e.g., lobster, striped bass, black sea bass, scup, and Atlantic cod); however, the local biomass increases are not anticipated to be significant enough to impact total quotas. This may lead to more and larger structure-oriented fish communities and larger predators opportunistically feeding on the communities, as well as increased private and for-hire recreational fishing opportunities around the infrastructure. Such changes could also result in increased space use conflicts between and within commercial and recreational fishing operations. These impacts would be both beneficial and adverse, likely resulting in minor impacts on commercial fisheries, negligible to minor impacts on for-hire recreational fisheries, and minor beneficial impacts on commercial and recreational fishery resources. Impacts are expected to be local to the individual foundations and may be temporary to permanent (for as long as foundations are present).

Human-made structures in the marine environment (e.g., shipwrecks, artificial reefs, buoys, and oil platforms) can attract finfish, invertebrates, and EFH that approach the structures during migration. This could slow species migrations (Section 3.6). Foundations would remain for the life of the proposed Project, and scour/cable protection would likely permanently remain. However, temperature is expected to be a larger driver of habitat occupation and species movement (Fabrizio et al. 2014; Moser and Shepherd 2009; Secor et al. 2018). Migratory animals would likely be able to proceed from structures unimpeded. Therefore, this impact would be negligible on commercial and for-hire recreational fishery resources.

The location of proposed offshore wind projects would affect the accessibility and availability of fish for commercial and for-hire recreational fishing. In particular, the location of the proposed infrastructure within the SWDA could impact transit corridors and access to preferred fishing locations. Depending on the width and location of transit corridors through, or routes around, the SWDA, commercial and for-hire recreational fishing fleets may find it more challenging to safely transit to and from homeports as there may be less space for maneuverability and greater risk of allision or collision if there is a loss of steerage. Transiting through the SWDA could also create challenges associated with using navigational radar when there are many radar targets that may obscure smaller vessels and where radar returns may be duplicated under certain meteorological conditions like heavy fog (Section 3.13 provides a more detailed evaluation of impacts on marine vessel radars). Larger vessels may find it necessary to travel around the SWDA to avoid maneuvering among the WTGs. This is especially true for fishing vessels homeported in New Bedford, with the SWDA being directly southeast of the port and regularly traversed by the commercial fleet. Fishing vessels not able to travel through or deploy fishing gear within the SWDA would need to travel longer distances to access fishing locations, resulting in increased travel time and trip costs. Additionally, as commercial fishing vessels typically stay out at sea over multiple days, vessels would be navigating at nighttime or during adverse weather conditions, which could present challenges for vessels traveling through the SWDA.

The applicant's analysis of the economic exposure of fisheries to Alternative B estimated that average annual dockside value of fish harvested commercially in the SWDA in 2019 dollars is $739,521 and that fishing revenue in areas impacted by cable installation activities in the OECC is approximately $12,000 (COP Appendix III-N; Epsilon 2023; King and Associates 2021). However, the economic impacts associated with lost fishing revenues would be less than total economic exposure (King and Associates 2021). Potential displacement of fishing vessels and increased competition on fishing grounds unoccupied by structures would have long-term impacts. Space use conflicts could cause a temporary or permanent reduction in fishing activities and fishing revenue, as some displaced fishing vessels may not opt to, or may not be able to, fish in alternative fishing grounds. Commercial fishing vessels have well established and mutually recognized traditional fishing locations. The relocation of fishing activity outside the SWDA or OECC may increase conflict among fishermen as other areas are encroached. Competition is expected to be higher for less mobile species (e.g., lobster, crab, surf clam/ocean quahog, and scallop). Additional Phase 1 structures could lead to fish aggregation of structure-oriented species, increasing the opportunities for for-hire recreational fishery resources. This could contribute to space use conflicts with the commercial fisheries within the SWDA. Moderate impacts are expected on commercial fisheries, and minor to moderate impacts are expected on for-hire recreational fishery resources due to potential displacement and lost revenue.

The presence of structures from Phase 1 operations would increase the risk of highly localized, periodic temporary impacts on fishing activities during construction and would have potentially long-term and minor to moderate impacts on commercial and for-hire recreational fisheries that use mobile bottom gear.

During decommissioning, removal of structures that produce an artificial reef effect would result in loss of any beneficial fishery impacts that would have occurred during operations but would also eliminate the potential allisions and snag hazards. Therefore, the impacts on commercial and for-hire recreational fisheries resources from Phase 1 decommissioning would be negligible to moderate, with a moderate beneficial impact due to structure removal.

Traffic: Phase 1 construction vessel traffic would increase the risk of collisions due to the presence of Phase 1 vessels. Non-Project vessels navigating around Phase 1 WTGs and ESPs under construction would experience more complex navigation conditions due to the need to avoid structures (allisions), as well as other proposed Project and non-Project vessels also conducting similar maneuvers. Offshore construction of Phase 1 would temporarily restrict access to the OECC route and SWDA during construction. Construction support vessels, including vessels carrying assembled WTGs or WTG components, would be present in the waterways between the SWDA and the ports used during Phase 1 construction. An average of 30 and a maximum of 60 vessels would operate in the OECC and SWDA at any time during Phase 1 construction (COP Volume III, Section 7.8.2; Epsilon 2023). The applicant's proposed Maritime Coordinator and vessel traffic management plan (Appendix H) are expected to reduce vessel conflicts. Although fishing vessels may experience increased transit times, such situations would be spatially and temporally limited. Overall, Phase 1 vessel activities in the open waters between the SWDA and ports and along the OECC would have minor impacts on fishing vessels.

Impacts of Phase 2

Except for the IPFs described below, the impacts of Phase 2 are expected to be similar to, and marginally larger than, those described for Phase 1 and would have the same impact magnitudes.

If the applicant selects the SCV as part of the final Phase 2 design, some or all of the impacts on commercial fisheries and for-hire recreational fishing from the Phase 2 OECC through Muskeget Channel may not occur, while impacts along the SCV route would occur. In particular, fishing vessels that primarily operate from New Bedford and nearby ports could be more directly impacted than vessels that primarily operate from Cape Cod, Martha's Vineyard, and Nantucket. Overall, based on available information, BOEM anticipates that the impacts of the SCV on commercial fisheries and for-hire recreational fishing would be similar to those for the Phase 2 OECC through Muskeget Channel, described below. If the SCV is chosen, BOEM will provide a more detailed analysis of the SCV impacts on commercial fisheries and for-hire recreational fishing in a supplemental NEPA analysis.

Phase 1 and Phase 2 would each result in a similar number of vessels performing similar operations, as well as similar construction methods and component infrastructure. Phase 2 would include the potential use of bottom-frame foundations for WTGs and ESPs (COP Volume I, Section 4.2.1; Epsilon 2023). As shown in Table C-3 in Appendix C, each bottom frame foundation would require up to 1.7 acres of scour protection, compared to 1.2 acres for monopiles and 1.6 acres for each jacket foundation. As a result, the impacts of Phase 2 would be marginally larger than, but substantively similar to, those described for Phase 1. Specifically, Phase 2 would have negligible to minor impacts for noise; negligible to moderate impacts for the presence of structures; minor to moderate impacts from climate change; and minor impacts from anchoring and gear utilization, cable emplacement and maintenance, and vessel traffic. Phase 2 construction would have minor beneficial impacts on commercial fishery and for-hire recreational fishery resources from the presence of structures.

Phase 2 operations would be similar to (and would likely be combined with) Phase 1 operations and would result in negligible to minor impacts for noise; negligible to moderate impacts for the presence of structures; minor to moderate impacts from climate change; and minor impacts from anchoring and gear utilization, cable emplacement and maintenance, and vessel traffic. Phase 2 operations would have minor beneficial impacts on commercial fishery and for-hire recreational fishery resources from the presence of structures.

Phase 2 decommissioning impacts would be similar to those described for Phase 1 decommissioning and would range from negligible to moderate, with a moderate beneficial impact due to structure removal. The negligible to moderate impacts of decommissioning Phase 2 would not increase the impacts beyond that of Alternative A.

Cumulative Impacts

The cumulative impacts of Alternative B considers the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-6 in Appendix G would contribute to impacts on commercial fisheries and for-hire recreational fisheries through the primary IPFs of anchoring and gear utilization, cable emplacement and maintenance, climate change, noise, port utilization, presence of structures, and traffic. Other offshore wind projects would each have land disturbance impacts, but these impacts would be unlikely to occur in the same geographic area or timeframe as Alternative B and are, thus, not considered as cumulative impacts. Cumulative impacts would primarily occur through changes in navigational hazards (e.g., from anchoring and gear utilization, cable emplacement and maintenance, presence of structures); changes to fishing locations; changes to gear type and size able to be used; change in fishery stock (e.g., from noise, presence of structures and scour protection); and increased risk of vessel collisions, allisions, and gear loss.

Up to seven offshore wind projects in the RI/MA Lease Areas (including the proposed Project) could be under construction simultaneously in 2025. The cumulative impacts of all IPFs from ongoing and planned activities, including offshore wind, range from negligible to **major** and **minor** beneficial.

Conclusions

Impacts of Alternative B. The impacts of Alternative B on commercial fisheries and for-hire recreational fishing would be **major** and **minor** beneficial from the presence of structures. Alternative B would contribute to impacts on commercial and for-fire recreational fisheries through all of the IPFs named in Section 3.9.2.1 except for port utilization. Impacts from Alternative B would include temporary and long-term consequences resulting from anchoring and gear utilization, cable emplacement and maintenance, noise, presence of structures, and vessel traffic. Other impacts associated with Alternative B may occur as a consequence of routine activities after the applicant completes construction (i.e., cable maintenance), although the impact of routine post-construction activities on commercial and for-hire recreational fisheries is likely to be negligible based on the small portion of area within the SWDA and OECC that would be affected. Impacts from the presence of structures may result in minor beneficial impacts on commercial fisheries and for-hire recreational fishing due to fish aggregation. The most prominent IPFs of Alternative B are expected to be presence of structures, noise (specifically from pile driving), and climate change. In general, the impacts are likely to be local and not alter the overall character of commercial and for-hire recreational fisheries resources in the geographic analysis area. Despite fishing location changes, risk to fishing gear and vessels from structures and other vessels, and temporary or permanent habitat alteration, the long-term impact on commercial and for-hire recreational fisheries resources from Alternative B would be **major**, as the impacts could be measurable on a site-level scale and have long-term impacts. The applicant may elect to pursue a course of action within the PDE that would cause less impact than the maximum-case scenario evaluated above but doing so would not likely result in different impact ratings than those described above.

Cumulative Impacts of Alternative B. The cumulative impacts on commercial fisheries and for-hire recreational fishing in the geographic analysis area would be **major** and **minor** beneficial from the presence of structures. The combined impacts from ongoing and planned activities, including Alternative A, would result in **major** impacts on commercial fisheries and for-hire recreation fishing in the geographic analysis area. The impact rating is driven mostly by impacts due to the presence of structures (cable protection measures and foundations), increased risk of vessel and structure strikes and gear loss, changes to available fishing locations, changes to fish distribution/availability due to ongoing climate change, and reduced stock levels due to ongoing fishing pressure.

The applicant is developing and would implement procedures for handling compensation to fishermen for potential gear loss (COP Appendix III-N; Epsilon 2023). The applicant also plans to contribute to fisheries research and education, including a commitment to provide up to $2.5 million to support fisheries research in partnership with the University of Connecticut and Connecticut Sea Grant. Additionally, as part of Phase 1, the applicant would allocate up to $7.5 million in funds to support environmental initiatives, assist Connecticut fishermen, and further bolster local communities in

Connecticut where offshore wind development is taking place (COP Appendix III-N and Volume III, Section 7.6.3; Epsilon 2023).

BOEM has proposed guidance to lessees for mitigating impacts on commercial and recreational fisheries (https://www.boem.gov/sites/default/files/documents/renewable-energy/DRAFT%20Fisheries%20Mitigation%20Guidance%2006232022_0.pdf). These mitigation measures may change as a result of comments on the guidance document. BOEM may include the following mitigation and monitoring measures to address impacts on commercial fisheries and for-hire recreational fishing, as described in detail in Table H-2 of Appendix H. The Final EIS lists the mitigation and monitoring measures that BOEM would require as a condition of COP approval:

- Implement a gear loss and damage compensation program consistent with BOEM's draft guidance for mitigating impacts on commercial fisheries and for-hire recreational fishing. This measure would address the IPF for presence of structures during construction and operations by reducing impacts resulting from loss of gear associated with uncharted obstructions resulting from the proposed Project.
- Implement a compensation program for lost income from commercial fisheries and for-hire recreational fishing activities and other eligible fishing interests consistent with BOEM draft guidance. This measure would address the IPF for presence of structures by compensating fishing interests for lost income during construction and a minimum of 5 years post-construction.
- Design cable protection measures to reflect the existing conditions at the site and specifically to avoid introducing new hangs for mobile fishing gear by making cable protection measures "trawl-friendly" with tapered/sloped edges. If cable protection is necessary in "non-trawlable" habitat, such as rocky habitat, the applicant would use materials that mirror that benthic environment, including rock placement or a gabion system.

The mitigation and monitoring measures listed above would address the presence of structures IPF by compensating fishing interests by reducing gear loss and compensating for lost income during and after proposed Project construction. These measures, if adopted, would reduce presence of structure impacts from moderate to minor but would not change the overall **major** impact rating for Alternative B.

3.9.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Commercial Fisheries and For-Hire Recreational Fishing

When analyzing the impacts of Alternative C on commercial fisheries and for-hire recreational fishing, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for commercial fisheries and for-hire recreational fishing. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of inter-array, inter-link, and export cables installed for the proposed Project. More information on export cable route scenarios can be found in Table 2.1-2 in Chapter 2, Alternatives. Each cable route scenario could affect the exact length of cable installed and area of ocean floor disturbed:

- Alternative C-1 would avoid impacts on complex habitats in the Western Muskeget Variant by removing that route as an option for Phase 2. Under this alternative, all three Phase 2 export cables would be installed in the Eastern Muskeget route, as well as both cables for Phase 1.
- Alternative C-2 would limit the number of export cables installed in the Eastern Muskeget route to three (both Phase 1 cables and one Phase 2 cable) and would include installation of up to two cables in the Western Muskeget Variant. This would reduce impacts on complex habitats in the Eastern Muskeget route.

The Western Muskeget Variant would affect less seafloor acreage than the Eastern Muskeget route; however, the Western Muskeget Variant is only comprised of a complex seafloor, while the Eastern Muskeget route is comprised of a complex seafloor, hard coarse deposits, and soft bottom (Table 3.4-2). Because of the rare habitats provided by complex and hard coarse deposit seafloor types, avoidance of disturbance to these habitats would also result in lower impacts on commercial fisheries and for-hire recreational fishing (additional discussion is provided in Section 3.9.1).

Alternative C-1 would use only the Eastern Muskeget route, which would eliminate impacts on commercial fisheries and for-hire recreational fishing in the Western Muskeget Variant. The Eastern Muskeget route contains more types of habitat than the Western Muskeget Variant, but less of the habitat is complex seafloor. Using only the Eastern Muskeget route in Alternative C-1 would, therefore, affect more habitat types and a wider variety of commercial fisheries and for-hire recreational fishing species inhabiting or reliant on these habitats than if the Western Muskeget Variant were used. However, Alternative C-1 would affect less of the complex habitat compared to Alternative B (which includes the potential use of the Western Muskeget Variant).

Alternative C-2 could use both the Eastern Muskeget route and the Western Muskeget Variant and would, therefore, affect fish species important to commercial fisheries and for-hire recreational fishing that inhabit or rely on complex seafloor, hard coarse deposits, and soft bottom habitats across a larger area than Alternative C-1. Under Alternative C-2, dredging for Phase 2 cable installation could impact up to 73 acres and could include up to 274,800 cubic yards of dredged material (compared to 67 acres and 235,400 cubic yards for Alternative B and Alternative C-1). The impacts of Alternative C-2 on commercial fisheries and for-hire recreational fishing for species in the Eastern Muskeget route would be less than those under Alternative C-1, and potentially less than those of Alternative B because Alternative C-2 would involve installation of fewer cables in the Eastern Muskeget route. The impacts of Alternative C-2 on commercial fisheries and for-hire recreational fishing for species present in complex habitats would be greater in Alternative C-2 than Alternative C-1, due to the installation of up to two cables in that corridor (where no such cables would be installed under Alternative B or Alternative C-1). Overall, Alternative C-2 would have greater impacts than Alternative C-1 on fish species important to commercial fisheries and for-hire recreational fishing that inhabit or rely on complex seafloor habitats due to impacts within both the Eastern and Western Muskeget.

To the degree that Alternatives C-1 and C-2 reduce impacts on commercially important fish and invertebrate species, they could have marginally lower impacts on commercial fisheries and for-hire recreational fishing than Alternative B. However, these differences in impacts would not result in meaningfully different impacts compared to those of Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on commercial fisheries and for-hire recreational fishing would be the same as those of Alternative B: **major** and **minor** beneficial from the presence of structures. In the context of ongoing and planned activities, the cumulative impacts of Alternatives C-1 and C-2 along with ongoing and planned activities would be similar to those of Alternative B: **major** and **minor** beneficial.

3.9.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Commercial Fisheries and For-Hire Recreational Fishing with the Western Muskeget Variant Contingency Option

Impacts on commercial fisheries and for-hire recreational fishing from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B (Scenario 2 for Phase 2). While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WT or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce the potential impacts on commercial fisheries and for-hire recreational fishing by a negligible increment for both Phase 1 (3.2 acres[29] if a foundation is eliminated or 3.9 acres[29] if a ESP foundation is eliminated) and Phase 2 (4.5 acres[29] if a WTG foundation is eliminated or 7.6 acres[29] if a ESP foundation is eliminated) as a result of one less foundation and associated scour protection and required construction vessel impacts (COP Volume III, Appendix III-T; Epsilon 2023). Additionally, the impacts would be slightly less, as less pile driving would be required.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on commercial fisheries and for-hire recreational fishing relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **major** impacts on finfish, invertebrates, and EFH within the geographic analysis area, as well as **minor** beneficial impacts from the presence of structures. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **major** and **minor** beneficial.

[29] This acreage assumes that the foundation and associated scour protection, as well as seafloor disturbance, as a result of construction vessel impacts would not occur at a single position.

3.10 Cultural Resources

3.10.1 Description of the Affected Environment

3.10.1.1 Geographic Analysis Area

This section discusses existing conditions in the geographic analysis area for cultural resources as described in Table D.1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.10-1. Specifically, this includes terrestrial and offshore areas potentially affected by the proposed Project's land- or bottom-disturbing activities, areas where structures from the proposed Project would be visible, and the area of intervisibility where structures from both the proposed Project and future offshore wind projects would be visible simultaneously. Table G.1-7 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor (or Lower) Impacts, describes existing conditions and the impacts, based on the IPFs assessed for ongoing and future offshore activities other than offshore wind, which is discussed below.

Cultural resources refer to many heritage-related resources defined in federal laws and EOs, including NEPA and the NHPA. For the purpose of this analysis, cultural resources, which broadly refers to archaeological sites, buildings, structures, objects, and districts, which may include cultural landscapes and traditional cultural properties (TCP), have been divided into three principal types: archaeological resources, historic structures, and TCPs. Archaeological resources comprise areas where human activity has altered the earth and/or deposits of physical remains of past human activity (e.g., artifacts) are found. Historic structures include standing buildings, bridges, dams, and other structures of historic or aesthetic significance. TCPs are places, landscape features, or locations associated with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. These resources may be historic properties as defined in 36 CFR Part 800 (Protection of Historic Properties), which are eligible for or listed in the National Register of Historic Places (NRHP), as well as those resources listed on state or local registers, or may 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 require a project to consider how it might affect significant cultural resources. Generally, historic properties must be more than 50 years old to warrant consideration for the NRHP. Historic properties less than 50 years old might warrant protection if they are of exceptional importance or have the potential to gain significance in the future.

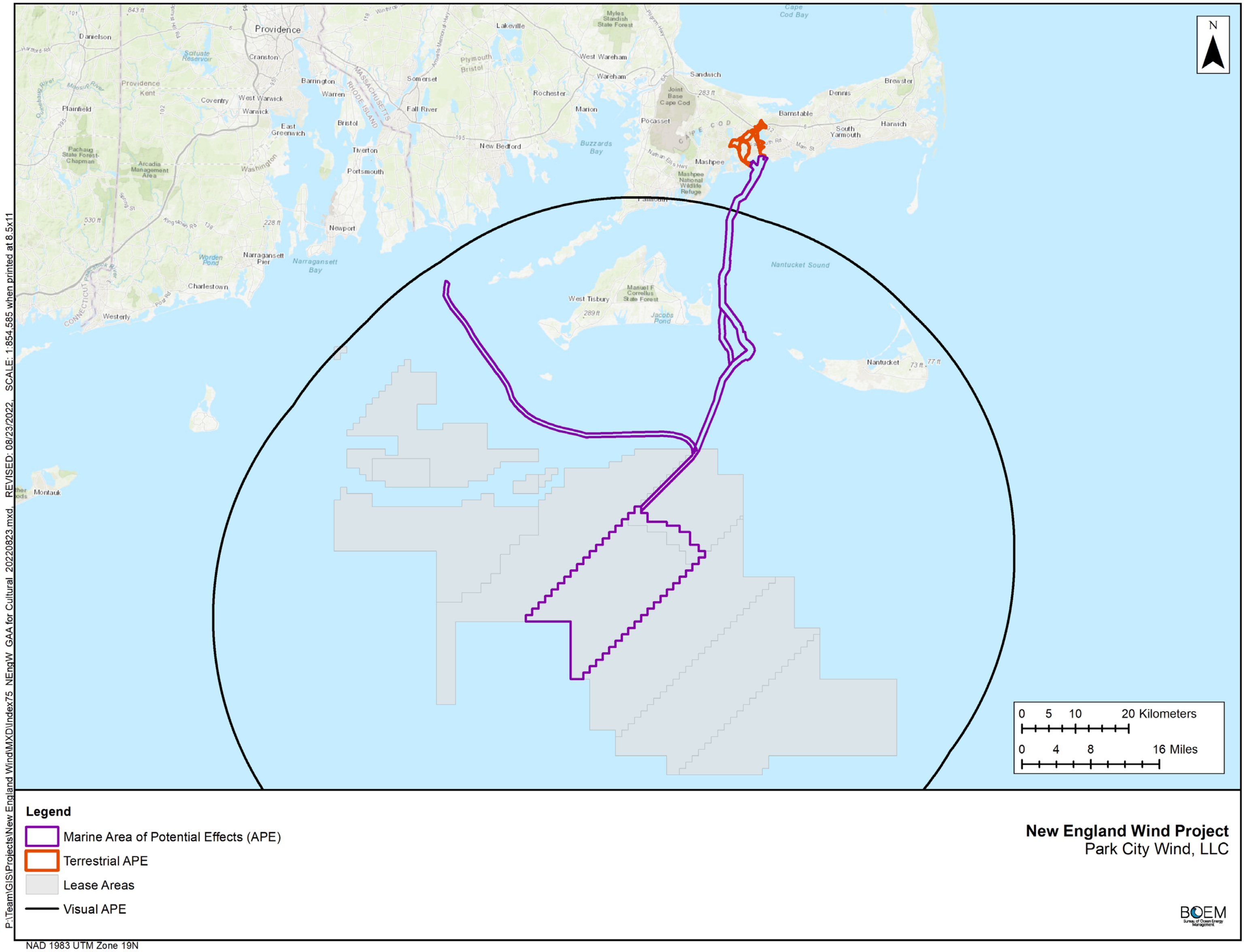


Figure 3.10-1: Geographic Analysis Area for Cultural Resources

The geographic analysis area for cultural resources is equivalent to the proposed Project's area of potential effect (APE), as defined in the implementing regulations for NHPA Section 106 at 36 CFR Part 800. In 36 CFR § 800.16(d), the APE is defined as "the geographic area or areas within which an undertaking may directly or indirectly cause alteration in the character or use of historic properties, if any such properties exist."[30] BOEM (2018c) defines the proposed Project APE as the following:

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

3.10.1.2 Cultural Resources within the Affected Environment

Onshore cultural resource investigations in the northeastern United States have identified a wide variety of archaeological resources, historic structures, and TCPs that could be adversely affected by development projects, including future offshore wind. Previously identified archaeological resources include terrestrial pre-Contact Period Native American sites and 17th through 20th century European American sites. Historic standing structures found across the northeastern United States include a wide variety of residential, commercial, and industrial buildings, structures, and infrastructure that date from the 17th through 20th centuries. Potential TCPs in the northeastern United States include a variety of locations associated with the cultural practices, traditions, beliefs, lifeways, arts, crafts, and/or social institutions of Native Americans, European Americans, and other living communities across the region.

Offshore cultural resources in the northeastern United States include pre-Contact and post-Contact period Native American and European American resources. Offshore archaeological resources include pre-Contact period Native American landscapes on the OCS, which likely contain Native American archaeological sites inundated and buried as sea levels rose at the end of the last Ice Age. Marine geophysical remote sensing studies performed for Alternative B identified 15 ancient submerged landform features with the potential to contain Native American archaeological resources within the combined Phase 1 and 2 SWDA (SAL04 through SAL19), 16 ancient submerged landform features (referred to as Channel Groups in the COP; nonsequential Channel Groups 8-30) within the OECC, and 3 ancient submerged landform features in the Western Muskeget Variant (Channel Groups 18, 19, and 20); all of the proposed offshore wind lease areas are in areas with high probability for containing these ancient submerged landform features. In addition to their archaeological potential, Native American tribes in the region consider remnant ancient submerged landscape features to be TCP resources representing places where their ancestors lived. Post-Contact period marine cultural resources consist of shipwrecks, downed aircraft, and related debris fields dating to the 16th through 20th centuries. Marine geophysical remote sensing studies performed for Phase 1 identified three potential shipwrecks (AF01 through AF03) within the SWDA, one potential shipwreck (PSW3) within the OECC, and two potential shipwrecks within the Western Muskeget Variant (PSW-1, PSW-2). Based on known historic and modern maritime

[30] 36 CFR Part 800 defines effects on historic properties in terms of direct and indirect effects. For the purposes of this analysis, both physical impacts or effects and visual impacts or effects on historic properties are considered direct effects as defined in the NHPA and its implementing regulations (36 CFR Part 800).

activity in the region, all of the proposed offshore wind lease areas are in areas with a high probability for containing shipwrecks, downed aircraft, and related debris fields.

The Phase 1 onshore APE includes the Phase 1 OECR, grid interconnection route, and substation sites. The Phase 2 onshore APE includes the Phase 2 OECR, grid interconnection route, and substation sites. A Historic Properties Visual Impact Assessment for Alternative B identified a circa 1956 motel within the onshore APE for direct physical impacts. The boundaries of two historic properties are within the onshore APE for direct physical impacts: the Old King's Highway Regional Historic District (BRN.O) and West Barnstable East Area (BRN.AN). Seven historic properties are located within the onshore APE for direct visual impacts near the Centerville River crossing, if trenchless crossing is not feasible: BRN.2225, 2226, 2227, 2228, and 2229. The Phase 1 offshore APE for direct visual impacts contains 19 historic properties, including the Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, the Vineyard Sound and Moshup's Bridge TCP, the Chappaquiddick Island TCP, the Nantucket Sound TCP, and the Nantucket Historic District National Historic Landmark (NHL). Applicant surveys and studies of the onshore component of Alternative B identified one recorded site (19BN253) within the construction area for a trenchless exit pit and pipe laydown and 16 archaeological sites that could be affected by ground-disturbing activities associated with Phase 1 onshore construction, in areas within 0.5 mile of the Phase 1 OECR, grid interconnection route, and substation sites. Applicant surveys and studies of the onshore component of Phase 2 identified 0 NRHP-listed archaeological sites, 42 pre-Contact archaeological sites, and 15 post-Contact archaeological sites that could be affected by ground-disturbing activities associated with Phase 2 construction in areas within 0.5 mile of the Phase 2 OECR, grid interconnection route, and substation sites (COP Appendix IIIG; Epsilon 2023).

Table 3.10-1 presents a summary of the pre-Contact period and post-Contact period cultural context of southern New England.[31]

The applicant has conducted onshore and offshore cultural resource investigations (Table 3.10-2) to identify known and previously undiscovered cultural resources within the marine archaeological, terrestrial archaeological, and visual portions of the APE.

[31] In this context, "Contact" refers to the arrival of Europeans in southern New England circa 1620.

Table 3.10-1: Summary of Southern New England Prehistoric and Historic Context

Period		Description
Pre-Contact Period	Paleoindian (12,500–10,000 B.P.)	Earliest scientifically documented human occupation of southern New England. Small highly nomadic family groups of hunter-gatherers inhabited the region during this period. At this time, much of Nantucket Sound was exposed land due to lower sea levels associated with the last Ice Age and likely occupied by Paleoindian groups.
	Archaic (10,000–3,000 B.P.)	Archaeologists typically divided the Archaic Period into three subperiods: Early (10,000–8,000 B.P.), Middle (8,000–6,000 B.P.), and Late (6,000–3,000 B.P.) Archaic. During the Early Archaic, the population of southern New England continued to practice a highly mobile, nomadic hunter-gatherer lifestyle adapted to the warming conditions and changing environment. By the Late Archaic, populations developed a more locally focused subsistence economy and a semi-sedentary lifestyle.
	Woodland (3,000–400 B.P.)	Archaeologists typically divided the Woodland Period into three sub-periods: Early (3,000–2,000 B.P.), Middle (2,000–1,000 B.P.), and Late (1,000–400 B.P.) Woodland. The Woodland Period is marked by the appearance of the first ceramic vessel technology in southern New England. The population of southern New England became increasingly sedentary throughout the Woodland Period. By the end of the Late Woodland Period, populations lived in settled, agricultural villages.
Post-Contact Period	European Exploration (A.D. 1000–1620)	This period began with the arrival of European explorers and anglers in New England during the 16th century. John Smith explored the southern New England coastline in 1614–1615, and Puritan colonists established the Plymouth Colony in 1620.
	European Settlement (A.D. 1620–1720)	During the 17th and early 18th centuries, both trade and conflict grew between Native American groups and European colonists. Europeans colonized Martha’s Vineyard in 1641–1642 with the establishment of Edgartown. Thomas Macy and family colonized Nantucket in the winter of 1659–1660. The earliest records of shore-based whaling on Nantucket by European colonists date to this period. European colonists founded the towns of Barnstable and Yarmouth during this period in the late 17th century.
	European Colonialism and Early Nationalism (A.D. 1720–1815)	During the 18th and early 19th centuries, trade between Europe and New England increased, leading to the growth of commercial cities along the southern New England coast. Colonization of interior New England progressed throughout the period, leading to the removal, forced migration, and/or extermination of Native American populations. European colonial powers fought numerous wars in North America during the 18th century, culminating in the Seven Years’ War between England, France, and their respective colonies. Near the end of the period, the American Revolution (1775–1783) ended English colonial rule in southern New England and led to the founding of the United States of America. After the war, the maritime economy of southern New England, including fishing and whaling, continued to grow. Near the end of the period, the United States and England fought a second war, the War of 1812 (1812–1814), which significantly affected the maritime economy of southern New England. As the 19th century began, industrial mill towns began to appear throughout New England.
	Early Industrialization (A.D. 1815–1865)	The 19th century was a period of population growth and rapid industrialization across New England, as well as the growth of shipbuilding, fishing, trade, and whaling industries. The 19th century was also the “Golden Age” of southern New England whaling industry on Nantucket and coastal cities such as New Bedford and New London. During the United States Civil War (1861–1865), thousands of men from southern New England fought in campaigns across the southern United States of America.
	Late 19th Century–Early 20th Century (A.D. 1865–1950s)	The late 19th and early 20th centuries saw a marked decline in the merchant marine and whaling industries across southern New England. In addition, American westward expansion and the rise of Midwest industrial centers also contributed to a general decline in the population of New England. The tourism industry on Martha’s Vineyard, Nantucket, Cape Cod, and across southern New England, including the recreational fishing industry and maritime tourism, expanded rapidly during the early and mid-20th century.

Source: COP Appendix III-G; Epsilon 2023

B.P. = before present; A.D. = Anno Domini

Table 3.10-2: Summary of Cultural Resources Investigations and Cultural Resources for the Proposed Project

Project Area/APE	Studies[a]	Summary of Findings
Offshore	Marine Archaeological Assessment Report for the New England Wind Offshore Wind Farm for OCS-A 0534 Construction and Operations Plan (COP Volume II-D; Epsilon 2023)	• The applicant's cultural resources consultant conducted a marine archaeological resources assessment of HRG survey data collected by multiple nonintrusive survey campaigns by third-party marine survey contractors within the SWDA. • Three potential shipwrecks were identified within the SWDA, which are recommended for avoidance. • Fifteen ancient submerged landform features were identified within the SWDA; avoidance is recommended to the extent feasible.
Offshore	Marine Archaeological Assessment Report for the OECC (COP Volume II-D, Appendix A; Epsilon 2023)	• The applicant's cultural resources consultant conducted a marine archaeological resources assessment for the proposed OECC, as well as support for HRG surveys and geotechnical activities for the OECC. • Survey activities were conducted over five seasons from 2016 to 2020 (extending to February 2021). • One potential shipwreck was identified within the OECC, which is recommended for avoidance. • Two potential shipwrecks were identified within the Western Muskeget Variant, which are recommended for avoidance. • Sixteen ancient submerged landform features, identified as Channel Groups 8-18, 21-22, 29, and 30 are considered to belong to the Nantucket Sound TCP; avoidance is recommended to the extent feasible. • Three ancient submerged landform features, identified in the Western Muskeget Variant as Channel Groups 18, 19, and 20, are considered to belong to the Nantucket Sound TCP; avoidance is recommended to the extent feasible.
Offshore	Marine Archaeological Assessment Report in Support of the South Coast Variant Offshore Export Cable Corridor Construction and Operations Plan (COP Volume II-D, Appendix E; Epsilon 2023)	• The applicant's cultural resources consultant conducted a marine archaeological resources assessment of the proposed SCV of the OECC, as well as to provide archaeological support for high-resolution geophysical marine surveys and subsequent geotechnical activities for the OECC. • Two potential shipwrecks were identified within the SCV OECC, which are recommended for avoidance. • Seventeen ancient, submerged landform features were identified within the SCV OECC. Avoidance is recommended to the extent feasible.
Onshore	Terrestrial Archaeology Reports: Phase 1 Report: Archaeological Reconnaissance Survey, Vineyard Wind 501 South Phase 1 Onshore Development Area, Potential Export Cable Routes and Proposed Substation (COP Appendix III-G; Epsilon 2023)	• The Phase 1 Reconnaissance Report survey was conducted for the potential export cable routes and proposed substation project in the Town of Barnstable. • The study area consisted of the preliminary APE and a 0.5-mile buffer. • Archival research identified 16 archaeological sites, including 8 pre-Contact sites, 7 post-Contact sites, and 1 multicomponent site within and/or adjacent to the study area. • Zones of high archaeological sensitivity were identified in the proposed landfall sites at Covell's and Craigville beaches and the southern end of the OECR in Barnstable. • Small zones of high sensitivity for pre-Contact sites are at the southern end of Long Pond and north shore of Wequaquet Lake. • Zones of high and moderate sensitivity within the north portion of the APE are the substation at 8 Shootflying Hill Road, a section of existing utility ROW, and west of Wequaquet Lake. • Zones of high sensitivity for post-Contact archaeological resources exist along the export cabling routes near an NRHP-listed property along Phinneys Lane. • Zones of moderate sensitivity for pre- and post-Contact resources are within the potential onshore export cabling routes along the Eversource ROW; Shootflying Hill; Great Marsh and Old Stage Roads; Main, South Main, and Oak Streets; and Phinneys Lane. • Archaeological monitoring of construction activities was recommended within the identified zones of high and moderate archaeological sensitivity along existing roads in the proposed Project area. The consultant also recommended an intensive

Project Area/APE	Studies[a]	Summary of Findings
		archaeological survey for the proposed substation at 8 Shootflying Hill Road and Parcel #214001.
Onshore	Terrestrial Archaeology Report - Phase 1 Report: Intensive Archaeological Survey New England Wind Phase 1 (Park City Wind)/New England Wind 1 Connector Onshore Project Components (COP Appendix III-G; Epsilon 2023)	• The Phase 1 Intensive Archaeological Survey was conducted in the locations of four proposed onshore components in the Town of Barnstable. • The four onshore proposed Project components are 6.7-acre and 1.00-acre parcels for a substation site at 6 and 8 Shootflying Hill Road, a trenchless crossing entry bore and a 1,960-square-foot temporary work zone for an onshore export cable crossing of the Centerville River within a 0.28-acre residential lot at 2 Short Beach Road, a trenchless exit pit and 400-foot-long pipe laydown north of the Centerville River in the shoulder of Craigville Beach Road, and a 2.8-acre parcel (Parcel #214001) for a proposed trenchless crossing under Route 6. • Two pre-Contact find spots and a site were identified and recommended not eligible for NRHP listing. • No additional archaeological investigations are recommended. Archaeological monitoring of other components within areas of moderate or high archaeological sensitivity will be conducted during construction.
Onshore	Technical Memorandum, Vineyard Wind 501 South Phase 2 Onshore Export Cable Routing and Substation Envelope, Cultural Resources Archaeological Due Diligence Study, June 1, 2020; Revised March 26, 2021 (COP Appendix III-G; Epsilon 2023)	• Due diligence study of the Phase 2 onshore export cable route and substation envelope was conducted. Portions overlap with Phase 1 potential cable routes. • No NRHP-listed archaeological sites are within the study area. • Forty-two pre-Contact and 15 post-Contact sites have been identified within the study area. • The recorded pre-Contact sites can be considered to form four broad groups or clusters within different physiographic settings in the Phase 2 study area. They are the Centerville Harbor; Cotuit/West Bay and North Bay; Santuit River; and the Race Lane and Wequaquet Lake clusters. • The post-Contact sites are within the Cotuit/West Bay and North Bay, Marstons Mills, Race Lane and Prospect Street, Wequaquet Lake and Garretts Pond (north of Route 6) sections of Barnstable. • Based on the results of the due diligence review and the drive over of the study area, the Phase 2 Onshore Export Cable Routing and Substation Envelope contains areas of moderate to high archaeological sensitivity.
Onshore	Archaeological Reconnaissance Survey New England Wind Phase 2 (Commonwealth Wind)/New England Wind 2 Connector (COP Appendix III-G; Epsilon 2023)	• The Phase 1 Reconnaissance Report survey was conducted for the Phase 2 connector, onshore export cable routes to identify known pre-Contact, Contact, and post-Contact cultural resources within the 0.5-mile study area and the APE. • The proposed Project area consisted of two alternate cable landfall sites at Dowses Beach and Wianno Avenue and potential onshore export cable routes along existing roadways and utility ROWs in Barnstable. • Research identified no NRHP-listed archaeological sites. Fifteen recorded pre-Contact and 13 post-Contact archaeological sites were identified within the onshore export cable route study area. • Of the research-identified sites, four pre-Contact, five post-Contact and one site with pre-Contact, Contact, and post-Contact components may be located within and/or adjacent to the Phase 2 onshore export cabling route options. • A combined windshield/walkover survey was conducted to further refine zones of archaeological sensitivity initially delineated in a due diligence study for the Phase 2 potential onshore export cable routes. • Archaeological monitoring of proposed Project construction areas within the staging areas required for HDD in the landfall area and during installation of onshore export cable and other components within the identified zones of high and moderate archaeological sensitivity are recommended.

Project Area/APE	Studies[a]	Summary of Findings
Onshore	Technical Memorandum, New England Phase 2 Potential Onshore Substation Sites, Cultural Resources Archaeological Due Diligence Study, April 20, 2022 (COP Appendix III-G; Epsilon 2023)	• Due diligence study of the Phase 2 OECR and substation envelope was conducted. Portions overlap with Phase 1 potential cable routes. • No NRHP-listed archaeological sites are within the study area. • Forty-two pre-Contact and 15 post-Contact sites have been identified within the study area. • The recorded pre-Contact sites can be considered to form four broad groups or clusters within different physiographic settings in the Phase 2 study area: Centerville Harbor, Cotuit/West Bay and North Bay, Santuit River, and the Race Lane and Wequaquet Lake clusters. • The post-Contact sites are within the Cotuit/West Bay and North Bay, Marstons Mills, Race Lane and Prospect Street, Wequaquet Lake, and Garretts Pond (north of Route 6) sections of Barnstable. • Based on the results of the due diligence review and the reconnaissance of the study area, the Phase 2 onshore export cable routing and substation envelope contains areas of moderate to high archaeological sensitivity.
Viewshed	New England Wind Visual Impact Assessment (COP Appendix III-H.a; Epsilon 2023)	• The applicant's consultants conducted a visual impact assessment to identify potential visibility of Alternative B's offshore facilities and determine the difference in landscape quality with and without the proposed Project in place.
Viewshed	New England Wind Historic Properties Visual Impact Assessment (COP Appendix III-H.b; Epsilon 2023)	• The Historic Properties Visual Impact Assessment identified a variety of historic properties that the proposed Project may affect. These include an NHL, properties listed in the NRHP, TCPs, properties on the Massachusetts State Register of Historic Places, and properties on the Inventory of Historic and Archaeological Assets of the Commonwealth. • It was determined that the proposed Project would have a visual impact on the Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, the Chappaquiddick Island TCP, and Vineyard Sound and the Moshup's Bridge TCP.

APE = area of potential effect; COP = Construction and Operations Plan; HDD = horizontal directional drilling; HRG = high-resolution geophysical; NHL = National Historic Landmark; NRHP = National Register of Historic Places; OECC = offshore export cable corridor; OECR = onshore export cable route; TCP = traditional cultural property; ROW = right-of-way; SCV = South Coast Variant; SWDA = Southern Wind Development Area
[a] Not all reports are publicly available due to sensitive information.

3.10.2 Environmental Consequences

Definitions of impact levels for cultural resources are described in Table 3.10-3.

Table 3.10-3: Impact Level Definitions for Cultural Resources

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts would be so small as to be unmeasurable (i.e., finding of "no historic properties affected" or "no historic properties adversely affected" pursuant to 36 CFR Part 800).
	Beneficial	Impacts that benefit cultural resources would be so small as to be unmeasurable.
Minor	Adverse	Cultural resources (historic properties that include archaeological sites, buildings, structures, objects and districts that are listed or eligible for listing in the NRHP) would be affected; however, conditions would be imposed to ensure consistency with the Secretary of the Interior's Standards for the Treatment of Historic Properties (36 CFR Part 68) to avoid adverse impacts (i.e., finding of "no historic properties adversely affected" pursuant to 36 CFR Part 800).
	Beneficial	Impacts that benefit cultural resources (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed or eligible for listing in the NRHP) would passively preserve historic properties consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties or passively create conditions to protect archaeological sites.

Impact Level	Impact Type	Definition
Moderate	Adverse	Characteristics of cultural resources would be altered in a way that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (i.e., finding of "historic properties adversely affected" pursuant to 36 CFR Part 800). Measures to resolve adverse effects would minimize impacts, and the adversely affected property would remain NRHP eligible.
	Beneficial	Impacts that benefit cultural resources would actively preserve historic properties (historic properties that include archaeological sites, buildings, structures, objects, and districts that are listed or eligible for listing in the NRHP) consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties.
Major	Adverse	Characteristics of cultural resources would be altered in a way that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (i.e., finding of "historic properties adversely affected" pursuant to 36 CFR § 800.5(a)(1)) and that would require mitigation to resolve. In some instances, important characteristics would be altered to the extent that the adversely affected property would no longer be listed or eligible for listing in the NRHP.
	Beneficial	Impacts that benefit cultural properties would rehabilitate, restore, or reconstruct historic properties consistent with the Secretary of the Interior's Standards for the Treatment of Historic Properties, including cultural landscapes and TCPs.

CFR = Code of Federal Regulations; NRHP = National Register of Historic Places; TCP = traditional cultural property

3.10.2.1 Impacts of Alternative A – No Action Alternative on Cultural Resources

When analyzing the impacts of Alternative A on cultural resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities on the existing conditions for cultural resources (Table G.1-7 in Appendix G). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for cultural resources described in Section 3.10.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Each of the ongoing offshore wind activities has been subject to NEPA and NHPA reviews, and BOEM assumes that each planned offshore wind project would also be subject to the same reviews. These reviews require the identification of cultural resources within their NEPA geographic analysis areas and NHPA APEs.[32] The results of some project-specific studies to identify cultural resources- impacted by planned offshore wind projects are not yet available. Therefore, Alternative A assumes that the same types of cultural resources identified within the geographic analysis area of the proposed Project (i.e., historic structures, terrestrial archaeological sites, marine archaeological sites, and TCPs) are present within the geographic scopes of the planned offshore wind projects and will be subject to the same IPFs as the proposed Project. The following discussion assesses the potential impacts on these types of cultural resources from proposed wind facility developments, excluding the proposed Project. BOEM assumes that if project-specific cultural resource investigations identify historic properties within a project's APE and determine that the project would affect said historic properties, BOEM will require the project to develop treatment plans to avoid, minimize, and/or mitigate effects in order to comply with- the NHPA.

[32] The NEPA geographic analysis area for each offshore project includes areas impacted by planned offshore wind projects, whereas the NHPA APE for each project is limited to the areas within which each project may affect historic properties.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on cultural resources include ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Ongoing construction of the Vineyard Wind 1 and South Fork Wind projects, along with planned offshore wind activities, would affect cultural resources through the primary IPFs described below.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Planned non-offshore wind activities that may affect cultural resources include new submarine cables, gas pipelines, and other submarine cables; tidal energy projects; marine minerals use and ocean-dredged material disposal; military use; marine transportation; and onshore development activities (see Appendix E for a description of planned activities). These activities may result in ground disturbance, which has the potential to disturb or destroy terrestrial archaeological resources; seafloor disturbance, which has the potential to damage or destroy marine archaeological resources or ancient submerged landforms; construction, which could damage, destroy, or diminish the integrity of buildings, structures, objects, and historic districts onshore; or introduction of intrusive visual elements, which could diminish integrity of setting, feeling, or association for cultural resources. See Table G.1-7 in Appendix G for a summary of potential impacts associated with planned non-offshore wind activities by IPF for cultural resources.

BOEM assumes that each of the planned wind projects will be subject to NEPA and NHPA reviews and, as a result, will require the identification of cultural resources within their NEPA geographic analysis areas and NHPA APEs. Alternative A assumes that the same types of cultural resources identified within the geographic analysis area of proposed Project (i.e., historic structures, terrestrial archaeological sites, marine archaeological sites, and TCPS) are present within the geographic scopes of the reasonably foreseeable wind projects and will be subject to the same IPFs as the proposed Project. The following discussion assesses the potential impacts on these types of cultural resources from proposed wind facility developments, excluding the proposed Project. BOEM assumes that if proposed Project-specific cultural resource investigations identify historic properties within the proposed Project's APE and determine that the proposed Project would adversely affect said historic properties, BOEM will require the project to develop treatment plans to avoid, minimize, or mitigate effects to comply with the NHPA.

Future offshore wind activities would affect the cultural resources through the following primary IPFs.

Accidental releases: Accidental release of hazardous materials and trash/debris, if any, may result in long-term, infrequent impacts on cultural resources. The majority of impacts associated with accidental releases would be incidental due to cleanup activities that require the removal of contaminated soils. There would be a low risk of a leak of fuel, fluids, or hazardous materials from any of the approximately 963 WTGs and ESPs. In total, approximately 5.3-million gallons of these materials would be stored within the geographic analysis area for cultural resources. By comparison, the smallest tanker vessel operating in these waters (a general purpose tanker) has a capacity of between 3.2- and 8-million gallons. As described in Section G.2.1, Air Quality, tankers are relatively common in these waters; therefore, the total storage capacity within the geographic analysis area is considerably less than the volumes of hazardous liquids transported by ongoing activities (U.S. Energy Information Administration 2014). The number of accidental releases from Alternative A, the volume of released material, and the associated need for cleanup activities would be limited due to the low probability of occurrence, the low volumes of material released in individual incidents, the low persistence time, standard BMPs to prevent releases, and the localized nature of such events. As such, the majority of individual accidental releases from future offshore wind development would not be expected to result in measurable impacts on cultural resources.

Although the majority of anticipated accidental releases would be small, resulting in small-scale impacts on cultural resources, a single, large-scale accidental release such as an oil spill could have significant impacts. A large-scale release would require extensive cleanup activities to remove contaminated materials resulting in damage to, or the complete removal of, coastal and marine cultural resources during the removal of contaminated terrestrial soil or marine sediment; environmental impacts could result in temporary or permanent impacts on the setting of coastal historic standing structures; and nearshore shipwreck or debris field resources could be damaged or removed during contaminated soil/sediment removal. In addition, the accidentally released materials in deep water could settle on seafloor cultural resources such as shipwreck sites, accelerating their decomposition and/or covering them and making them inaccessible/unrecognizable to researchers, resulting in a significant loss of historic information. As a result, although considered unlikely, a large-scale accidental release and associated cleanup could result in permanent, geographically extensive, and large-scale impacts on cultural resources.

Anchoring and gear utilization: Anchoring associated with ongoing commercial and recreational activities and the development of future offshore wind projects has the potential to cause permanent impacts on marine cultural resources. Anchoring would increase during the construction, maintenance, and eventual decommissioning of future offshore wind energy facilities. The placement and relocation of anchors and other seafloor gear such as wire ropes, cables, and anchor chains that impact or sweep the seafloor could potentially disturb shipwreck and debris field resources on or just below the seafloor surface. The damage or destruction of submerged archaeological sites or other underwater cultural resources from these activities would result in the permanent and irreversible loss of scientific or cultural value.

Ongoing and planned offshore wind activities are likely to include monitoring surveys in the offshore wind lease areas. These could include acoustic, trawl, and trap surveys, as well as other methods of sampling the biota in the area. The presence of monitoring gear could affect cultural resources through seafloor disturbance; however, it is expected that monitoring plans would have sufficient mitigation procedures in place to reduce potential impacts. These procedures are expected to include, but not be limited to, avoidance of shipwrecks and debris fields. Monitoring surveys are unlikely to involve activities that penetrate the seafloor deeply enough to affect ancient submerged landforms. Impacts from gear utilization from other offshore wind activities on benthic resources are likely to occur at short-term, regular intervals over the lifetime of the projects and have no perceptible consequences for cultural resources.

The scale of impacts on shipwreck and debris field cultural resources would depend on the number of wreck and debris field sites within the proposed wind project development areas. The potential for impacts would be mitigated, however, by existing federal and state requirements to identify and avoid marine cultural resources. Specifically, as part of its compliance with the NHPA (including NHPA Section 106 requirements fulfilled through the NEPA substitution process, as described in 36 CFR § 800.8[c]), BOEM requires offshore wind developers to conduct geophysical remote sensing surveys of proposed development areas to identify cultural resources and implement plans to avoid, minimize, and/or mitigate impacts on these resources. As a result, impacts on marine cultural resources from anchoring are considered unlikely and would only affect a small number of individual marine cultural resources if they were to occur, resulting in long-term, localized impacts. The scale of any impacts on individual resources (the proportion of the resource damaged or removed) would vary on a case-by-case basis.

Cable emplacement and maintenance: Construction of future offshore wind infrastructure would have permanent, geographically extensive impacts on cultural resources. Future offshore wind projects would result in the construction of up to 963 WTGs and ESPs (excluding the proposed Project), as well as seabed disturbance from installation of associated offshore export, inter-array, and inter-link cables. Impacts from these WTG and ESP foundations, as well as all associated inter-array and inter-link cables under Alternative A, would be outside of the marine archaeological resources APE. Impacts from associated offshore export cables would also be outside of the marine archaeological resources APE, except for approximately 69 acres of impact from the Vineyard Wind 1 OECC (which would be collocated with the proposed Project) and an unknown acreage where the SouthCoast Wind OECC would cross the proposed Project OECC. Crossings of other OECCs with the proposed Project OECC are possible but have not yet been identified.

The effects of dredging activities on marine cultural resources would be similar to the effects of anchoring and could damage or destroy submerged archaeological sites or other underwater cultural resources, resulting in the permanent and irreversible loss of scientific or cultural value. The potential for impacts would be mitigated, however, by existing federal and state requirements to identify and avoid marine cultural resources, similar to those discussed in the IPF for anchoring and gear utilization. As a result, impacts on marine cultural resources from dredging are considered unlikely and would only affect a small number of individual marine cultural resources if they were to occur, resulting in long-term, localized impacts.

As part of compliance with the NHPA, BOEM and state historic preservation officers will require future offshore wind project applicants to conduct extensive geophysical surveys of the SWDA and OECC areas to identify shipwreck and debris field resources, and avoid, minimize, and/or mitigate these resources when identified. Due to these federal and state requirements, the impacts of offshore construction on shipwreck and debris field resources would be infrequent and isolated.

The entire RI/MA Lease Areas cover area with high probability for containing ancient submerged cultural resources (TRC 2012). In the event an unanticipated discovery is made, the unanticipated discovery plan would be implemented. Formerly sub-aerially exposed and now ancient submerged landscapes that date to a time of Native American inhabitation are considered potentially significant resources due to their potential to contain archaeological sites, as well as their significance to regional Native American tribes. Regional Native American tribes may consider extant submerged landform features to be part of a larger cultural landscape occupied by their ancestors. As a result, the ancient submerged landform features are considered part of one or more TCPs due to their association with the cultural practices, traditions, and beliefs of Native American tribes.

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

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

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

Lighting: Development of future offshore wind projects would increase the amount of offshore anthropogenic light from vessels, area lighting during the construction and decommissioning of projects (to the degree that construction occurs at night), and the use of aircraft and vessel hazard/warning lighting on WTGs and ESPs during operation. Up to 963 WTGs and 10 ESPs (other than those for the proposed Project) would be added within the geographic analysis area for cultural resources.

Construction and decommissioning lighting would be most noticeable if construction activities occur at night. As shown in Table E-1 in Appendix E, up to nine offshore wind projects could be constructed in the APE from 2023 through 2030, with up to six projects simultaneously under construction in 2025 (excluding the proposed Project). Some of the future offshore wind projects could require nighttime construction lighting, and all would require nighttime hazard lighting during operations. Construction lighting from any project would be temporary, lasting only during nighttime construction, and could be visible from shorelines and elevated locations, although such light sources would be limited to individual WTG or ESP sites rather than the entire RI/MA Lease Areas. Aircraft and vessel hazard lighting systems would be in use for the entire operations stage of each future offshore wind project, resulting in long-term duration impacts. The intensity of these impacts would be relatively low, as the lighting would consist of small intermittent flashing lights at a significant distance from the resources.

The impacts of construction and operations lighting would be limited to cultural resources and historic properties on the southern shores and inland-elevated locations of Martha's Vineyard and Nantucket, including the Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, Nantucket NHL, Vineyard Sound and Moshup's Bridge TCP, the Chappaquiddick Island TCP, and the Nantucket Sound TCP, for which a dark nighttime sky is a contributing element to historical integrity. While some resources such as historic buildings and lighthouses would be closed to stakeholders at night, and some resources, such as historic districts, generate their own nighttime light, the dark nighttime sky is still a contributing element to these cultural resources. The intensity of lighting impacts would be limited by the distance between resources and the nearest lighting sources, as the majority of the proposed WTGs are located over 15 miles from the nearest shoreline (Section 3.16, Scenic and Visual Resources). The intensity of lighting impacts would be further reduced by atmospheric and environmental conditions such as clouds, fog, and waves that could partially or completely obscure or diffuse sources of light. As a result, nighttime construction and decommissioning lighting would have temporary, intermittent, and localized impacts on a limited number of cultural resources. Operational lighting would have longer term, continuous, and localized impacts on a limited number of cultural resources.

Permanent aviation hazard and vessel navigation lighting would be required on all WTGs and ESPs built by ongoing and planned offshore wind projects. Aviation hazard lighting on WTGs consisting of red lights on the nacelle flashing 30 times per minute, as well as mid-tower red lights flashing at the same frequency. Of the up to 963 WTGs constructed in the geographic analysis area for cultural resources, 692 would have nacelle-top aviation warning lights that could potentially be visible from onshore historic properties (Section 3.16). BOEM assumes that FAA hazard lighting for all offshore wind projects in the RI/MA Lease Areas would use ADLS. ADLS would activate the aviation lighting on WTGs and ESPs only when an aircraft is within a predefined distance of the structures (Section 3.16). For the proposed Project, this is estimated to occur during less than 0.1 percent of total annual nighttime hours (COP Appendix III.H-b; Epsilon 2023). The use of ADLS lighting on future offshore wind projects other than the proposed Project would likely result in similar limits on the frequency of WTG and ESPs aviation warning lighting use. This technology, if used, would reduce the already low-level impacts of lighting on cultural resources.

Port utilization: Future offshore wind activity could lead to port expansion and increased port utilization in Massachusetts, Rhode Island, Connecticut, New York, and other states along the U.S. east coast (Section G.2.7, Land Use and Coastal Infrastructure). Offshore wind developers have made commitments to upgrade or expand port infrastructure and utilization in some locations. For example, Ørsted has committed to improvements to Rhode Island ports in support of the Revolution Wind Project (Kuffner 2018). These port modification and expansion projects could affect historic structures and/or archaeological sites within or near port facilities. Future channel deepening by dredging that may be required to accommodate larger vessels necessary to carry WTG and ESP components and/or increased vessel traffic associated with future offshore wind projects could affect marine cultural resources in or near ports. Due to state and federal requirements to identify and assess impacts on cultural resources as part of NEPA and the NHPA and the requirements to avoid, minimize, and/or mitigate impacts on cultural resources, these impacts would be long term and isolated to a limited number of cultural resources that cannot be avoided or that were previously undocumented.

Presence of structures: Based on marine archaeology assessments conducted for the proposed Project (COP Appendix II-D; Epsilon 2023) and other ongoing and planned offshore wind projects in the RI/MA Lease Areas, BOEM assumes that planned offshore wind projects in the geographic analysis area would also affect ancient submerged landform features unless these features could be avoided. None of the foundations, inter-link cables, or inter-array cables from other offshore wind projects would be within the marine archaeological APE. Nearly all OECCs for other offshore wind projects would also be outside of the marine archaeological APE, except for the Vineyard Wind 1 OECC (which would be collocated with the proposed Project) and the SouthCoast Wind OECC (which would cross the proposed Project OECC). Any damage to ancient submerged landform features in these limited areas of cumulative impact would threaten the viability of the affected portion of these resources.

The development of future offshore wind projects would introduce new, modern, and intrusive visual elements to the viewsheds of cultural resources along the southern coasts of Rhode Island and Massachusetts, including Martha's Vineyard, Nantucket, and adjacent islands. Onshore development associated with future offshore wind projects, including substations and possibly transmission lines, would also introduce new, modern, and intrusive visual elements to the viewsheds of cultural resources along the transmission routes and near the new onshore substations.

Under Alternative A, onshore visual impacts on cultural resources from the presence of structures would be limited to those cultural resources from which any aboveground component, (i.e., substations and transmission lines) would be visible, which may include both standing structures and archaeological sites for which landscape or setting are contributing elements to NRHP eligibility. The magnitude of impacts from the presence of structures would be greatest for cultural resources for which a view, free of modern visual elements, is an integral part of their historic integrity and contributes to their eligibility for listing in the NRHP. Visibility of structures would be affected by distance and environmental conditions such as vegetation. Additional mitigation, such as vegetative buffering, could reduce the visibility of onshore structures and reduce the magnitude of visual impacts on cultural resources.

Under Alternative A, offshore visual impacts on cultural resources from the presence of structures would be limited to those cultural resources from which future offshore wind projects would be visible, which would typically be limited to historic standing structures relatively close to shorelines and on elevated landforms near the coast. Portions of the up to 963 WTGs (excluding the proposed Project) could be visible from onshore cultural resources for which an uninterrupted sea view, free of intrusive visual elements, is a contributing element to NRHP eligibility. The magnitude of impacts from the presence of structures would be greatest for cultural resources for which a maritime view, free of modern visual elements, is an integral part of their historic integrity and contributes to their eligibility for listing in the NRHP. Due to the distance between planned offshore wind development and the nearest cultural resources, in most instances exceeding 15 miles, WTGs within individual projects would appear relatively small on the horizon, and the visibility of individual structures would be further affected by environmental and atmospheric conditions such as vegetation, clouds, fog, sea spray, haze, and wave action. Additional mitigations, such as the use of non-reflective off white and light grey paint on offshore structures, could reduce the visibility of offshore structures and further reduce the magnitude of visual impacts on cultural resources.

Conclusions

Impacts of Alternative A. Under Alternative A, the proposed Project would not be built. However, cultural resources would continue to be affected by regional commercial, industrial, and recreational activities including approved offshore wind projects. While the proposed Project would not be built under Alternative A, ongoing activities would have continuing short- and long-term impacts on cultural resources. The primary source of onshore impacts from ongoing activities includes ground-disturbing activities and the introduction of intrusive visual elements, while the primary source of offshore impacts includes dredging, cable emplacement and maintenance, and other activities that disturb the seafloor. These ongoing activities would have **major** impacts on individual onshore and offshore cultural resources.

Cumulative Impacts of Alternative A. In addition to ongoing activities, planned activities could include the same type of onshore and offshore actions listed for ongoing activities, and in different locations than ongoing activities. These planned activities would also have major impacts on individual onshore and offshore cultural resources depending on the scale and extent of impacts and the unique characteristics of the resource. Examples of individual resources are paleo landforms, terrestrial archaeological sites, historic standing structures, and TCPs. Impacts vary widely because the impacts are dependent on the unique characteristics of the individual resources. The combination of ongoing and planned activities would result in major impacts on individual cultural resources depending on the scale and extent of impacts and the unique characteristics of the resources.

The construction, operations, and decommissioning of planned offshore wind projects would have major impacts, as well as minor beneficial impacts on individual offshore cultural resources as a result of slowing climate change-related impacts. The construction of onshore components and port expansion, as well as their operation, would have minor impacts on individual cultural resources.

Considering all the IPFs together, both adverse and beneficial, as well as state and federal requirements to avoid, minimize, or mitigate impacts on cultural resources, the overall impacts of ongoing and planned activities in the geographic analysis area would result in moderate impacts on cultural resources.

The primary sources of impacts would be physical disturbance from onshore and offshore construction, as well as changes in views from aboveground historic resources. The impacts would be geographically limited to marine and terrestrial archaeological resources within onshore and offshore construction areas and to historic structures and TCPs for which an uninterrupted sea view, free of intrusive visual elements, is a contributing element to NRHP eligibility but who would then have views of offshore and onshore wind components. The duration of impacts would range from temporary to permanent, while the impact extent and frequency is largely dependent on the unique characteristics of individual cultural resources but could potentially result in **major** impacts.

While impacts on cultural resources could be **major**, implementation of existing state and federal cultural resource laws and regulations would reduce the magnitude of overall impacts on cultural resources due to requirements to avoid, minimize, or mitigate Project-specific impacts on cultural resources. These state and federal requirements may not be able to reduce the severity of impacts on some cultural resources due to the unique character of specific resources but would reduce the severity of potential impacts in a majority of cases.

3.10.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on cultural resources:

- Physical impacts on terrestrial cultural resources (e.g., archaeological sites) would depend on the location of onshore ground-disturbing activities.
- Physical impacts on marine cultural resources (e.g., archaeological sites and ancient submerged landscapes) would depend on the location of offshore bottom-disturbing activities. This includes the locations where the applicant would embed the WTG and ESP towers into the seafloor in the SWDA and the location of the cable in the OECC.
- Visual impacts on cultural resources (e.g., historic structures, landscapes, and TCPs) would depend on the design, height, number, and distance of WTGs visible from these resources.

Potential impacts on cultural resources include damage or destruction of terrestrial archaeological sites or TCPs from onshore ground-disturbing activities and damage to or destruction of submerged archaeological sites or other underwater cultural resources (e.g., shipwreck, debris fields, and ancient submerged landforms) from offshore bottom-disturbing activities, resulting in a loss of scientific and/or cultural value. Potential impacts from the construction of onshore export cable routes, grid interconnection routes, and the onshore substation also include demolition of, damage to, or alteration of historic structures or districts, resulting in a loss of historic and/or cultural value. Potential visual impacts also include introduction of visual elements out of character with the setting or feeling of historic structures, landscapes, and TCPs, if that setting is a contributing element to the resource’s eligibility for listing in the NRHP. The most impactful IPFs would include lighting, the presence of structures, anchoring and gear utilization, land disturbance, and cable emplacement and maintenance.

3.10.2.3 Impacts of Alternative B – Proposed Action on Cultural Resources

This section identifies potential impacts of Alternative B on cultural resources. When analyzing the impacts of Alternative B on cultural resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for cultural resources. Except where otherwise stated, the impacts of Phase 1 decommissioning would be similar to those for Phase 1 construction for all of the IPFs described below.

Impacts of Phase 1

Phase 1 would affect cultural resources through the following primary IPFs during construction, operations, and decommissioning. Except where specifically discussed, the impacts of decommissioning would be similar to the impacts from construction and would be eliminated entirely as decommissioning is completed.

Accidental releases: Accidental release of hazardous materials and trash/debris, if any, could affect cultural resources. Section G.2.2, Water Quality, describes the types and volumes of hazardous materials in Phase 1 WTGs and ESPs, along with the likelihood of a release. Phase 1 is predicted to have up to 36,440 gallons of fuels and oils stored in each WTG and 124,098 gallons of fuels and oils per ESP, for a total of approximately 1.5 million gallons of these materials, about 45 percent of the total for both phases of the proposed Project (COP Table 3.3-6, Volume I; Epsilon 2023). In the event of an accidental release, the volume of materials released is unlikely to require cleanup operations that would permanently impact cultural resources. As a result, the impacts of accidental releases from Phase 1 on cultural resources would be short term, localized, and negligible.

Impacts from accidental release of hazardous materials, trash, or debris would have the same intensity and extent during Phase 1 operations as during construction. As a result, impacts on cultural resources under this IPF from Phase 1 operations would be negligible.

Anchoring and gear utilization: Phase 1 construction, operations, and decommissioning may require anchoring within the geographic analysis area that could potentially affect cultural resources. The applicant conducted HRG surveys and marine archaeological resource assessment of the SWDA and OECC over five survey seasons in 2016, 2017, 2018, 2019, and 2020 (COP Appendix II-D; Epsilon 2023). Field investigations during all five surveys included a marine HRG survey using magnetometer, side-scan sonar, sub-bottom profiler, and multibeam echosounder. Geotechnical explorations included bottom grabs, cone penetration tests, bores, and/or vibracores conducted in the SWDA and along the OECC. These data assisted in validating the geophysical data and interpretations and provided material for additional archaeological analysis (COP Appendix II-D; Epsilon 2023). The HRG and geotechnical surveys identified one shipwreck in the Phase 1 OECC, and none within the Phase 1 SWDA. The applicant has committed to avoiding these resources where possible during construction activities. Due to these commitments, BOEM does not anticipate impacts on known shipwrecks from Phase 1 anchoring. SAL-04 and SAL-05 would be avoided (COP Appendix II-D; Epsilon 2023), and SAL-014 through SA-019 in the Phase 1 SWDA and the 16 ancient submerged landforms in the OECC may not be avoidable during construction activities. As a result, the Phase 1 anchoring would have long-term, localized, and negligible to major impacts depending on the physical effects on these resources. Larger impacts could occur if a submerged ancient landform is affected by anchors or if a previously undiscovered resource is affected (COP Volume I, Table 3.3.3; Epsilon 2023).

As described in Section 3.10.2.1, survey gear could affect cultural resources through seafloor disturbance. BOEM assumes surveys would be required to avoid shipwrecks and debris fields, and sampling activities would not penetrate the seafloor to a depth sufficient to disturb ancient submerged landforms. Therefore, the impacts of gear utilization associated with Phase 1 on cultural resources would have no perceptible consequences for cultural resources. Operational vessel traffic would be lower than during construction (Section 3.13, Navigation and Vessel Traffic); therefore, anchoring from Phase 1 operations would have negligible impacts on marine cultural resources. Anchoring during Phase 1 decommissioning would have the same impacts as during construction: long term, localized, and negligible to major.

Cable emplacement and maintenance: The expected installation method for Phase 1 offshore cables is jet plow embedment or jet trenching limited dredging for installing the offshore export cable and an inter-array cable system. As previously stated, remote sensing studies for the proposed Project identified 1 shipwreck and 21 landform features (stream channel, lake, and estuarine landscape features) within the SWDA and OECC (COP Appendix IIIG; Epsilon 2023). While applicant studies did not find any direct evidence of pre-Contact Native American cultural materials, regional Native American tribes consider the ancient submerged landforms culturally significant TCPs as portions of a landscape occupied by their ancestors.

Disturbance and destruction of even a portion of potential shipwrecks or identified ancient submerged landform features could threaten the scientific and/or cultural viability of these resources in their entirety as both potential repositories of scientific and archaeological knowledge, as well as their cultural significance to tribes. For shipwrecks, the severity of impacts would depend on the horizontal and vertical extent of the proposed disturbance relative to both the size of the cultural resource, but also relative to the nature of the information that may be lost from future archaeological and scientific understanding within that discrete portion of the resource. The applicant has voluntarily committed to avoiding the shipwreck and debris fields by a recommended 164 feet and would not affect these resources. BOEM determined that Phase 1 would have long-term, localized, and negligible impacts on shipwreck and debris field cultural resources.

For ancient submerged landform features that cannot be avoided by Phase 1 construction, additional required mitigations to resolve impacts would be determined by ongoing Section 106 consultation. Implementation of a treatment plan agreed to by all parties would likely reduce the magnitude of impacts on ancient submerged landform features; however, the magnitude of these impacts would remain major due to the permanent, irreversible nature of the potential impacts.

Cables emplaced during construction would continue to affect cultural resources, especially ancient submerged landform features. Additional ground-disturbing activities associated with maintenance could result in additional disturbance and destruction of potential shipwrecks or identified ancient submerged landform features, which could threaten the scientific and/or cultural viability of these resources in their entirety as both potential repositories of scientific and archaeological knowledge, as well as their cultural significance to tribes. Operations of Phase 1 would have long-term, localized, and negligible impacts on shipwreck and debris field cultural resources.

For unavoidable ancient submerged landform features, additional mitigation to resolve impacts would be required, as determined by ongoing Section 106 consultation. Implementation of a treatment plan agreed to by all parties would reduce the impact magnitude on ancient submerged landform features; however, the magnitude of these impacts would remain major due to the permanent, irreversible nature of the impacts.

Phase 1 decommissioning would have the same impacts as construction: long term, localized, and negligible to major.

Climate change: Construction of Phase 1 would generate impacts on air quality (Section G.2.1). Therefore, Phase 1 construction would have a short-term and negligible impact on cultural resources.

Operations of Phase 1 would marginally reduce or displace emissions from conventional power generation, thereby contributing to slowing or arresting global warming and associated climate change and having a long-term and negligible to minor beneficial impact on cultural resources.

Land disturbance: Applicant surveys and studies of the onshore component of Phase 1 (COP Appendix IIIG; Epsilon 2023) identified one recorded site (19BN253) within the construction area for a trenchless exit pit and pipe laydown and 16 archaeological sites that could be affected by ground-disturbing activities associated with Phase 1 onshore construction (Phase 1 landfall site, export cables, onshore substation site, and connection from the proposed substation site to the existing bulk power grid), in areas within 0.5 mile of the Phase 1 OECR, grid interconnection route, and substation sites (COP Appendix IIIG; Epsilon 2023). These surveys identified zones of high sensitivity for pre-Contact archaeological sites at the southern end of Long Pond and northern shore of Wequaquet Lake. Zones of high and moderate sensitivity for pre-Contact archaeological sites are in the proposed substation at 8 Shootflying Hill Road (Parcel #124001) and sections of existing utility ROW in proximity to the Shootflying Hill Site (19BN699, BRN.HA.17) and west of Wequaquet Lake. A zone of high sensitivity for post-Contact archaeological resources exists along the OECR adjacent to the Ancient Burying Ground (BRN.807), a NRHP-listed property on Phinney's Lane, and the Old Town House (BRN.HA.56), a property for which eligibility for listing in the NRHP is undetermined (COP Appendix IIIG; Epsilon 2023). Zones of moderate sensitivity for pre- and post-Contact archaeological resources are within the OECR along the Eversource ROW; at Shootflying Hill; at Great Marsh and Old State Roads; at Main, South Main, and Oak Streets; and at Phinneys Lane. Based on these findings, the applicant has recommended archaeological monitoring of Phase 1 onshore construction activities within the staging areas required for the HDD in the selected landfall area and during installation of the OECR and other components within the identified zones of high and moderate sensitivity.

An intensive-level archaeological survey was conducted in the locations of four proposed onshore components: the substation sites at 6 and 8 Shootflying Hill Road, the entire 2.8-acre Parcel #214001, and a trenchless crossing entry bore and temporary work zone of the Centerville River within a residential lot at 2 Short Beach Road. Pre-Contact Native American material was identified during this survey. These finds and site were recommended not eligible for listing in the NRHP, and no additional investigations would be warranted. The applicant completed terrestrial archaeological investigations aligned with Massachusetts state requirements in all portions of the terrestrial archaeological APE.

The applicant's onshore cultural resource investigations determined that Phase 1 would not impact any known terrestrial cultural resources. The applicant has committed to conducting archaeological monitoring during construction in areas previously determined to have a moderate to high potential for undiscovered archaeological resources and would employ the unanticipated discovery plan in the event of such a discovery. Based on the results of the terrestrial archaeological investigations and considering the possible presence of undiscovered resources, onshore construction of Phase 1 would have localized, long-term, and minor to moderate impacts on terrestrial cultural resources.

BOEM may include the following mitigation and monitoring measures to address impacts on cultural resources, as described in detail in Table H-2 of Appendix H, Mitigation and Monitoring. The Final EIS lists the mitigation and monitoring measures that BOEM would require as a condition of COP approval:

- Require the applicant to avoid any identified archaeological resource or TCP; or, if the applicant cannot avoid the resource, it must perform additional investigations to determine eligibility for listing in the NRHP. Of those resources determined eligible, BOEM would require Phase III data recovery investigations for the purposes of resolving adverse effects per 36 CFR § 800.6. Avoidance would result in negligible direct impacts whereas data recovery investigations for resources that cannot be avoided and would otherwise be damaged or destroyed would result in major impacts on terrestrial archaeological resources.
- Require archaeological monitoring during onshore construction in areas identified as having high or moderate archaeological sensitivity and implementation of a terrestrial post-review discoveries plan would reduce potential impacts on any previously undiscovered archaeological resources (if present) encountered during construction. Archaeological monitoring and the implementation of a post-review discoveries plan would reduce potential impacts on undiscovered archaeological resources to negligible by preventing further physical impacts on the archaeological resources encountered during construction.

A Historic Properties Visual Impact Assessment for both phases of Alternative B identified a circa 1956 motel within the onshore APE for direct physical impacts; the applicant recommended this property as not eligible for listing in the NRHP (COP Appendix III.Hb; Epsilon 2023). The boundaries of two historic properties are within the onshore APE for both direct physical impacts and direct visual impacts: the Old King's Highway Regional Historic District (BRN.O) and West Barnstable East Area (BRN.AN). Based on the results of the onshore visual impact investigations, and considering the possible presence of unidentified resources, onshore construction of Phase 1 would have localized, long-term, and minor to moderate impacts on aboveground cultural resources.

The Phase 1 onshore substation site, OECR, and splice vaults would require minimal maintenance, typically completed by accessing the cables through utility access holes or within the fenced perimeter of the substation. If the selected OECR follows existing utility ROWs rather than roads, trees along those portions of the OECR would be removed (as needed) and would not be allowed to regrow. As a result, Phase 1 operations would have negligible impacts on cultural resources. Excavation for repairs would be rare and could impact undiscovered archaeological sites. Federal (i.e., NEPA and NHPA Section 106) and state requirements to identify cultural resources, assess impacts, and implement measures to avoid, minimize, and/or mitigate impacts, including the unanticipated discovery plan, would minimize impacts on cultural resources if these circumstances arose in future development.

Removal of Phase 1 onshore cables during decommissioning, if required, would be accomplished without land disturbance or excavation. If the substation, or other aboveground components, were to be removed, the impacts would be similar to those experienced during construction. As a result, Phase 1 decommissioning would result in localized, long-term, and minor impacts on terrestrial cultural resources.

Lighting: The susceptibility and sensitivity of cultural resources to lighting impacts from Phase 1 would vary based on the unique characteristics of individual cultural resources. Nighttime lighting impacts would be restricted to cultural resources for which a dark nighttime sky is a contributing element to their historic integrity, cultural resources stakeholders use at night, and resources that do not generate a substantial amount of their own light pollution. Examples of these types of resources in the geographic analysis area of this study include the Chappaquiddick Island TCP, Vineyard Sound and Moshup's Bridge TCP, and the Nantucket Sound TCP.

Phase 1 construction may require nighttime vessel and construction area lighting. Impacts of this lighting on cultural resources would be short term, occurring only during Phase 1 construction, and would be limited to the active construction area at any given time. Impacts would be further reduced by the distance between the nearest construction area (i.e., the closest line of WTGs) and the nearest cultural resources on Martha's Vineyard and Nantucket. On Martha's Vineyard and Nantucket, the nearest WTGs and ESPs from cultural resources on the islands range from 21.2 to 28.6 miles. The intensity of nighttime construction lighting impacts would also decrease significantly during the construction of WTGs and ESPs farther from shore as distance between the lighting source and resources increases. The intensity of lighting impacts would be further reduced by atmospheric and environmental conditions such as clouds, fog, and waves that could partially or completely obscure or diffuse sources of light. As previously stated, these impacts would be limited to cultural resources for which a dark nighttime sky is a contributing element to their historic integrity and/or resources used by stakeholders at night, limiting the scale of impacts on cultural resources. As a result, nighttime vessel and construction area lighting from Phase 1 would have short-term, low intensity effects on Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, Chappaquiddick Island TCP, Vineyard Sound and Moshup's Bridge TCP, the Nantucket Sound TCP, and the Nantucket Historic District, resulting in minor impacts on cultural resources.

Phase 1 operations would include aviation hazard lighting on top of WTG nacelles and navigation warning lights for vessels on WTGs and ESPs. Aviation warning lights would use ADLS to reduce operations stage nighttime lighting impacts. ADLS would only activate the required FAA aviation obstruction lights on WTGs and ESPs when aircraft enter a predefined airspace and turn off when the aircraft are no longer in proximity to the SWDA (COP Appendix III-K; Epsilon 2023). More specifically, in accordance with FAA Advisory Circular 70/7460-1M (FAA 2020), lights controlled by an ADLS must be activated and illuminated prior to an aircraft reaching 3 nautical miles (3.5 miles) from within

1,000 vertical feet of any WTG. Due to the speed of the traveling aircraft and size of the SWDA, the resulting appearance of the lights would be limited to a few minutes in each instance. ADLS activation for Phase 1 would occur for less than 9 minutes per year (less than 0.1 percent of annual nighttime hours) (COP Appendix III-K; Epsilon 2023). As a result, the use of ADLS for Phase 1 would result in intermittent, low intensity (rather than continuous), and minor impacts on the nine cultural resources located near Martha's Vineyard and Nantucket, in the APE for direct visual effects offshore.

USCG navigation warning lights would be mounted near the top of the foundation on each WTG and ESP. The lighting is relatively low intensity and is designed to be visible up to at least 5 nautical miles (5.8 miles) (COP Appendix III-H.a; Epsilon 2023). This lighting could be visible to mariners at sea but would not be visible from coastal vantage points because the closest land location, the shoreline of Martha's Vineyard, to the nearest WTG or ESP would be over 21 miles away.

Phase 1 decommissioning would have the same intensity/extent of impacts as those during construction. As a result, nighttime lighting associated with decommissioning the infrastructure of Phase 1 would have long-term, low intensity impacts on a limited number of resources, resulting in minor impacts on cultural resources.

Port utilization: Phase 1 construction would use the Port of Bridgeport and possibly numerous other ports in Massachusetts, Rhode Island, Connecticut, and beyond (Section G.2.7). As stated in Section 3.10.1.1, some of these ports have been or would be expanded to accommodate the offshore wind industry, although the applicant has not funded or otherwise prompted any specific expansions. BOEM assumes that state and federal legal requirements to identify and assess—and to avoid, minimize, and/or mitigate—potential impacts on cultural resources were or would be followed as part of any port expansions. As a result, Phase 1 construction would have negligible impacts on cultural resources under this IPF.

Operations and decommissioning of Phase 1 would have the same intensity and extent of impacts on cultural resources as construction. Therefore, Phase 1 would have negligible impacts on cultural resources under this IPF.

Presence of structures: A Historic Properties Visual Impact Assessment for Alternative B identified the boundaries of two historic properties that are within the onshore APE for both direct physical impacts and direct visual impacts: the Old King's Highway Regional Historic District (BRN.O) and West Barnstable East Area (BRN.AN). Seven historic properties are located within the onshore APE for direct visual impacts, near the Centerville River crossing, if trenchless crossing is not feasible, and a utility bridge must be constructed: BRN.2225, 2226, 2227, 2228, and 2229. The applicant determined that both phases of Alternative B would have no effect on the historic properties identified within the onshore APE for direct physical impacts or visual impacts. Heavy vegetation in the area would obscure visibility of the potential utility bridge from these properties, and the Centerville River Bridge, a modern 2002 construction, is already part of the viewshed. Thus, adding another small bridge and fence would not alter the viewshed significantly.

Applicant surveys concluded that Phase 1 would be unable to avoid, and would thus have physical impacts on, 21 ancient submerged landform features in the marine APE due to design constraints (i.e., the submerged landform crosses the entire OECC), engineering, and/or environmental constraints (COP Appendix II-D; Epsilon 2023). Physical impacts on these resources would threaten the viability of the affected portion of these resources as both potential repositories of archaeological information, as well as the cultural significance of these landforms to local Native American tribes. The severity of impacts would depend on the horizontal and vertical extent of impacts relative to the size of the intact ancient submerged landform feature. Due to the limited size of the offshore remote sensing survey areas in the OECC and SWDA, the full extent or size of individual ancient submerged landforms cannot be defined.

The applicant's efforts to identify potential submerged archaeological sites are described in the COP (Appendix II-D; Epsilon 2023). In the event of an unanticipated discovery, the applicant would notify BOEM and implement the Unanticipated Discoveries Plan. The applicant would notify BOEM within 24 hours of the discovery and provide written notification within 72 hours of the discovery. No action would occur that could affect the potential resource until BOEM conducts an evaluation and instructs the applicant on how to proceed. Based on available information, Phase 1 construction would result in the physical damage or destruction of all or part of the 21 ancient submerged landforms that cannot be avoided. To mitigate impacts, the applicant has proposed conducting additional archaeological investigations in the SWDA and OECC, including vibracore analysis. The results of the geotechnical archaeological studies would be shared with the tribes and other stakeholders in a variety of formats as necessary (COP Volume II-D; Epsilon 2023). As a result, the presence of structures from Phase 1 would have major impacts on ancient submerged landform features.

The applicant has voluntarily committed to avoiding the shipwrecks and debris fields by a recommended 164 feet and would not affect these resources. As a result, the presence of structures from Phase 1 would have negligible impacts on the potential shipwreck in the OECC.

The Phase 1 offshore APE for direct visual impacts includes 19 historic properties, and BOEM determined that the construction of WTGs would affect 7 historic properties: the Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, the Vineyard Sound and Moshup's Bridge TCP, the Chappaquiddick Island TCP, the Nantucket Sound TCP, and the Nantucket Historic District NHL. The visual impact during construction would consist of vessel traffic within the SWDA and possible use of jack-up barges with mobile cranes and other larger construction vessels (COP Appendix III-H.a; Epsilon 2023). Partially built WTGs and ESPs may also be visible. The limited geographic extent of impacts and the intensity of visual impacts on these historic properties would be limited by distance, environmental, and atmospheric factors. As discussed in Section 3.16, the visibility of WTGs and ESP(s) would be further reduced by environmental and atmospheric factors such as cloud cover, haze, sea spray, vegetation, and wave height. While these factors would limit the intensity of impacts, construction of Phase 1 would have short-term and minor impacts on the seven historic properties listed above.

As described above, the applicant determined that the presence of structures in Phase 1 would have minor impacts on the historic properties identified within the onshore APE for direct physical effects and direct visual effects. The APE for direct visual effects is the viewshed from which renewable energy structures, whether located offshore or onshore, would be visible for Phase 1 and was determined to be a maximum distance of 37.5 miles from the Phase 1 WTGs.

The cultural resources within the APE for direct visual impacts during Phase 1 operations are the same as those described for this IPF during Phase 1 construction. These include 19 historic properties in the offshore visual APE, of which 7 would be affected: the Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, the Vineyard Sound and Moshup's Bridge TCP, Chappaquiddick Island TCP, Nantucket Sound TCP, and the Nantucket Historic District. BOEM determined that an uninterrupted sea view, free of modern visual elements, is a contributing element to the NRHP eligibility of the seven historic properties. In addition, Phase 1 would only affect southern views from these resources, primarily in coastal and elevated locations (COP Appendix IIIH.b; Epsilon 2023). When viewed broadside, a Phase 1 WTG at the distance of 21.2 miles (the closest Phase 1 WTG to any of the resources listed above) would occupy 0.16 degree horizontally on the horizon and 0.33 degree vertically to the nacelle top. This is the approximate equivalent of a pencil viewed 113 feet away (COP Appendix IIIH.a; Epsilon 2023). The maximum width of the 26 foot blade would measure 0.013 degree horizontally, about the equivalent to the width of a drinking straw viewed 91 feet away (COP Appendix IIIH.b; Epsilon 2023). As a result, the presence of visible WTGs from Phase 1 would have long-term, continuous, widespread, and moderate impacts on these resources. The scale, extent, and intensity of these impacts would be partially mitigated by environmental and atmospheric factors such as clouds, haze, fog, sea spray, vegetation, and wave height that would partially or fully screen the WTGs from view at various times throughout the year.

To further minimize and mitigate effects of Phase 1, the applicant has voluntarily committed to the following mitigation and monitoring measures:

- Fund a mitigation plan to resolve impacts on the Gay Head Lighthouse pursuant to NHPA Section 106; and
- Fund a mitigation plan to resolve impacts on the Vineyard Sound and Moshup's Bridge TCP pursuant to NHPA Section 106.

The final avoidance, minimization, and mitigation measures for resolution of adverse effects will be identified in the executed Memorandum of Agreement for BOEM's NHPA Section 106 consultation and included as conditions of COP approval.

Phase 1 decommissioning would have similar impacts as construction. As structures are removed, visual impacts on cultural resources would disappear.

Impacts of Phase 2

The impacts of Phase 2 on cultural resources would be marginally more extensive than, but would have similar impact magnitudes as, those described for Phase 1 for IPFs related to accidental releases, anchoring and gear utilization, climate change, port utilization, and traffic. The impacts of Phase 2 associated with the IPF for lighting would be less intense than, but would have similar magnitude to, Phase 1, due to the increased distance between onshore viewers and Phase 2 WTGs. While Phase 2 would involve more WTGs and ESPs, a greater length of inter-array cables, and a different OECR in Barnstable, the incremental differences in activity between Phase 2 and Phase 1, as well as the combined effect of Phase 1 and Phase 2 together, would not change any of the impact magnitudes described for Phase 1 construction, except for the IPFs discussed below.

If the applicant includes the SCV as part of the final proposed Project design, some or all of the impacts on cultural resources from the Phase 2 OECC through Muskeget Channel would not occur. BOEM would provide a more detailed analysis of the impacts of the SCV on cultural resources in a supplemental NEPA analysis, if the SCV is selected. The operations and decommissioning within the geographic area of analysis during Phase 2 (with or without the SCV) would have similar impacts as Phase 1 for all IPFs, except as discussed below.

Anchoring and gear utilization: The SCV diverges from the OECC at the northern boundary of Lease Area OCS-A 0501 and travels west-to-northwest to the state waters boundary near Buzzards Bay. The portion of the SCV in federal waters would disturb approximately 307 acres of seafloor (Epsilon 2023). The seafloor impact within state waters in Buzzard's Bay has not been determined and would be evaluated as part of a supplemental NEPA analysis. The applicant's geophysical surveys and marine archaeological resources assessment of the OECC for the SCV (Epsilon 2023), identified 17 ancient submerged landform features and 2 possible shipwreck sites. The applicant anticipates both possible shipwrecks would be avoided. Current proposed Project designs may not be able to avoid the ancient submerged landform features. As a result, Phase 2 would have negligible to major impacts on marine cultural resources.

Cable emplacement and maintenance: The impacts of SCV cable emplacement on cultural resources would be similar to the impacts of Phase 1, although the number of identified ancient submerged landform features would increase from 16 to 17. The magnitude of these impacts would remain major, due to the permanent, irreversible nature of the impacts.

Climate change: The impacts of Phase 2 and SCV construction on climate change would be similar to those for Phase 1: a short-term and negligible impact on cultural resources.

Land disturbance: Applicant surveys and studies of the onshore component of Phase 2 (COP Appendix IIIG; Epsilon 2023) identified no NRHP-listed archaeological sites, 42 pre-Contact archaeological sites, and 15 post-Contact archaeological sites that could be affected by ground-disturbing activities associated with Phase 2 construction in areas within 0.5 mile of the Phase 2 OECR, grid interconnection route, and substation sites (COP Appendix IIIG; Epsilon 2023). Portions of the area potentially affected by Phase 2 overlap with the Phase 1 potential cable routes. Based on these findings, the applicant has determined that Phase 2 would not impact any known terrestrial cultural resources. The applicant recommends archaeological monitoring of proposed Project construction activities within the staging areas required for the HDD in the selected Phase 2 landfall area and during installation of the Phase 2 OECR. Based on the results of the terrestrial archaeological investigations and considering the possible presence of undiscovered resources and the associated unanticipated discovery plan, onshore construction of Phase 2 would have localized, long-term, and minor to moderate impacts on terrestrial cultural resources.

BOEM could reduce potential impacts of Phase 2 onshore construction by requiring one or both of the mitigation and monitoring measures described for Phase 1 construction as a condition of COP approval (Appendix H).

Lighting: The impacts of Phase 2 offshore construction on lighting for the SCV would involve similar impacts as those of Phase 1, but in additional locations, and would be short term, localized, and minor**.**

Presence of structures: Applicant surveys concluded that Phase 2 construction within the SWDA would be unable to avoid 8 ancient submerged landform features and 3 potential shipwrecks and would, therefore, have physical impacts on these 11 features (COP Appendix II-D; Epsilon 2023). The Phase 2 construction impacts on these features would be similar to those described for Phase 1. As a result, Phase 2 construction under this IPF would have major impacts on ancient submerged landform features. As with Phase 1, every reasonable effort has been made to identify potential submerged archaeological sites; however, in the event of an unanticipated discovery, the applicant would notify BOEM and implement the Unanticipated Discoveries Plan. To mitigate impacts, the applicant has proposed conducting additional archaeological investigations in the SWDA, including vibracore analysis. The results of the geotechnical archaeological studies would be shared with the tribes and other stakeholders in a variety of formats as necessary (COP Volume II-D; Epsilon 2023). The impacts from the presence of structures during Phase 2 construction on cultural resources in the APE for direct visual impacts would be similar to, but less intense than, those of Phase 1 because Phase 2 WTG and ESP locations would be farther from cultural resources in the APE for direct visual impacts, 37.5 miles, than Phase 1 structures at 35.7 miles. As a result, Phase 2 construction would have short-term and minor impacts on the seven historic properties for which an uninterrupted sea view, free of intrusive visual elements, is a contributing element to NRHP eligibility.

The SCV would require approximately 41 acres of hard protection in federal waters. However, the impacts of SCV construction would be similar to those described for Phase 1: short term, localized, and minor to major.

The final avoidance, minimization, and mitigation measures for resolution of adverse effects will be identified in the executed Memorandum of Agreement for BOEM's NHPA Section 106 consultation and included as conditions of COP approval.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-7 in Appendix G would contribute to impacts on cultural resources through the primary IPFs of anchoring and gear utilization, cable maintenance and emplacement, lighting, and the presence of structures. These impacts would primarily occur through impacts on seven historic properties for which an uninterrupted sea view, free of intrusive visual elements, is a contributing element to NRHP eligibility, as well as impacts on cultural practices and values of Native American tribes resulting from views of WTGs, and damage to submerged ancient landforms.

Other offshore wind projects in the RI/MA Lease Areas would have limited areas of overlap with the proposed Project, primarily limited to shared portions of the proposed Project OECC. Nonetheless, construction of other offshore wind projects that cannot avoid ancient submerged landform features in the marine archaeological APE would result in long-term, widespread, unmitigated, and major impacts on ancient submerged landform features. BOEM has committed to working with applicants, consulting parties, Native American tribes, and the Massachusetts Historical Commission to develop specific treatment plans to address impacts on ancient submerged landform features that cannot be avoided by future offshore wind development projects. Development and implementation of proposed Project-specific treatment plans, agreed to by all consulting parties, would reduce the magnitude of unmitigated impacts on ancient submerged landform features; however, these impacts would remain permanent and irreversible.

The cumulative impacts on cultural resources would be **major**, with the largest impacts occurring due to the permanent and irreversible impacts on ancient submerged landform features.

Conclusions

Impacts of Alternative B. Alternative B would have **major** impacts on cultural resources. Impacts could be reduced through the avoidance, minimization, and mitigation of identified cultural resources and mitigation and monitoring measures (Appendix H) that BOEM includes as conditions of COP approval. The impacts analysis is based on a maximum-case scenario; impacts would be reduced by implementation of a less impactful construction or infrastructure development scenario within the PDE (Appendix C). However, neither of these impact reductions would result in different impact ratings than those described above, given the fact that the damage to ancient submerged landform features is irreversible, even with mitigation.

Major impacts would occur without the pre-construction identification of cultural resources to assess potential impacts, and development of treatment plans to resolve effects through avoidance, minimization, and/or mitigation. These efforts to identify cultural resources and address impacts resulted in or contributed to the applicant making commitments to reduce the magnitude of impacts on cultural resources, including, but not limited to, the use of ADLS hazard lighting (if approved), the use of non-reflective pure white and light grey paint on offshore structures, and the development of treatment plans with consulting parties to address impacts on cultural resources (Appendix H). Requirements to identify historic properties and resolve impacts would similarly reduce the significance of potential impacts on cultural resources from future offshore wind projects as they complete the review process. Thus, the overall impacts on cultural resources from Alternative B would qualify as **major** because a notable and measurable impact is anticipated and mitigation would be required.

Cumulative Impacts of Alternative B. The cumulative impacts on cultural resources in the geographic analysis area would be **major**. This reflects the permanent and irreversible impacts on ancient submerged landforms. It also reflects long-term impacts on seven historic properties for which an uninterrupted sea view, free of intrusive visual elements, is a contributing element to NRHP eligibility: the Gay Head Lighthouse, the Edwin Vanderhoop Homestead, the Gay Head – Aquinnah Shops Area, Vineyard Sound and Moshup's Bridge TCP, Chappaquiddick Island TCP, the Nantucket Sound TCP, and the Nantucket Historic District.

3.10.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Cultural Resources

When analyzing the impacts of Alternative C on cultural resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for cultural resources. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. To the degree that Alternatives C-1 and C-2 reduce impacts on ancient submerged landforms, they could have marginally different impacts on cultural resources than Alternative B. However, these differences in impacts would not change the magnitude of impact. Therefore, the impacts of Alternatives C-1 and C-2 on cultural resources would be the same as those of Alternative B: **major**. The cumulative impacts of Alternative C on cultural resources would be **major**.

3.10.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Cultural Resources with the Western Muskeget Variant Contingency Option

Impacts on cultural resources from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B (Scenario 2 for Phase 2). While the overall impacts of Alternative B cable Scenario 2 would not be materially different than those described under Scenario 4 (the maximum level of impact under Alternative B), Scenario 2 impacts would be slightly less, as only one cable would be placed in the Western Muskeget Variant.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce the potential impacts on cultural resources by a negligible increment for both Phase 1 (3.2 acres[33] if a foundation is eliminated or 3.9 acres[33] if a ESP foundation is eliminated) and Phase 2 (4.5 acres[33] if a WTG foundation is eliminated or 7.6 acres[33] if a ESP foundation is eliminated) as a result of one less foundation and associated scour protection and required construction vessel impacts (COP Volume III, Appendix III-T; Epsilon 2023). Additionally, the impacts would be slightly less, as less pile driving would be required.

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[33] This acreage assumes that the foundation and associated scour protection, as well as seafloor disturbance, as a result of construction vessel impacts would not occur at a single position.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on cultural resources relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **major** impacts on cultural resources within the geographic analysis area. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **major**.

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3.11 Demographics, Employment, and Economics

3.11.1 Description of the Affected Environment

3.11.1.1 Geographic Analysis Area

This section discusses demographic, employment, and economic conditions in the geographic analysis area described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.11-1. Specifically, this includes the counties where proposed onshore infrastructure and potential port cities are located, as well as the counties in closest proximity to the SWDA: Barnstable, Bristol, Dukes, Nantucket, and Essex counties, Massachusetts; Providence and Washington counties, Rhode Island; Fairfield and New London counties, Connecticut; Kings, Richmond, Rensselaer, Albany, and Suffolk counties, New York; and Gloucester County, New Jersey. Statewide data for Massachusetts and Rhode Island are provided for reference. Table 3.11-1 describes existing conditions and the impacts of ongoing and future offshore activities other than offshore wind on demographics, employment, and economics based on the IPFs assessed.

Proposed Project facilities and associated port activities would be located primarily within coastal Massachusetts and Rhode Island. Other states that would host proposed Project-related activities include Connecticut, New York, and New Jersey. Tables 3.11-1 through 3.11-35 provide detailed demographic information for the study area. Due to the COVID-19 pandemic, the U.S. Census Bureau has not released 2020 and 2021 demographic, employment, and economic data.

3.11.1.2 Massachusetts

Barnstable, Dukes, and Nantucket Counties, Massachusetts

Barnstable, Dukes, and Nantucket counties are notable for the importance of coastal recreation and tourism to their economies and their high proportion of seasonal housing. Nantucket has the lowest overall population of these three counties, as well as the lowest unemployment rate (Table 3.11-1). Barnstable County has the highest total population and population density of the three counties.

Table 3.11-1: Demographic Data (Massachusetts), 2019

Jurisdiction	Population (2019)	Population Density (persons per square mile)[a]	Per Capita Income (2019)	Total Employed (2019)	Unemployment Rate (2019)
Massachusetts	6,850,553	648.4	$43,761	1,780,625	4.8%
Barnstable County	213,496	542.3	$44,505	52,558	4.1%
Bristol County	561,037	1,014.4	$35,747	141,991	5.4%
Dukes County	17,312	167.7	$45,990	4,291	3.4%
Nantucket County	11,168	248.3	$55,398	2,996	2.9%
Essex County	789,034	1,601.9	$33,828	366,590	6.8%

Source: U.S. Census Bureau 2020a

[a] Population density is based on the 2019 population estimates divided by the square miles of each county (World Media Group 2022).

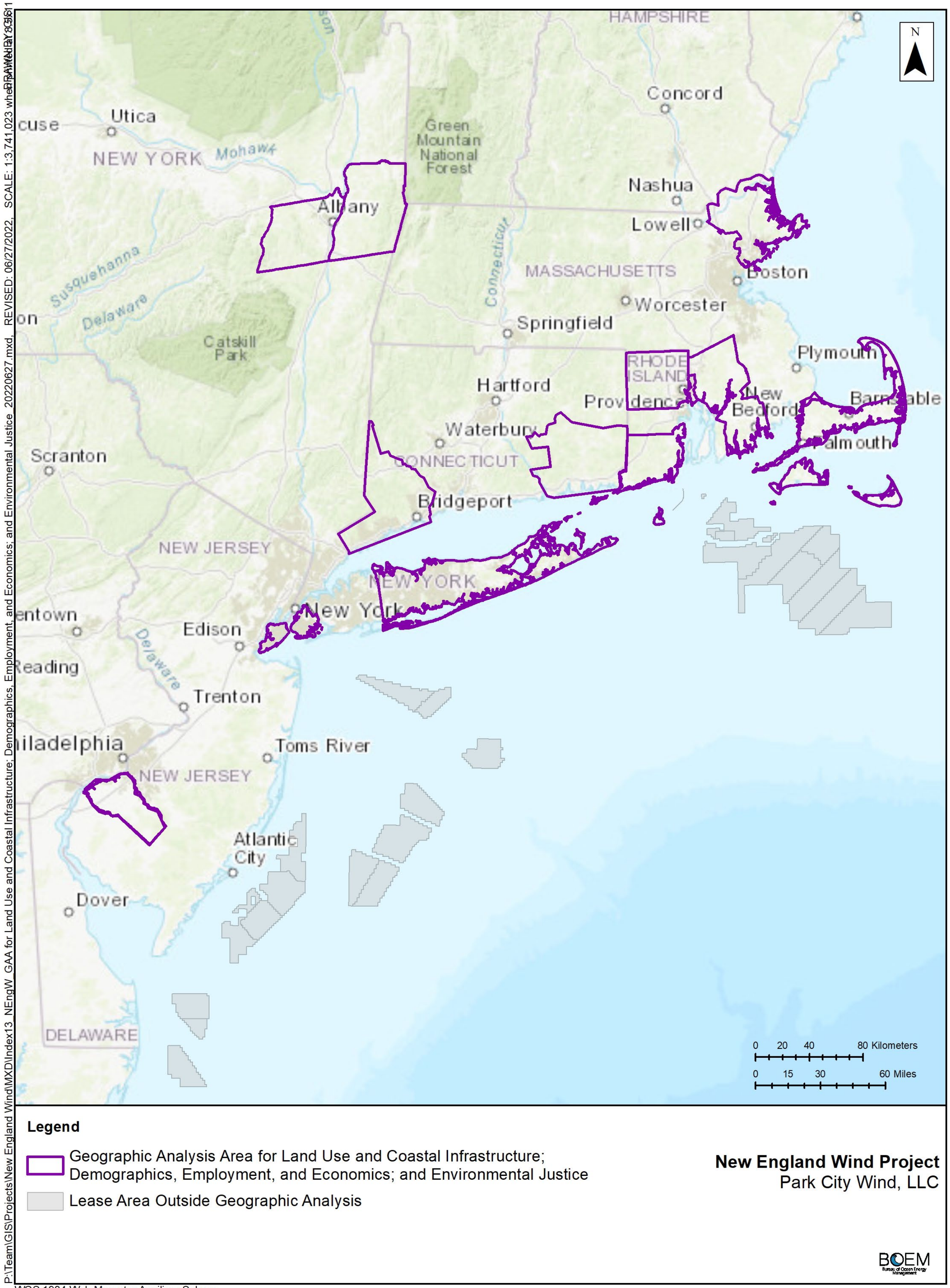


Figure 3.11-1: Geographic Analysis Area for Demographics, Employment, and Economics

The population of Barnstable County declined from 2010 to 2019, while the population of Dukes and Nantucket counties grew (Table 3.11-2). Dukes and Nantucket counties have the smallest population of any counties in Massachusetts (U.S. Census Bureau 2020a). The population of Barnstable and Dukes counties are older, on average, than the population of surrounding counties and Massachusetts as a whole, while Nantucket County's age distribution is similar to the statewide profile (U.S. Census Bureau 2020a). The population in Nantucket County is slightly older than the state average (U.S. Census Bureau 2020a).

Table 3.11-2: Demographic Trends (Massachusetts), 2000–2019

Jurisdiction	Population				2019 Population by Age			
	2000	2010	2019	Change 2000-2019	Under Age 18 (%)	Age 18-64 (%)	Age 65 or Older (%)	Median Age
Massachusetts	6,349,105	6,547,629	6,850,553	8.6%	20.0%	55.0%	16.2%	39.5
Barnstable County	222,230	215,888	213,496	4.2%	15.3%	62.6%	29.8%	53.3
Bristol County	534,678	548,285	561,037	5.7%	20.8%	58.2%	16.6%	41.0
Dukes County	14,987	16,535	17,312	15.6%	18.5%	64.7%	23.3%	47.1
Nantucket County	9,520	10,172	11,168	19.7%	20.7%	55.0%	14.6%	40.3
Essex County	723,419	744,644	789,034	9%	21.1%	61%	17.6%	40.6

Source: U.S. Census Bureau 2020b

In Massachusetts as a whole, approximately 4 percent of housing units are seasonally occupied, compared to 38 percent of homes in Barnstable County, 60 percent of homes Dukes County, and 62 percent of homes in Nantucket County (Table 3.11-3). Towns in Barnstable County experience significant seasonal population change due to tourism. During the peak tourist season from June through August, the population of Cape Cod grows by "an equivalent [of] 68,856 full-time residents" (COP Volume III, Section 7.1.1; Epsilon 2023), equivalent to approximately 32 percent of Barnstable County's 2019 population. In addition, "seasonal population continues to grow even as the number of Cape Cod's year-round residents decreased" (COP Volume III, Section 7.1.1; Epsilon 2023).

Table 3.11-3: Housing Data (Massachusetts), 2019

Jurisdiction	Housing Units	Seasonal Vacant Units	Vacant Units (Non-Seasonal)	Percent Non-Seasonal Vacancy	Median Value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
Massachusetts	2,897,259	127,398	152,364	5.3%	$ 381,600	$ 1,282
Barnstable County	163,557	62,643	6,591	4.0%	$ 393,500	$ 1,311
Bristol County	235,275	2,892	14,471	6.2%	$ 299,800	$ 901
Dukes County	17,902	10,681	456	2.5%	$ 699,500	$ 1,459
Nantucket County	12,345	7,860	772	6.3%	$ 1,084,700	$ 1,764
Essex County	312,992	5,506	18,790	6.0%	$ 409,900	$ 1,241

Source: U.S. Census Bureau 2020a

Table 3.11-4 summarizes the employment characteristics of residents of Barnstable, Bristol, Dukes, Nantucket, and Essex counties and Massachusetts as a whole. Table 3.11-5 summarizes the characteristics of jobs held in those counties and Massachusetts, regardless of where employees live. Approximately 14 percent of Massachusetts residents are employed in the professional, scientific, management, administrative, and waste management services industries (Table 3.11-4). Arts, entertainment, and recreation, and accommodation and food services jobs account for approximately 9 percent of employment for Massachusetts residents, compared to nearly 12, 8, and 10 percent in Barnstable, Dukes, and Nantucket counties, respectively (Table 3.11-4).

Table 3.11-4: Employment of Residents, By Industry (Massachusetts), 2019

Industry	Massachusetts Total	Barnstable County	Bristol County	Dukes County	Nantucket County	Essex County
Agriculture, forestry, fishing, and hunting	14,795	1,094	1,771	242	100	1,723
Construction	205,718	10,411	21,691	1,280	1,011	20,963
Manufacturing	317,827	4,104	31,395	261	168	44,605
Wholesale trade	78,806	2,038	9,081	161	168	10,992
Retail trade	370,824	14,461	36,337	789	812	41,277
Transportation, warehousing, and utilities	140,484	3,975	12,547	490	165	14,548
Information	82,102	1,833	4,478	163	39	10,461
Finance, and insurance, real estate	265,085	6,262	16,652	589	468	28,701
Professional, scientific, management; administrative and waste management services	506,967	12,766	25,915	1,162	1,030	43,733
Educational services, and health care and social assistance	1,018,564	25,464	76,736	2,022	1,162	89,018
Arts, entertainment, and recreation, and accommodation and food services	312,504	12,376	24,859	691	659	29,382
Other services, except public administration	161,589	5,783	11,939	523	327	16,529
Public administration	137,110	5,148	11,269	357	309	14,658
Total	**3,612,375**	**105,715**	**284,670**	**8,730**	**6,418**	**366,590**

Source: U.S. Census Bureau 2020a

Table 3.11-5: At-Place Employment, By Industry (Massachusetts), 2019

Industry	Massachusetts Total	Barnstable County	Bristol County	Dukes County	Nantucket County	Essex County
Agriculture, forestry, fishing and hunting	1,152	111	148	17	ND	4,202
Mining, quarrying, and oil and gas extraction	809	51	49	804	ND	1,533
Utilities	12,527	226	497	123	ND	9,615
Construction	151,366	6,164	10,766	66	954	88,885
Manufacturing	233,428	2,069	24,323	1,007	63	159,421
Wholesale trade	150,935	1,432	15,132	205	39	35,509
Retail trade	363,220	14,998	34,118	157	887	101,930
Transportation and warehousing	102,311	2,179	8,550	219	132	47,599
Information	123,296	1,301	2,874	169	94	24,310
Finance and insurance	187,058	2,017	4,116	246	96	111,809
Real estate and rental and leasing	52,199	1,385	1,910	17	131	22,549
Professional, scientific, and technical services	315,966	4,757	5,593	804	236	106,357
Management of companies and enterprises	111,216	1,005	4,773	ND	36	2,375
Administrative and support and waste management and remediation services	214,224	3,415	9,918	464	501	41,783
Educational services	230,028	1,635	5,362	58	106	120,811
Health care and social assistance	625,474	15,761	41,948	832	562	186,794
Arts, entertainment, and recreation	66,150	1,904	3,632	346	261	27,871
Accommodation and food services	316,291	12,574	21,720	626	664	45,886
Other services (except public administration)	128,034	4,086	7,968	344	233	46,896
Industries not classified	688	46	49	464	1	54,495
Total	**3,386,372**	**77,116**	**203,446**	**5,709**	**5,009**	**1,240,630**

Source: U.S. Census Bureau 2020a
ND = no data

NOAA tracks economic activity dependent upon the ocean in its "Ocean Economy" data, which generally include commercial fishing and seafood processing, marine construction, commercial shipping and cargo handling facilities, ship and boat building, marine minerals, harbor and port authorities, passenger transportation, boat dealers, and coastal recreation and tourism, among others. Table 3.11-6 reports data on the Ocean Economy as a whole in terms of gross domestic product (GDP) and employment; Table 3.11-7 reports employment by industry. In Barnstable, Dukes, and Nantucket counties, recreation and tourism accounted for approximately 89, 91, and 93 percent of the overall Ocean Economy GDP (NOAA 2019c). This category includes recreational and charter fishing, as well as commercial ferry services based in Hyannis Harbor and Woods Hole, which provide service to Nantucket, Martha's Vineyard, and other surrounding locations. The Woods Hole, Martha's Vineyard, and Nantucket Steamship Authority generated over $110 million in revenues in 2019 with almost 3,004,436 passenger trips (Steamship Authority 2020).

Table 3.11-6: Ocean Economy Data for Geographic Analysis Area Counties (Massachusetts), 2018

Jurisdiction	Ocean Economy GDP,[a] All Ocean Sectors	Ocean Economy GDP, Recreation and Tourism Sector[b]	Ocean Economy GDP, Living Resources Sector[b]	Total County GDP (Coastal Economy, Employment Data) Total, All Industries[c]	Ocean Economy GDP, as Percent of Total County GDP (%)[d]
Barnstable County	$1,324,724,000	$1,111,159,000	$77,672,000	$10,448,424,257	10%
Bristol County	$741,180,000	$107,444,000	$586,309,000	$25,768,897,279	3%
Dukes County	$130,390,000	$122,702,000	$6,934,000	$1,051,674,934	8%
Nantucket County	164,622,000	161,463,000	2,703,000	976,566,296	11%
Essex County	43,968,731,674	813,227,000	187,487,000	1,039,495,000	2%

Source: NOAA 2019c, 2019d

GDP = gross domestic product (U.S. dollars)
[a] GDP calculated as Ocean Economy Employment Data GDP plus Self-Employed Workers Gross Receipts
[b] Search Parameters: Ocean Economy (Employment Data); Ocean Economy Geographies (NOAA 2019c); Ocean Economy (Self-Employed); Ocean Economy Geographies (NOAA 2019d)
[c] Search Parameters: Coastal Economy (Employment Data); Coastal Shoreline Counties; Total, all industries (NOAA 2019e)
[d] Total GDP by county retrieved from U.S. Bureau Economic Analysis data (U.S. BEA 2020).

Table 3.11-7: Ocean Economy Employment[a] by Industry (Massachusetts), 2018

Jurisdiction	Marine Construction	Living Resources[b]	Offshore Mineral Extraction	Ship and Boat Building	Recreation and Tourism	Marine Transportation	Total, all Sectors[c]
Barnstable County	114	1,168	4	29	17,222	710	19,247
Bristol County	27	764	6	360	3,006	78	6,964
Dukes County	0[a]	111	0	6	1,424	18	1,561
Nantucket County	0	104	0	0	1,709	16	1,833
Essex County	121	1,230	ND	ND	17,617	306	19,274

Source: NOAA 2019c, 2019d

[a] For sectors showing no employment, data for certain businesses may have been suppressed because the number of businesses was too small to report based on privacy. This also results in total employment exceeding the sum of the sectors.
[b] Total employment calculated as All Ocean Sectors Employment (NOAA 2019c) plus All Ocean Sectors Self-Employed Workers (NOAA 2019d).
[c] "Living resources" includes fishing, aquaculture, seafood processing, and seafood markets.

The living resource sector of the Ocean Economy includes commercial fishing, aquaculture, seafood processing, and seafood markets. Although the number employed or self-employed in this sector in Barnstable, Dukes, and Nantucket counties is minor compared to recreation and tourism (Table 3.11-7), local fishing fleets form an important part of the identity and tourist attraction of local communities. As an example, the Town of Barnstable was host to a commercial fishing fleet of 27 vessels in 2014, of which 20 were classified as small vessels (less than 50 feet) (NEFSC 2019). Landed fish values in 2014 for the Town of Barnstable range from $0.44 million to $5.8 million depending on species (NEFSC 2019). Self-employed workers and company employees employed in the living resources sector are shown in Table 3.11-8.

Table 3.11-8: Employment and Wages for Ocean Economy Living Resource Industries (Massachusetts), 2018

	Ocean Economy Living Resources Sector				All Industry Sectors	
	Company Employees		Self-Employed Workers		All Workers	
County	Total Number	Average Wage[a]	Total Number	Average Gross Receipts[b]	Total Employment	Average Wage
Barnstable	347	$43,078	821	$54,189	97,408	$47,903
Bristol	2,661	$76,682	764	$98,421	228,565	$50,349
Dukes	36	$60,056	96	$31,677	9,016	$52,092
Nantucket	1,230	$72,600	39	$59,923	7,577	$57,559
Essex	8	$25,375	691	$61,670	325,671	$60,294
Total/Average	**4,282**	**$55,558**	**2,411**	**$61,176**	**668,237**	**$53,639**

Sources: NOAA 2022c, 2022d, 2022e

[a] Average wage is calculated as total wages divided by total number of employees.
[b] Average gross receipts are calculated as total gross receipts divided by number of self-employed workers.

The applicant would use Vineyard Haven Harbor on Martha's Vineyard as an operations facility for the proposed Project (COP Appendix III-I; Epsilon 2023).

Menemsha, located in Dukes County, Massachusetts, is an example of a fishing community with established cultural identities and place attachments strongly correlated with the fishing economy. Menemsha is a community with great social pride for its fishing history. Place attachments can be defined as connections to physical and social settings that provide social and psychological benefits. Factors related to place attachments can impact well-being of individuals and the community as a whole (Khakzad and Griffith 2016). The NMFS Social Indicator Map classifies fishing communities in Barnstable, Dukes, and Nantucket counties as having varying levels of social vulnerability, in part based on commercial fishing engagement and reliance (NMFS 2019). Barnstable and Nantucket were rated high on commercial fishing engagement and reliance. The communities of Chilmark and Sandwich were rated medium to low for commercial fishing engagement and low for commercial fishing reliance.

Bristol County, Massachusetts

Bristol County is a manufacturing center and has an ocean-based economy dominated by shipping, seafood processing and commercial fishing. New Bedford in Bristol County is a nationally important commercial fishing center. Bristol County is more densely populated than Massachusetts as a whole and had lower per capita income and housing values. In 2018, Ocean Economy activities accounted for 3 percent of Bristol County's GDP, and employed approximately 6,964 individuals, including self-employed individuals (Table 3.11-7). Commercial fishing, aquaculture, and seafood processing accounted for 87 percent of Bristol County's total Ocean Economy value (NOAA 2019c).

The Port of New Bedford is a full-service port with well-established fishing and cargo handling industries. The port is an international seafood hub and the highest-grossing commercial fishing port in the United States (Harriman et al. 2020; New Bedford Port Authority 2018). The Port of New Bedford generated 14,429 jobs in 2018 (direct, indirect, and induced)[34], mostly from commercial fishing and seafood processing activity (Martin Associates and Foth-CLE Engineering Group 2019). The seafood processing industry at New Bedford handles seafood landed at New Bedford Harbor, as well as seafood from other domestic and international sources. An additional 26,499 related jobs were generated by downstream logistics operations in seafood processing, after the seafood leaves the port processing operations and cold storage facilities (Martin Associates and Foth-CLE Engineering Group 2019).

The applicant may use the Marine Commerce Terminal (MCT) at the Port of New Bedford, other areas at the Port of New Bedford, Brayton Point, and the Fall River Terminal in Bristol County to support proposed Project construction and may also use the MCT as an operations facility (COP Volume III, Section 7.7 and Appendix III-I; Epsilon 2023). The recent history of industrial activity in these locations suggests the presence of a skilled workforce consistent with proposed Project needs (MassCEC 2022).

NMFS classifies fishing communities in New Bedford and Fairhaven as having high commercial fishing engagement and medium (Fairhaven) to low (New Bedford) reliance (NMFS 2019). Westport and Fall River were classified as having medium-high commercial fishing engagement, and low (Westport) and medium (Fall River) commercial fishing reliance. Other communities in Bristol County are identified as having medium to low ratings in both categories (NMFS 2019).

Essex County, Massachusetts

Essex County is located along Massachusetts Bay between Boston and the New Hampshire state border. The county is traditionally known for shipbuilding and tourism. Essex County is more densely populated than Massachusetts as a whole and has a lower per capita income (Table 3.11-1) and a higher median home value (Table 3.11-3). The Ocean Economy in Essex County employs over 20,000 individuals and accounted for over $1 billion of the county's overall GDP in 2018, equating to 3.4 percent of total GDP (FRED 2022; NOAA 2022f). Additionally, in 2018 the recreation and tourism sector employed 91 percent of Essex County's Ocean Economy workforce (NOAA 2019c). The applicant is considering using Salem Harbor in Essex County to support proposed Project construction (COP Volume III, Section 7.7; Epsilon 2023). Approximately 36 miles northeast of Boston, Salem Harbor contains commercial, recreational, and water transportation facilities (COP Volume I, Section 3.2; Epsilon 2023).

3.11.1.3 Providence and Washington Counties, Rhode Island

Both Providence and Washington counties have diverse economies. Their ocean-based economy sectors include shipping and commercial fishing in addition to tourism-related economic activity. Point Judith in Washington County is a center for the regional commercial and recreational for-hire fishing industries.

Providence County is Rhode Island's largest county in terms of population and is home to over 60 percent of Rhode Island's residents (Table 3.11-9). Providence County's housing values and per capita income are slightly lower than the state average, while unemployment is higher than the state average (Table 3.11-9). Washington County has a lower population and population density than both Providence County and the state of Rhode Island as a whole. The population of Rhode Island increased slightly from 2000 to 2019; Providence and Washington counties grew slightly faster (Table 3.11-10).

[34] The terms "direct," "indirect," and "induced" are commonly used both within and outside the NEPA context to describe economic impacts and are, thus, used in this section. The remainder of the EIS does not distinguish between direct and indirect impacts.

Table 3.11-9: Demographic Data (Rhode Island), 2019

Jurisdiction	Population (2019)	Population Density (persons per square mile)[a]	Per Capita Income (2019)	Total Employed (2019)	Unemployment Rate (2019)
Rhode Island	1,057,231	870.9	$36,121	262,281	5.4%
Providence County	635,737	1,552.5	$31,522	154,655	5.9%
Washington County	126,060	382.9	$42,869	31,854	6.1%

Source: U.S. Census Bureau 2020a

[a] Population density is based on the 2019 population estimates divided by the square miles of each county (World Media Group 2022).

Table 3.11-10: Demographic Trends (Rhode Island), 2000–2019

Jurisdiction	Population				2019 Population by Age			
	2000	2010	2019	Change 2000-2019	Under Age 18 (%)	Age 18-64 (%)	Age 65 or Older (%)	Median Age
Rhode Island	1,048,319	1,052,567	1,057,231	1.1%	19.3%	63.0%	17.7%	39.9
Providence County	621,602	626,667	635,737	2.8%	20.5%	63.9%	15.6%	37.4
Washington County	123,546	126,242	126,060	1.6%	16.8%	42.9%	19.9%	44.6

Source: U.S. Census Bureau 2020b

Rhode Island has just under 17,500 seasonal vacant units, 63 percent of which are located in Washington County (Table 3.11-11). More than 17 percent of the homes in Washington County are seasonally occupied, and the median home value and rent in Washington County are substantially higher than both Providence County and the state as a whole.

Table 3.11-11: Housing Data (Rhode Island), 2019

Jurisdiction	Housing Units	Seasonal Vacant Units	Vacant Units (Non-Seasonal)	Percent Non-Seasonal Vacancy	Median Value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
Rhode Island	468,335	17,478	40,368	8.6%	$ 261,900	$ 1,004
Providence County	266,330	1,174	27,185	10.2%	$ 233,500	$ 967
Washington County	64,016	11,074	3,840	6.0%	$ 343,000	$ 1,133

Source: U.S. Census Bureau 2020a

A majority of residents in Washington County, Providence County, and the state of Rhode Island are employed in the educational services, and health care and social assistance industries (Tables 3.11-12 and 3.11-13). Approximately 12.7 percent of residents in Washington County are employed in the arts, entertainment, and recreation, and accommodation and food services industries, higher than the 9.8 percent employed in Providence County and 10.3 percent employed in Rhode Island as a whole.

Table 3.11-12: Employment of Residents, By Industry (Rhode Island), 2019

Industry	Rhode Island Total	Providence County	Washington County
Agriculture, forestry, fishing, and hunting	2,397	965	669
Construction	29,358	16,199	3,949
Manufacturing	57,803	36,160	6,825
Wholesale trade	12,688	7,558	1,404
Retail trade	62,821	39,595	6,988
Transportation, warehousing, and utilities	21,433	13,040	1,951
Information	8,360	5,030	939
Finance, and insurance, real estate	36,509	20,992	3,815
Professional, scientific, and management, and administrative and waste management services	54,829	31,518	6,741
Educational services, and health care and social assistance	146,688	85,795	18,155
Arts, entertainment, and recreation, and accommodation and food services	55,466	30,923	8,242
Other services, except public administration	24,034	14,625	2,791
Public administration	21,492	11,600	2,526
Total	**533,878**	**314,000**	**64,995**

Source: U.S. Census Bureau 2020a

Table 3.11-13: At-Place Employment, By Industry (Rhode Island), 2019

Industry	Rhode Island Total	Providence County	Washington County
Agriculture, forestry, fishing and hunting	173	22	67
Mining, quarrying, and oil and gas extraction	148	97	44
Utilities	1,292	1,101	95
Construction	19,904	12,262	1,939
Manufacturing	39,469	22,087	8,587
Wholesale trade	20,075	12,020	2,813
Retail trade	47,840	24,644	6,521
Transportation and warehousing	12,129	6,466	614
Information	6,625	4,085	288
Finance and insurance	31,771	23,874	956
Real estate and rental and leasing	5,386	3,153	368
Professional, scientific, and technical services	23,070	12,959	1,670
Management of companies and enterprises	14,557	11,783	953
Administrative and support and waste management and remediation services	24,879	15,638	1,212
Educational services	30,312	24,072	557
Health care and social assistance	87,067	58,097	7,359
Arts, entertainment, and recreation	9,150	5,374	1,396
Accommodation and food services	52,985	29,373	5,963
Other services (except public administration)	18,073	10,926	1,855
Industries not classified	43	15	3
Total	**444,948**	**278,048**	**43,260**

Source: U.S. Census Bureau 2020a

In 2018, Ocean Economy activities accounted for 18 percent of Washington County's total GDP (Table 3.11-14). Washington County has a diverse Ocean Economy; recreation and tourism accounted for 18 percent of the county's total Ocean Economy value and 51 percent of Ocean Economy employment, while the living resources sector accounted for 1 percent of the Ocean Economy value and 6 percent of employment (Table 3.11-15).

Statewide, Rhode Island's primary sectors in the total Ocean Economy value of $3.2 billion in 2018 were recreation and tourism (58.2 percent), marine transportation (10.2 percent), and living resources (3.4 percent). A 2018 study estimated that the commercial seafood industry statewide generated 3,147 jobs and $538 million in sales in 2016, with commercial fishing providing the highest number of firms and employees (Sproul and Michaud 2018). Self-employed workers and company employees employed in the living resources sector are shown in Table 3.11-16.

Table 3.11-14: Ocean Economy Data for Geographic Analysis Area Counties (Rhode Island), 2018

Jurisdiction	Ocean Economy GDP,[a] All Ocean Sectors	Ocean Economy GDP, Recreation and Tourism Sector[b]	Ocean Economy GDP, Living Resources Sector[b]	Total County GDP (Coastal Economy, Employment Data) Total, All Industries[c]	Ocean Economy GDP, as Percent of Total County GDP (%)[d]
Providence County	816,912,000	707,538,000	9,696,000	38,331,959,740	2%
Washington County	1,235,079,000	329,308,000	38,905,000	6,317,811,368	18%

Source: NOAA 2019c, 2019d

GDP = gross domestic product (U.S. dollars)
[a] GDP calculated as Ocean Economy Employment Data GDP plus Self-Employed Workers Gross Receipts
[b] Search Parameters: Ocean Economy (Employment Data); Ocean Economy Geographies (NOAA 2019c); Ocean Economy (Self-Employed); Ocean Economy Geographies (NOAA 2019d)
[c] Search Parameters: Coastal Economy (Employment Data); Coastal Shoreline Counties; Total, all industries (NOAA 2019e)
[d] Total GDP by county retrieved from U.S. Bureau Economic Analysis data (U.S. BEA 2020).

Table 3.11-15: Ocean Economy Employment[a] for Geographic Analysis Area Counties by Industry (Rhode Island), 2018

Jurisdiction	Marine Construction	Living Resources[b]	Offshore Mineral Extraction	Ship and Boat Building	Recreation and Tourism	Marine Transportation	Total, all Sectors[c]
Providence County	41	188	6	4	14,950	1,014	16,541
Washington County	68	757	0	3	6,104	45	11,896

Source: NOAA 2019c, 2019d

[a] For sectors showing no employment, data for certain businesses may have been suppressed because the number of businesses was too small to report based on privacy. This also results in total employment exceeding the sum of the sectors.
[b] Total employment calculated as All Ocean Sectors Employment (NOAA 2019c) plus All Ocean Sectors Self-Employed Workers (NOAA 2019d).
[c] "Living resources" includes fishing, aquaculture, seafood processing, and seafood markets.

Table 3.11-16: Employment and Wages for Ocean Economy Living Resource Industries (Rhode Island), 2018

	Ocean Economy Living Resources Sector				All Industry Sectors	
	Company Employees		Self-Employed Workers		All Workers	
County	**Total Number**	**Average Wage[a]**	**Total Number**	**Average Gross Receipts[b]**	**Total Employment**	**Average Wage**
Providence	85	$30,753	103	$30,738	287,533	$55,649
Washington	267	$70,644	490	$79,398	53,170	$49,601
Total/Average	**352**	**$50,699**	**593**	**$55,068**	**340,703**	**$52,625**

Sources: NOAA 2022c, 2022d, 2022e

[a] Average wage is calculated as total wages divided by total number of employees.
[b] Average gross receipts are calculated as total gross receipts divided by number of self-employed workers.

The applicant is considering using the Port of Providence (ProvPort) and the South Quay Terminal (in the Providence area) in Providence County and the Port of Davisville in Washington County to support proposed Project construction (COP Volume III, Section 7.7; Epsilon 2023). ProvPort is a privately owned marine terminal that has generated approximately $164 million in economic output for Providence and $211 million for the state of Rhode Island since 1994 (COP Volume III, Section 7.1.1; Epsilon 2023). In 2018, Ocean Economy activities accounted for 2 percent of Providence County's GDP (Table 3.11-14), about 87 percent of which was associated with recreation and tourism (NOAA 2019c).

The Port of Davisville in Washington County accounts for over 1,500 direct and indirect jobs (COP Volume I, Section 7.1; Epsilon 2023). Washington County also contains Point Judith, a center of the Rhode Island fishing industry. Washington County is also home to the first offshore wind farm in the United States, which has become a source of income for the Washington County tourism industry.

NMFS classifies fishing communities in Bristol County, Rhode Island, as having very low commercial and recreational engagement and reliance. Newport County is classified as having low commercial and recreational fishing reliance and medium to low commercial and recreational engagement. Providence County is classified as having low commercial fishing engagement and reliance. The communities of North Kingstown and Narragansett/Point Judith were identified as having medium commercial fishing engagement and low reliance. Other communities in Providence and Washington counties are identified as having medium to low ratings in both categories (NMFS 2019).

3.11.1.4 Fairfield and New London Counties, Connecticut

Fairfield and New London counties are located along Long Island Sound in southern Connecticut. Fairfield County sits in southwestern Connecticut and shares a border with New York and is close to New York City. New London County is located in southeastern Connecticut and shares its eastern border with Rhode Island. Table 3.11-17 shows additional demographic data for Connecticut and Fairfield and New London counties. Fairfield County's population density is almost two times the population density of Connecticut as a whole and has a higher per capita income than both the state and New London County. The populations of Fairfield County, New London County, and the State of Connecticut increased overall from 2000 to 2019 (Table 3.11-18). Fairfield County experienced the highest growth (7 percent) and now contains over 26 percent of Connecticut's population.

Table 3.11-17: Demographic Data (Connecticut), 2019

Jurisdiction	Population (2019)	Population Density (persons per square mile)[a]	Per Capita Income (2019)	Total Employed (2019)	Unemployment Rate (2019)
Connecticut	3,565,287	648	$36,775	1,765,549	7.6%
Fairfield County	943,332	1,116	$48,295	439,341	7.6%
New London County	265,206	355	$32,888	134,193	6.2%

Source: U.S. Census Bureau 2020a

[a] Population density is based on the 2019 population estimates divided by the square miles of each county (World Media Group 2022).

Table 3.11-18: Demographic Trends (Connecticut), 2000–2019

Jurisdiction	Population				2019 Population by Age			
	2000	2010	2019	Change 2000-2019	Under Age 18 (%)	Age 18-64 (%)	Age 65 or Older (%)	Median Age
Connecticut	3,405,565	3,577,073	3,565,287	5%	20.4%	62%	17.6%	41.2
Fairfield County	882,567	918,714	943,332	7%	22.2%	61%	16.3%	40.6
New London County	259,088	274,055	265,206	2%	19.2%	62%	18.8%	41.9

Source: U.S. Census Bureau 2020b

New London County has a higher percentage of non-seasonal vacant units (8.6 percent) than Fairfield County (7.2 percent) and Connecticut as a whole (7.7 percent) (Table 3.11-19).

Table 3.11-19: Housing Data (Connecticut), 2019

Jurisdiction	Housing Units	Seasonal Vacant Units	Vacant Units (Non-Seasonal)	Percent Non-Seasonal Vacancy	Median Value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
Connecticut	1,516,629	29,521	116,362	7.7%	$275,400	1,180
Fairfield County	372,565	5,484	26,892	7.2%	$428,500	1,499
New London County	123,426	5,033	10,566	8.6%	$241,700	1,130

Source: U.S. Census Bureau 2020a

Educational services and the health care and social assistance industry employ the largest number of residents of Connecticut, as well as Fairfield and New London counties (Table 3.11-20). More than 12 percent of jobs in Fairfield County are in health care and social assistance, while more than 18 percent of New London County jobs are in manufacturing (Table 3.11-21).

Table 3.11-20: Employment of Residents, By Industry (Connecticut), 2019

Industry	Connecticut Total	Fairfield County	New London County
Agriculture, forestry, fishing, and hunting	7,173	1,411	822
Construction	110,308	30,948	7,739
Manufacturing	188,968	37,712	18,304
Wholesale trade	42,782	12,002	2,187
Retail trade	190,314	48,246	13,844
Transportation, warehousing, and utilities	78,107	17,655	5,268
Information	36,880	12,085	1,774
Finance, and insurance, real estate	163,661	57,138	5,913
Professional, scientific, and management, and administrative and waste management services	211,665	75,860	11,865
Educational services, and health care and social assistance	478,318	109,514	32,885
Arts, entertainment, and recreation; accommodation and food services	149,684	38,675	18,868
Other services, except public administration	82,940	23,340	5,738
Public administration	66,725	12,171	6,865
Total	**1,807,525**	**476,757**	**132,072**

Source: U.S. Census Bureau 2020a

Table 3.11-21: At-Place Employment, By Industry (Connecticut), 2019

Industry	Connecticut Total	Fairfield County	New London County
Agriculture, forestry, fishing and hunting	4,202	642	496
Mining, quarrying, and oil and gas extraction	1,533	265	154
Utilities	9,615	1,808	1,603
Construction	88,885	26,516	5,962
Manufacturing	159,421	30,628	16,387
Wholesale trade	35,509	11,448	1,114
Retail trade	101,930	25,936	8,595
Transportation and warehousing	47,599	11,999	1,705
Information	24,310	8,375	765
Finance and insurance	111,809	41,351	3,185
Real estate and rental and leasing	22,549	6,917	1,458
Professional, scientific, and technical services	106,357	38,306	6,335
Management of companies and enterprises	2,375	1,072	105
Administrative and support and waste management and remediation services	41,783	15,544	1,760
Educational services	120,811	24,546	8,145
Health care and social assistance	186,794	40,906	12,786
Arts, entertainment, and recreation	27,871	6,883	7,738
Accommodation and food services	45,886	13,260	3,703
Other services (except public administration)	46,896	12,986	3,571
Public administration	54,495	10,043	4,540
Total	**1,240,630**	**329,431**	**90,107**

Source: U.S. Census Bureau 2020a

The Ocean Economy provides over 17,000 jobs in Fairfield County and $1 billion of the county's overall GDP (Table 3.11-22). New London County has a lower population and overall GDP than Fairfield County; however, New London County's Ocean Economy GDP is twice that of Fairfield County (Table 3.11-22). Approximately 14 percent of New London County's overall GDP comes from the Ocean Economy. More than 20,000 individuals are employed in New London County's Ocean Economy sector (Table 3.11-23). More than 12,000 of these jobs, largely in the marine transportation subsector are suppressed (i.e., not reported) by NOAA for confidentiality purposes (NOAA 2019c), indicating a large number of small employers. Fairfield County's largest employment sector is tourism and recreation, accounting for over 17,000 jobs. Self-employed workers and company employees employed in the living resources sector are shown in Table 3.11-24.

Table 3.11-22: Ocean Economy Data for Geographic Analysis Area Counties (Connecticut), 2018

Jurisdiction	Ocean Economy GDP,[a] All Ocean Sectors	Ocean Economy GDP, Recreation and Tourism Sector[b]	Ocean Economy GDP, Living Resources Sector[b]	Total County GDP (Coastal Economy, Employment Data) Total, All Industries[c]	Ocean Economy GDP, as Percent of Total County GDP (%)[d]
Fairfield County	1,157,101,000	17,390	126	92,932,974,479	1%
New London County	2,409,839,000	7,397	39	17,635,622,267	14%

Source: NOAA 2019c, 2019d

GDP = gross domestic product (U.S. dollars)
[a] GDP calculated as Ocean Economy Employment Data GDP plus Self-Employed Workers Gross Receipts
[b] Search Parameters: Ocean Economy (Employment Data); Ocean Economy Geographies (NOAA 2019c); Ocean Economy (Self-Employed); Ocean Economy Geographies (NOAA 2019d)
[c] Search Parameters: Coastal Economy (Employment Data); Coastal Shoreline Counties; Total, all industries (NOAA 2019e)
[d] Total GDP by county retrieved from U.S. Bureau Economic Analysis data (U.S. BEA 2020).

Table 3.11-23: Ocean Economy Employment[a] for Geographic Analysis Area Counties by Industry (Connecticut), 2018

Jurisdiction	Marine Construction	Living Resources[b]	Offshore Mineral Extraction	Ship and Boat Building	Recreation and Tourism	Marine Transportation	Total, all Sectors[c]
Fairfield County	113	126	ND	17	17,390	481	18,489
New London County	29	39	71	323	7,397	ND	20,431

Source: NOAA 2019c, 2019d

[a] For sectors showing no employment, data for certain businesses may have been suppressed because the number of businesses was too small to report based on privacy. This also results in total employment exceeding the sum of the sectors.
[b] "Living resources" includes fishing, aquaculture, seafood processing, and seafood markets.
[c] Total employment calculated as All Ocean Sectors Employment (NOAA 2019c) plus All Ocean Sectors Self-Employed Workers (NOAA 2019d).

Table 3.11-24: Employment and Wages for Ocean Economy Living Resource Industries (Connecticut), 2018

	Ocean Economy Living Resources Sector				All Industry Sectors	
	Company Employees		Self-Employed Workers		All Workers	
County	Total Number	Average Wage[a]	Total Number	Average Gross Receipts[b]	Total Employment	Average Wage
Fairfield	126	$44,746	68	$37,912	420,677	$86,216
New London	39	$29,153	118	$75,475	123,881	$55,559
Total/Average	**165**	**$36,950**	**186**	**$56,694**	**544,558**	**$70,888**

Sources: NOAA 2022c, 2022d, 2022e

[a] Average wage is calculated as total wages divided by total number of employees.
[b] Average gross receipts are calculated as total gross receipts divided by number of self-employed workers.

The applicant may use the Port of Bridgeport in Fairfield County and the New London State Pier in New London County to support proposed Project construction (COP Volume III, Section 7.7; Epsilon 2023). The Port of Bridgeport is a deepwater port with industrial, commercial, and recreational uses. The applicant would use Bridgeport as an operations facility for the proposed Project (COP Appendix III-I; Epsilon 2023). The New London State Pier is a deepwater port scheduled for redevelopment by the Connecticut Port Authority, Eversource, and Ørsted for the use of the Atlantic offshore wind industry as a whole (COP Volume III, Section 7.1; Epsilon 2023).

3.11.1.5 New York

Kings and Richmond Counties, New York

Kings County (i.e., Brooklyn) and Richmond County (i.e., Staten Island) are two of New York City's five boroughs. Richmond and Kings counties are more densely populated than New York State as a whole (Table 3.11-25). Overall, the population for the State of New York and Kings and Richmond counties are growing (Table 3.11-26).

Table 3.11-25: Demographic Data (New York), 2020

Jurisdiction	Population (2020)	Population Density (persons per square mile)[a]	Per Capita Income (2020)	Total Employed (2020)	Unemployment Rate (2019)
New York	20,201,249	428	39,326	8,597,216	7.5%
Albany County	314,848	603	37,635	183,540	6.0%
Kings County	2,736,074	39,086	34,173	677,323	8.4%
Rensselaer County	161,130	247	35,903	45,372	7.3%
Richmond County	495,747	8,547	36,907	109,566	6.2%
Suffolk County	1,525,920	1,673	44,465	594,392	5.8%

Source: U.S. Census Bureau 2020a

[a] Population density is based on the 2020 population estimates divided by the square miles of each county (World Media Group 2022).

Table 3.11-26: Demographic Trends (New York), 2000–2019

Jurisdiction	Population				2019 Population by Age			
	2000	2010	2019	Change 2000–2019	Under Age 18 (%)	Age 18–64 (%)	Age 65 or Older (%)	Median Age
New York	18,976,457	19,392,283	19,453,561	3%	20.7%	62%	16.9%	39.2
Albany County	294,565	303,833	305,506	4%	18.3%	64%	17.5%	38.0
Kings County	2,465,326	2,508,340	2,559,903	4%	22.7%	63%	14.4%	35.6
Rensselaer County	152,538	159,428	158,714	4%	19.3%	63%	17.8%	39.7
Richmond County	443,728	469,363	476,143	7%	21.8%	62%	16.7%	40.0
Suffolk County	1,419,369	1,494,434	1,476,601	4%	20.9%	62%	17.3%	41.8

Source: U.S. Census Bureau 2020b

Kings County has over 1 million housing units; of these, 9,703 are seasonal (Table 3.11-27). The median home value in Kings County is twice the New York State average, and the median monthly rent price in both Richmond and Kings County is higher than the New York state average (Table 3.11-27).

Table 3.11-27: Housing Data (New York), 2019

Jurisdiction	Housing Units	Seasonal Vacant Units	Vacant Units (Non-Seasonal)	Percent Non-Seasonal Vacancy	Median Value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
New York	8,322,722	348,027	631,461	7.6%	$313,700	$1,280
Albany County	141,553	1,896	13,117	9.3%	$222,500	$1,022
Kings County	1,044,493	9,703	76,223	7.3%	$706,000	$1,426
Rensselaer County	73,011	1,459	6,646	9.1%	$188,700	$973
Richmond County	180,325	932	13,147	7.3%	$504,800	$1,319
Suffolk County	575,960	53,765	32,894	5.7%	$397,400	$1,742

Source: U.S. Census Bureau 2020a

Over 2 million New York state residents are employed in the educational services, as well as health care and social assistance industry (Table 3.11-28). There are more than 640,000 jobs in New York in professional, scientific, and technical roles statewide, of which 12,761 are in Richmond County and more than 103,000 are in Kings County (Table 3.11-29). More than 17 percent of jobs in Richmond County and more than 14 percent of Kings County jobs are in health care and social assistance.

Table 3.11-28: Employment of Residents, By Industry (New York), 2019

Industry	Total	Albany County	Kings County	Rensselaer County	Richmond County	Suffolk County
Agriculture, forestry, fishing, and hunting	54,877	673	1,159	585	80	2,568
Construction	533,243	6,957	62,823	5,287	15,075	57,640
Manufacturing	654,700	8,075	50,949	5,921	6,394	57,424
Wholesale trade	254,079	3,231	28,328	2,069	4,504	27,026
Retail trade	955,413	15,768	100,751	8,892	19,976	84,979
Transportation, warehousing, and utilities	479,165	6,557	71,684	3,502	14,903	41,407
Information	282,991	3,723	43,651	1,951	5,416	22,671
Finance, and insurance, real estate	775,195	12,335	90,061	5,144	25,398	55,871
Professional, scientific, and management; administrative and waste management services	980,577	14,546	129,028	7,204	21,354	80,772
Educational services, and health care and social assistance	2,409,408	43,265	303,204	21,314	56,139	182,393
Arts, entertainment, and recreation, and accommodation and food services	766,879	12,025	96,274	6,092	12,773	47,483
Other services, except public administration	453,649	6,676	59,783	3,453	9,437	30,158
Public administration	445,823	20,988	48,465	9,184	16,437	37,932
Total	**9,045,999**	**154,819**	**1,086,160**	**80,598**	**207,886**	**728,324**

Source: U.S. Census Bureau 2020a

Table 3.11-29: At-Place Employment, By Industry (New York), 2019

Industry	Total	Albany County	Kings County	Rensselaer County	Richmond County	Suffolk County
Agriculture, forestry, fishing and hunting	36,602	445	517	561	462	1,211
Mining, quarrying, and oil and gas extraction	5,482	0	264	0	268	41
Utilities	54,205	719	4,408	748	1,234	4,250
Construction	448,497	5,682	53,539	5,274	14,335	49,865
Manufacturing	475,098	7,159	25,838	6,175	5,610	43,848
Wholesale trade	183,725	2,335	20,845	1,115	3,465	21,162
Retail trade	538,982	5,435	74,649	3,801	10,896	46,894
Transportation and warehousing	374,835	3,160	65,569	1,632	11,360	30,171
Information	214,207	1,557	48,589	843	3,729	12,778
Finance and insurance	475,900	7,731	46,474	3,160	13,896	36,690
Real estate and rental and leasing	163,744	2,296	26,371	755	5,101	9,222
Professional, scientific, and technical services	641,693	11,897	103,321	4,518	12,761	45,501
Management of companies and enterprises	12,046	283	1,442	0	50	513
Administrative and support and waste management and remediation services	240,333	2,983	32,108	1,502	7,474	19,761
Educational services	698,544	9,645	84,487	6,672	20,763	62,264
Health care and social assistance	1,177,346	17,109	169,005	9,490	30,224	91,817
Arts, entertainment, and recreation	134,657	1,439	22,246	358	1,626	8,664
Accommodation and food services	351,526	4,429	51,017	1,291	7,278	19,574
Other services (except public administration)	274,403	4,280	38,212	1,921	4,261	21,285
Industries not classified	393,021	17,898	40,202	6,725	15,594	33,516
Total	**6,894,846**	**106,482**	**909,103**	**56,541**	**170,387**	**559,027**

Source: U.S. Census Bureau 2020a

The applicant is considering using up to four ports in the greater New York City area for proposed Project construction. These include the South Brooklyn Marine Terminal and GMD Shipyard in Kings County, and the Arthur Kill and Homeport Pier ports in Richmond County (COP Volume III, Section 7.7; Epsilon 2023).

Rensselaer and Albany Counties, New York

Rensselaer and Albany counties are in upstate New York along the Hudson River. Residents of Albany and Rensselaer counties are involved in various industries including government, education, healthcare, and technology (U.S. Census Bureau 2020a). Both counties rely minimally on the Ocean Economy, and data are limited, although the Ocean Economy in Albany County provides 594 jobs (Table 3.11-30).

The applicant is considering using three upstate New York ports during proposed Project construction staging in upstate New York: the Port of Coeymans and the Port of Albany in Albany County, and the New York Offshore Wind Port in Rensselaer County (COP Volume III, Section 7.7; Epsilon 2023). The Port of Coeymans is 100 miles north of New York City and employs approximately 200 people (Carver Companies 2022). The Port of Albany is approximately 120 miles north of New York City and employs a crew of nine individuals (Port of Albany 2019). The Port of Albany recently acquired 80 acres of additional land, with plans to expand operations for offshore wind capabilities. The New York State Offshore Wind Port is approximately 110 miles from New York City and 9 miles north of Coeymans.

Suffolk County, New York

Suffolk County encompasses the central and eastern portion of Long Island. Educational services, and health care and social assistance industry employ the largest number of Suffolk County residents. The county also has a large number of seasonal vacant units, reflecting the importance of the recreation and tourism industry for Long Island (Table 3.11-27).

Over 43,000 residents in Suffolk County rely on occupations in the Ocean Economy, accounting for $3 billion of the county’s overall GDP (NOAA 2022f). Approximately 36,385 individuals in the Ocean Economy workforce are employed in the marine recreation and tourism sector (87.9 percent of the overall workforce), with an additional 3,746 employed in the marine transportation sector (Tables 3.11-30 and 3.11-31). Self-employed workers and company employees employed in the living resources sector are shown in Table 3.11-32.

Table 3.11-30: Ocean Economy Employment for Geographic Analysis Area Counties by Industry (New York), 2018[a]

Jurisdiction	Marine Construction	Living Resources[b]	Offshore Mineral Extraction	Ship and Boat Building	Recreation and Tourism	Marine Transportation	Total, all Sectors[c]
Albany County	ND	ND	ND	ND	0	594	594
Kings County	ND	1,412	ND	ND	33,228	1,517	36,157
Rensselaer County	ND	ND	ND	ND	ND	ND	ND
Richmond County	166	72	ND	ND	8,359	283	8,880
Suffolk County	563	614	23	69	36,385	3,746	41,400

Source: NOAA 2019c, 2019d

ND = no data
[a] For sectors showing no employment, data for certain businesses may have been suppressed because the number of businesses was too small to report based on privacy. This also results in total employment exceeding the sum of the sectors.
[b] Total employment calculated as All Ocean Sectors Employment (NOAA 2019c) plus All Ocean Sectors Self-Employed Workers (NOAA 2019d).
[c] "Living resources" includes fishing, aquaculture, seafood processing, and seafood markets.

Table 3.11-31: Ocean Economy Data for Geographic Analysis Area Counties (New York), 2018

Jurisdiction	Ocean Economy GDP,[a] All Ocean Sectors	Ocean Economy GDP, Recreation and Tourism Sector[b]	Ocean Economy GDP, Living Resources Sector [b]	Total County GDP (Coastal Economy, Employment Data) Total, All Industries[c]	Ocean Economy GDP, as Percent of Total County GDP (%)[d]
Albany County	32,689,000	32,689,000	ND	ND	NA
Kings County	2,052,466,000	1,802,669,000	167,428,000	95,011,253,174	2%
Rensselaer County	ND	ND	ND	ND	NA
Richmond County	461,652,000	380,762,000	9,878,000	16,437,421,205	3%
Suffolk County	2,611,517,000	1,916,676,000	54,149,000	101,317,008,894	3%

Source: NOAA 2019c, 2019d

GDP = gross domestic product (U.S. dollars); NA = not applicable; ND = No data
[a] GDP calculated as Ocean Economy Employment Data GDP plus Self-Employed Workers Gross Receipts
[b] Search Parameters: Ocean Economy (Employment Data); Ocean Economy Geographies (NOAA 2019c); Ocean Economy (Self-Employed); Ocean Economy Geographies (NOAA 2019d)
[c] Search Parameters: Coastal Economy (Employment Data); Coastal Shoreline Counties; Total, all industries (NOAA 2019e)
[d] Total GDP by county retrieved from U.S. Bureau Economic Analysis data (U.S. BEA 2020).

Table 3.11-32: Employment and Wages for Ocean Economy Living Resource Industries (New York), 2018

County	Ocean Economy Living Resources Sector				All Industry Sectors	
	Company Employees		Self-Employed Workers		All Workers	
	Total Number	Average Wage[a]	Total Number	Average Gross Receipts[b]	Total Employment	Average Wage
Albany	ND	ND	19	$55790	223,634	$58,297
Kings	1,412	$43,645	89	$66,921	767261	$48,817
Rensselaer	ND	ND	ND	ND	53759	$51,568
Richmond	72	$54,681	27	$54,704	122908	$52,722
Suffolk	614	$37,340	693	$42,856	661066	$60,419
Total/Average	**2,098**	**$27,133**	**828**	**$44,054**	**1,828,628**	**$54,365**

Sources: NOAA 2022c, 2022d, 2022e

ND = no data
[a] Average wage is calculated as total wages divided by total number of employees.
[b] Average gross receipts are calculated as total gross receipts divided by number of self-employed workers.

The applicant is considering the East Shoreham site in Suffolk County to support proposed Project construction (COP Volume III, Section 7.7; Epsilon 2023) and may use Greenpoint Harbor for operations (COP Appendix III-I; Epsilon 2023). The East Shoreham facility may be used for both port usage and construction staging, and the Greenport Harbor facility would likely only be used for operations activities.

3.11.1.6 Gloucester County, New Jersey

Gloucester County is located in southwestern New Jersey, immediately south of and adjacent to Philadelphia. The county's western border is the Delaware River. Gloucester County's population density and per capita income are lower than the New Jersey State average (Tables 3.11-33 and 3.11-34). The population of Gloucester County has grown substantially since 2000.

Table 3.11-33: Demographic Data (New Jersey), 2019

Jurisdiction	Population (2019)	Population Density (persons per mi^2)[a]	Per Capita Income (2019)	Total Employed (2019)	Unemployment Rate (2019)
New Jersey	8,882,190	1,017	$34,858	4,230,560	7.8%
Gloucester County	291,636	859	$31,210	142,108	8.2%

Source: U.S. Census Bureau 2020a

[a] Population density is based on the 2019 population estimates divided by the square miles of each county (World Media Group 2022)

Table 3.11-34: Demographic Trends (New Jersey), 2000–2019

Jurisdiction	Population				2019 Population by Age			
	2000	2010	2019	Change 2000-2019	Under Age 18 (%)	Age 18–64 (%)	Age 65 or Older (%)	Median Age
New Jersey	8,414,350	8,801,624	8,882,190	6%	21.8%	62%	16.6%	40.2
Gloucester County	254,673	288,581	291,636	15%	21.6%	62%	16.2%	40.7

Source: U.S. Census Bureau 2020b

Gloucester County's median home value is substantially less than the New Jersey State average, although rents are more comparable (Table 3.11-35). The seasonal vacancy percentage in Gloucester County is substantially lower than the New Jersey average.

Table 3.11-35: Housing Data (New Jersey), 2019

Jurisdiction	Housing Units	Seasonal Vacant Units	Vacant Units (Non-Seasonal)	Percent Non-Seasonal Vacancy	Median Value (Owner-Occupied)	Median Monthly Rent (Renter-Occupied)
New Jersey	3,616,614	135,990	248,750	6.9%	$335,600	$1,334
Gloucester County	113,485	320	8,257	7.3%	$219,700	$1,225

Source: U.S. Census Bureau 2020a

Approximately 16 percent of Gloucester County's overall workforce is employed in the construction and manufacturing industries (Table 3.11-36), while more than half of Gloucester County jobs are in administrative and support and waste management and remediation services industry establishments (Table 3.11-37).

Table 3.11-36: Employment of Residents, By Industry (New Jersey), 2019

Industry	New Jersey Total	Gloucester County
Agriculture, forestry, fishing, and hunting	14,702	742
Construction	259,043	9,406
Manufacturing	396,329	13,438
Wholesale trade	160,966	5,808
Retail trade	469,625	18,443
Transportation, warehousing, and utilities	242,906	8,991
Information	134,690	3,045
Finance, and insurance, real estate	385,143	10,595
Professional, scientific, and management; administrative and waste management services	517,257	14,292
Educational services, and health care and social assistance	942,587	35,174
Arts, entertainment, and recreation, and accommodation and food services	325,783	10,106
Other services, except public administration	186,453	5,533
Public administration	195,076	6,535
Total	**4,230,560**	**142,108**

Source: U.S. Census Bureau 2020a

Table 3.11-37: At-Place Employment, By Industry (New Jersey), 2019

Industry	New Jersey Total	Gloucester County
Agriculture, forestry, fishing and hunting	10,897	268
Mining, quarrying, and oil and gas extraction	1,485	14
Utilities	31,014	2,193
Construction	219,414	8,780
Manufacturing	318,127	10,437
Wholesale trade	122,129	4,988
Retail trade	283,845	9,879
Transportation and warehousing	205,317	7,406
Information	85,434	2,338
Finance and insurance	265,605	6,336
Real estate and rental and leasing	61,867	1,383
Professional, scientific, and technical services	342,095	10,604
Management of companies and enterprises	7,203	166
Administrative and support and waste management and remediation services	131,262	2,608
Educational services	277,410	12,045
Health care and social assistance	446,028	17,193
Arts, entertainment, and recreation	50,689	1,727
Accommodation and food services	136,260	4,324
Other services (except public administration)	120,843	3,054
Public administration	165,967	4,944
Total	**5,940,389**	**202,159**

Source: U.S. Census Bureau 2020a

Nearly all of Gloucester County's Ocean Economy GDP is from the recreation and tourism industry (Table 3.11-38). The Ocean Economy accounts for approximately 5,500 jobs in the county, with 61 percent of those positions in the marine transportation sector (Table 3.11-39). Self-employed workers and company employees employed in the living resources sector are shown in Table 3.11-40.

Table 3.11-38: Ocean Economy Data for Geographic Analysis Area Counties (New Jersey), 2018

Jurisdiction	Ocean Economy GDP,[a] All Ocean Sectors	Ocean Economy GDP, Recreation and Tourism Sector[b]	Ocean Economy GDP, Living Resources Sector[b]	Total County GDP (Coastal Economy, Employment Data) Total, All Industries[c]	Ocean Economy GDP, as Percent of Total County GDP (%)[d]
Gloucester County	275,105,000	52,348,000	ND	416,820,000	2%

Source: NOAA 2019c, 2019d

GDP = gross domestic product (U.S. dollars); ND = no data
[a] GDP calculated as Ocean Economy Employment Data GDP plus Self-Employed Workers Gross Receipts
[b] Search Parameters: Ocean Economy (Employment Data); Ocean Economy Geographies (NOAA 2019c); Ocean Economy (Self-Employed); Ocean Economy Geographies (NOAA 2019d)
[c] Search Parameters: Coastal Economy (Employment Data); Coastal Shoreline Counties; Total, all industries (NOAA 2019e)
[d] Total GDP by county retrieved from U.S. Bureau Economic Analysis data (U.S. BEA 2020).

Table 3.11-39: Ocean Economy Employment[a] for Geographic Analysis Area Counties by Industry (New Jersey), 2018

Jurisdiction	Marine Construction	Living Resources[b]	Offshore Mineral Extraction	Ship and Boat Building	Recreation and Tourism	Marine Transportation	Total, all Sectors[c]
Gloucester County	283	15	ND	ND	1,528	3,439	5,579

Source: NOAA 2019c, 2019d

ND = no data
[a] For sectors showing no employment, data for certain businesses may have been suppressed because the number of businesses was too small to report based on privacy. This also results in total employment exceeding the sum of the sectors.
[b] Total employment calculated as All Ocean Sectors Employment (NOAA 2019c) plus All Ocean Sectors Self-Employed Workers (NOAA 2019d).
[c] "Living resources" includes fishing, aquaculture, seafood processing, and seafood markets.

Table 3.11-40: Employment and Wages for Ocean Economy Living Resource Industries (New Jersey), 2018

County	Ocean Economy Living Resources Sector				All Industry Sectors	
	Company Employees		Self-Employed Workers		All Workers	
	Total Number	Average Wage[a]	Total Number	Average Gross Receipts[b]	Total Employment	Average Wage
Gloucester	ND	ND	15	$46,533	110,526	$46,871

Sources: NOAA 2022c, 2022d, 2022e

ND = no data
[a] Average wage is calculated as total wages divided by total number of employees.
[b] Average gross receipts are calculated as total gross receipts divided by number of self-employed workers.

The applicant may use the Port of Paulsboro (Paulsboro Marine Terminal) to support proposed Project construction. The Paulsboro Marine Terminal is part of the South Jersey Port Corporation, which manages and maintains seven ports in New Jersey (South Jersey Port Corporation 2022).

3.11.1.7 Employment and Economic Trends

Offshore wind is becoming a key industry for the Atlantic states and the nation. Several recent reports provide national estimates of employment and economic activity. While offshore wind component manufacture and installation capacity exists primarily outside the United States, domestic capacity is anticipated to increase. This EIS uses available data, analysis, and projections to make reasoned conclusions on potential economic and employment impacts within the geographic analysis area.

During the initial implementation of offshore wind projects along the U.S. northeast coast, a base level of 35 percent of jobs, with a high probability of up to 55 percent of jobs, would likely be sourced from within the United States (BVG 2017). The proportion of jobs filled within the United States would increase as the offshore wind energy industry grows due to growth of a supply chain and supporting industries along the east coast, as well as a growing number of local operations jobs for established wind facilities. By 2030 and continuing through 2056, approximately 65 to 75 percent of jobs associated with offshore wind are projected to be within the United States. Overseas manufacturers of components and specialized ships based overseas that are contracted for installation of foundations and WTGs would fill jobs outside of the United States (BVG 2017). As an example of the mix of local, national, and foreign job creation, for the 5-turbine Block Island Wind Farm, turbine blade manufacturing occurred in Denmark, generator and nacelle manufacturing occurred in France, tower component manufacturing occurred in Spain, and foundation manufacturing occurred in Louisiana (Gould and Cresswell 2017).

American Clean Power (ACP; formerly the American Wind Energy Association) estimated that the offshore wind industry would invest $80 to $106 billion in U.S. offshore wind development by 2030, including $28 to $57 billion invested within the United States, depending on installation levels and supply chain growth (other investment would occur in countries manufacturing or assembling wind energy components for U.S. based projects) (AWEA 2020, 2021). Economic and employment impacts would occur nationwide but be most concentrated in Atlantic coastal states that host offshore wind development. ACP lists over $1.3 billion in announced domestic investments in wind energy manufacturing facilities, ports, and vessel construction in Atlantic states (AWEA 2020). The ACP report analyzes a base scenario and a high scenario for offshore wind direct impacts, turbine and supply chain impacts, and induced impacts. The base scenario assumes 20 GW of offshore wind power by 2030 and domestic content increasing to 30 percent in 2025 and 50 percent in 2030 (AWEA 2021). The high scenario assumes 30 GW of offshore wind power by 2030 and domestic content increasing to 40 percent in 2025 and 60 percent in 2030. ACP estimates offshore wind energy development would support $25 billion in economic output and 83,000 jobs by 2030 (AWEA 2021). These estimates reflect state targets (at the time of publication of the ACP report) of 25,400 MW of offshore wind by 2035, based on commitments from Connecticut, Massachusetts, New Jersey, New York, and Virginia (AWEA 2021).

The ACP estimates are consistent with the University of Delaware (2021) projections, which estimate that deployment of 30 GW of planned and contracted offshore wind energy projects through 2030 would require capital, development, and operational expenditures of $109 billion over the next 10 years (University of Delaware 2021). The study notes that, while the offshore wind supply chain is global and expenditures would be directed to both domestic and foreign sources, a growing number of U.S. suppliers are preparing to enter the industry.

Compared to the $14.2 to $25.4 billion in offshore wind economic output (AWEA 2020), the 2019 annual GDP for states with offshore wind projects (Connecticut, Massachusetts, Rhode Island, New York, New Jersey, Delaware, Maryland, Virginia, and North Carolina) ranged from $63.5 billion in Rhode Island to $1.73 trillion in New York (U.S. BEA 2020) and totaled nearly $5 trillion. The $14.2 to $25.4 billion in offshore wind industry output would represent 0.3 to 0.5 percent of the combined GDP of these states.

The ACP study estimates offshore wind would support 45,500 (base scenario) to 82,500 (high scenario) full-time equivalent (FTE) jobs in 2030 nationwide, including direct, supply chain, and induced jobs. About 60 percent of jobs would be short term (i.e., design and construction) and 40 percent would be long term (i.e., operations). A 2020 study commissioned by the Responsible Offshore Development Alliance estimated that offshore wind projects through 2030 would generate 55,989 to 86,138 job years (an FTE job lasting 1 year) for construction, and 5,003 to 6,994 long-term jobs (an FTE lasting for more than 1 year) for operations (Georgetown Economic Services 2020). The National Renewable Energy Laboratory estimates that installation and operation of 30 GW of offshore wind capacity would require 15,000 to 58,000 direct and indirect FTE jobs (reflecting 25 and 100 percent domestic employment, respectively, in the industry) between 2024 and 2030 (Stefek et al. 2022). These estimates are generally consistent with the ACP study in total jobs supported, although the Georgetown Economic Services study concludes that a greater proportion of jobs would be in the construction stage. As with the ACP estimates of economic output, the Responsible Offshore Development Alliance study assumed that offshore wind energy jobs would be focused in states hosting offshore wind projects but would also be generated in other states where manufacturing and other supply chain activities occur.

Presently, over 500 domestic factories that employ more than 25,000 Americans build wind turbine components (AWEA 2021). U.S. companies have publicized investments of $307 million in port-related infrastructure, $650 million in transmission infrastructure, and $342 million in U.S. manufacturing and supply chain development, which can support the domestic supply chain growth (AWEA 2021).

Some local economic activity has already begun in preparation for the anticipated offshore wind industry. For example, Massachusetts Clean Energy Center has implemented programs to train and certify a diverse set of workers to participate in the offshore wind industry (MassCEC 2022). Massachusetts Clean Energy Center also released a workforce training and development report in 2021 that highlighted several (12) investments to support offshore wind workforce training (MassCEC 2021).

3.11.2 Environmental Consequences

Definitions of potential impact levels for demographics, employment, and economics are provided in Table 3.11-41.

Table 3.11-41: Impact Level Definitions for Demographics, Employment, and Economics

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

3.11.2.1 Impacts of Alternative A – No Action Alternative on Demographics, Employment, and Economics

When analyzing the impacts of Alternative A on demographics, employment, and economics, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for demographics, employment, and economics (Table G.1-8 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for demographics, employment, and economics described in Section 3.11.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on demographics, employment, and economics include regional demographic and economic trends. While the proposed Project would not be built under Alternative A, ongoing activities, future non-offshore wind activities, and future offshore wind activities to continue to sustain and support growth of the geographic analysis area's diverse economy, based on anticipated population growth and ongoing development of businesses and industry. Tourism and recreation would continue to be important to the economies of the coastal areas, especially Barnstable, Nantucket, Washington, and Dukes counties. Marine industries such as commercial fishing and shipping would continue to be active and important components of the regional economy. Counties in the geographic analysis area would continue to seek to diversify their economies, protect environmental resources, and maintain or increase their year-round population.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on demographics, employment, and economics include continued operation of the Block Island Wind Farm, as well as ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Ongoing operation of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 and South Fork Wind Project, along with planned offshore wind activities, would affect demographics, employment, and economics through the primary IPFs described below.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). In addition to the regional economic impact of a growing offshore wind industry, future offshore wind development would affect demographics, employment, and economics through the following IPFs.

Cable emplacement and maintenance: Offshore cable emplacement for future offshore wind would temporarily impact commercial and for-hire fishing businesses based in the geographic analysis area during cable installation and infrequent maintenance. Offshore cable emplacement for offshore wind would result in about 8,347 acres of seafloor disturbance in the RI/MA Lease Areas from 2023 through 2030 (Appendix E). The total area of hard cable protection for Alternative A is estimated to be 584 acres. Fishing vessels may not have access to impacted areas during active construction. The disruption from cable installation may occur concurrently or sequentially, with similar impacts on commercial fishery resources. Disruption may result in conflict over other fishing grounds, increased operating costs for vessels, and lower revenue (e.g., if the substituted fishing area is less productive or supports fewer valuable species). Short-term productivity reductions would also affect seafood processing and wholesaling businesses that depend upon the fishing industry. Although cable routes and lengths for other offshore wind projects are not known at this time, the total seafloor disturbance from offshore cable emplacement is estimated to be 8,347 acres between 2023 and 2030, although only a portion of this total would be affected at any single time. Most affected areas are soft-bottom habitats, and impacts would be short term with the resources recovering naturally.

Assuming projects use installation procedures similar to those proposed for the proposed Project (COP Volume I, Sections 3.3 and 4.3; Epsilon 2023), the duration and extent of impacts would be limited. Commercial and for-hire fishing and the related processing industries represent a small portion of the employment and economic activity in the geographic analysis area. Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing, discusses the economic impact of cable emplacement and maintenance on fishing businesses. These impacts would be localized and short term.

Lighting: Based on COPs submitted to date, BOEM assumes that ADLS would be used for all offshore wind projects in the RI/MA Lease Areas. ADLS only activate aviation warning lighting on WTGs when aircraft enter a predefined airspace. For the proposed Project, this was estimated to occur approximately 13 minutes per year (less than 0.1 percent of annual nighttime hours) (COP Appendix III-H.b; Epsilon 2023). Depending on exact location and layout, the use of ADLS for all WTGs in Alternative A would likely result in similar limits on the frequency of WTG aviation warning lighting use on offshore wind facilities. Implementation of ADLS could, thus, reduce the amount of time that WTG lighting is visible, thereby making WTG lighting visible only sporadically rather than continuously at night. This would reduce the impacts on demographics, employment, and economics associated with lighting.

When illuminated due to a passing aircraft, warning lighting from some or all 963 WTGs constructed in the RI/MA Lease Areas (other than the proposed Project) could theoretically be visible within the geographic analysis area, depending on viewer location, vegetation, topography, and atmospheric conditions. This includes up to 52 (5 percent of all WTGs in the RI/MA Lease Areas) within 15 miles of onshore viewers. Due to the rarity of such events, the variable views from onshore locations, and the relatively short-term nature of each event (i.e., lasting only as long as the aircraft is in range), lighting on WTGs would have an intermittent and short-term impact on demographics, employment, and economics.

Nighttime operations of offshore wind projects would require lighting for vessels in transit and at offshore construction work areas. Concurrent construction of up to six offshore wind projects (not including the proposed Project) could occur in 2025, all potentially contributing to nighttime vessel lights. Vessel lighting would enable commercial shipping and commercial fishing operations to safely navigate around the vessels and work areas and would be visible from coastal locations, primarily while the vessels are in transit. Vessel lighting is not anticipated to affect the volume of business at visitor-oriented businesses or other businesses. Impacts of vessel lighting would be localized, short term, and intermittent.

Noise: Noise from G&G site assessment survey activities, operations, pile driving, trenching, and vessels could result in temporary, impacts on employment and economics via the impacts on marine businesses (e.g., commercial fishing, for-hire recreational fishing, and recreational sightseeing).

Noise (especially site assessment G&G surveys and pile driving) would affect fish populations, with impacts on commercial and for-hire fishing. As discussed in Sections 3.6, Finfish, Invertebrates, and EFH, and Section 3.9, increased noise could temporarily affect the availability of fish within work areas, causing fishing vessels to relocate to other fishing locations in order to continue to earn revenue. This could potentially lead to increased conflict in relocation areas, increased operating costs for vessels, and lower revenue. The severity of such impacts would depend on the overlap of construction activities, where construction activities occur in relation to preferred fishing locations, and how exactly the commercial fishing industry responds to future construction activities.

Population-level impacts on marine mammals would have impacts on employment and economic activity due to impacts on marine sightseeing businesses that benefit from the visible presence of marine mammals in the waters offshore from the geographic analysis area. As stated in Section 3.7, Marine Mammals, noise impacts associated with future offshore wind development could contribute to impacts on individual marine mammals. If construction activities for multiple offshore wind projects occur in close spatial and temporal proximity, population-level impacts are possible; however, as noted in Section 3.7, BMPs can minimize exposure of individual mammals to harmful impacts and avoid population-level impacts.

As noted in Section 3.6, noise from trenching and vessel operation is expected to occur but would have little effect on finfish and invertebrates and, therefore, little effect on commercial or for-hire fishing or recreational businesses. Likewise, offshore wind projects may use aircraft for crew transport during maintenance and/or construction; however, aircraft noise is not likely to affect finfish, invertebrates, EFH, or marine mammals. While noise associated with operational WTGs may be audible to some finfish and invertebrates, this would only occur at relatively short distances from the WTG foundations, and there is no information to suggest that such noise would affect finfish and invertebrates (English et al. 2017).

Offshore wind-related construction noise from pile driving, cable laying and trenching, and vessels are anticipated to affect tour boat and for-hire fishing businesses, making the affected areas temporarily unattractive for the visitor-oriented businesses. Impacts would be localized and temporary.

Overall, offshore wind-generated noise could affect commercial and for-hire fishing and could result in visitor-oriented services avoiding areas of noise and impacts on marine life important for fishing and sightseeing. Both types of impacts would be localized and short term, occurring during surveying and construction, with no noticeable impacts during operations and only periodic, short-term impacts during maintenance. Noise impacts during surveying and construction would be more widespread when multiple offshore wind projects are under construction at the same time in the marine area off the coast of the geographic analysis area. Pile-driving noise could be generated from up to six other offshore wind projects in the RI/MA Lease Areas (in 2025), which could result in greater noise impacts on finfish and invertebrates (Sections 3.6 and 3.9) and marine mammal (Section 3.7) species linked to economic activity. As indicated in Appendix E, Table E-1, the RI/MA Lease Areas could have 963 WTGs and ESPs installed between 2023 and 2030 (excluding the proposed Project).

Onshore construction noise would temporarily inconvenience visitors, workers, and residents, possibly resulting in a short-term reduction of economic activity for businesses near installation sites for onshore cables, substations, or port improvements. Because the location of onshore improvements is not known and cannot be determined until specific projects are proposed, the magnitude of noise associated with onshore construction and the number of businesses and homes affected cannot be determined.

Port utilization: Future offshore wind development would support use and expansion of ports and supporting industries in Rhode Island, Massachusetts, Connecticut, New York, and New Jersey. Section 3.11.1 lists ports identified as possibly supporting proposed Project construction. Section 3.13, Navigation and Vessel Traffic, and Section G.2.7, Land Use and Coastal Infrastructure, provide more detailed information about these ports. Projects constructed as part of Alternative A could also use these ports, as well as others along the Atlantic coast. Deepwater Wind has committed to improvements to ProvPort and the Port of Davisville to support the Revolution Wind Project (Kuffner 2018). Most other utilization or expansion of existing ports or development of new port facilities is intended to support the offshore wind industry as a whole and are not specifically tied to individual offshore wind projects.

Port utilization would require additional shore-based and marine workers, resulting in a trained workforce for the offshore wind industry and contributing to beneficial local and regional economic activity. Where existing ports are improved and channels are dredged to support offshore wind, the improvements would also be beneficial to other port activity. Port utilization in the geographic analysis area associated with offshore wind would occur primarily during development and construction of projects in the RI/MA

Lease Areas, which would be constructed between 2023 and 2030 (Appendix E, Table E-1). Ongoing maintenance and operational support would sustain port activity and employment at a lower-level once construction is complete.

The port investment and usage generated by offshore wind would have long-term, beneficial impacts on employment and economic activity by providing employment opportunities and supporting marine service industries such as marine construction, ship construction and servicing, and related manufacturing. The beneficial impact of offshore wind operations services and improved port facilities would provide sustained long-term employment and economic activity. The most intensive beneficial impacts would occur during construction of offshore wind projects near the geographic analysis area between 2023 and 2030. The beneficial impact of offshore wind operations services and improved port facilities would provide sustained long-term employment and economic activity.

Port usage could potentially have short- to medium-term impacts on commercial shipping if offshore wind construction results in competition for limited berthing space and port services. The proposed Brayton Point site is a redevelopment site specifically for offshore wind and would, thus, accommodate offshore wind activity without competing with other marine interests. The MCT was built specifically to support offshore wind, and the ports of Davisville, ProvPort, and the Port of Albany are pursuing expansion suitable for offshore wind development support. Depending on the success of these planned expansions and the volume of activity at these and other ports outside the geographic analysis area, offshore wind development could result in increased competition and costs, as well as possible delays or displacement for current port users.

Presence of structures: Alternative A would include construction of up to 963 WTGs and ESPs, up to 2,964 acres of foundation and scour protection, and 584 acres of hard protection for cables (excluding the proposed Project). Commercial fishing operators, marine recreational businesses, and shore-based supporting services (such as seafood processing) could experience short-term impacts during construction. This could lead to higher costs and reduced income for commercial and for-hire recreational fishing businesses during construction, resulting from the need to adjust routes and fishing grounds to avoid offshore construction areas. Allisions could lead to vessel damage and spills, with direct costs (i.e., vessel repairs and spill cleanup), as well as indirect costs from damage caused by spills.

Commercial trawlers/dredgers would need to be aware of and avoid the locations of hard cable coverage (especially concrete mattresses) to avoid potential gear loss, damage, or entanglement. The impacts of hard cable protection on commercial fishing businesses would be long term and localized. Operators would be able to adjust to avoid affected locations, but the complexity of selecting fishing areas and the areas where trawling or dredging methods cannot be used without possible gear loss would increase as the extent of hard protection area increases.

Offshore wind structures could also hinder the current routes of commercial vessels providing offshore recreational services, although many such businesses would be able to adjust by changing routes with limited impacts. The presence of WTGs could require adjustment of vessel routes used for activities such as sailboat races, tour boat routes, and recreational fishing. Long-distance sailing races that traverse the waters offshore of the geographic analysis area, such as the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race, generate business for visitor services within the geographic analysis area. These races may vary in their routes and only occur every 2 to 4 years, so impacts of offshore wind construction areas and permanent structures would depend upon the particular locations where construction would occur or be completed at the time of a specific race. Up to six offshore wind projects in the RI/MA Lease Areas, excluding the proposed Project, could be under construction simultaneously in 2025. With advance communication and planning, races could be routed to avoid offshore wind construction areas or structures.

Recreational fishing targeting HMS such as tuna, shark, and marlin also generates business for charter fishing and visitor services providers. These businesses are likely to be affected by offshore wind structures because the HMS fisheries are more likely to overlap areas where offshore wind development would occur than other fisheries, which tend to occur closer to shore. While HMS angling has fewer participants and trips than coastal recreational fishing, HMS anglers often spend significantly more than other fishing participants on individual fishing trips and tournaments. There were 20,020 vessels with a permit for Atlantic HMS in 2016 (NOAA 2019e).

Additionally, structures in the marine environment are known to attract certain marine species through the reef effect, which can lead to economic impacts and new opportunities for commercial or for-hire recreational fishing (Kularathna et al. 2019). The fish aggregation and reef impacts of up to 2,964 acres of hard protection around offshore wind structures would also provide new opportunities for recreational fishing. Aggregation and reef impacts would impact the minority of recreational fishing vessels that travel as far from shore as offshore wind structures (Section 3.9). Although the likelihood of recreational vessels visiting offshore foundations would vary based on relative proximity to shore, increasing offshore wind development could change recreational fishing patterns within the larger socioeconomic study area, as the tourist industry learns to make use of the structures. Businesses that would benefit from fish aggregation and reef effects—such as those that cater to HMS and offshore fishing recreationists—may grow. The attraction of anglers to offshore wind structures is not anticipated to result in a volume of new recreational fishing large enough to replace or displace commercial fishing businesses by recreational fishing businesses.

In summary, offshore wind structures and hard protection for cables would have long-term impacts on commercial fishing operations and support businesses such as seafood processing. The impacts would increase in intensity as more offshore structures are completed, but the fishing industry is anticipated to be able to adjust fishing practices over time in order to maintain the commercial fishing industry in the context of offshore wind structures (also see discussion of economic impacts on commercial and for-hire recreational fishing in Section 3.9). The offshore structures would also necessitate alterations in the routes of for-hire recreational fishing, recreational tour boat businesses, sailing races, and HMS angling. Some offshore wind structures would provide new business opportunities due to fish aggregation and reef effects—which could attract fish valued for recreational fishing—and the possibility of tours for visitors interested in a close-up view of the wind structures, as has occurred for the Block Island Wind Farm.

The views of offshore WTGs could have impacts on certain businesses serving the recreation and tourism industry. Impacts could be adverse if visitors and customers avoid certain businesses (i.e., hotels or rental dwellings) due to views of the WTGs; impacts could be neutral or beneficial if views do not affect visitor decisions or influence some visitors beneficially. As discussed in Section 3.16, Scenic and Visual Resources, portions of up to 903 WTGs (excluding the proposed Project) would theoretically be visible from beaches and coastal areas in the geographic analysis area for demographics, employment, and economics.

A joint research study of the University of Connecticut and Lawrence Berkeley National Laboratory found no net impacts from WTGs on property values in Massachusetts (Atkinson-Palombo and Hoen 2014). The study examined impacts of 41 onshore WTGs located 0.25 to 1 mile from residences. The study noted weak evidence linking the announcement of new WTGs to impacts on home prices and found that those impacts were no longer apparent after the start of WTG operations. The offshore wind structures would be different than those analyzed in that report in that offshore WTGs would be much larger than the onshore WTGs but located much further from residences and would appear small on the horizon (also see for additional discussion of visual impacts on vacation rental properties in Section 3.16).

Overall, the presence of offshore wind structures would have a continuous, long-term impact on employment and economics in commercial/for-hire fishing, marine recreation, coastal recreation, and tourism.

Traffic: Increased vessel traffic from construction, operations, and decommissioning of ongoing and planned activities, including offshore wind, would produce demand for supporting marine services, with beneficial impacts on employment and economics, particularly during construction. Construction, operations, and decommissioning of other offshore wind projects in the RI/MA Lease Areas would increase vessel traffic and demand for supporting marine services at ports throughout the geographic analysis area. Alternative A would also increase vessel congestion and safety risk near ports.

Other considerations: Once built, over the long term, future offshore wind could ensure reliability and enhance energy security by diversifying the regional energy supply, given that various power plants in the region have recently retired or are expected to retire in the coming years (COP Volume III, Section 4.1.1; Epsilon 2023). Offshore wind could significantly increase the proportion of energy from renewable sources not subject to fossil fuel costs, with a potential for 9,404 MW of power (compared to more than 21,000 MW currently provided by renewable sources in Massachusetts) from offshore wind development for Massachusetts and Rhode Island (U.S. Energy Information Administration 2019). A greater share of electricity produced by offshore wind for a given market would also result in a greater need for energy storage and peaker generation capacity due to anticipated variations in generation. The economic impacts of future offshore wind activities (including associated energy storage and peaker generation capacity projects) on energy generation and energy security cannot be quantified but could be long term and beneficial. Future offshore wind activities would have similar contributions as Phase 1, but on a larger scale and over a larger geographic area.

Conclusions

Impacts of Alternative A. Under Alternative A, demographics, employment, and economics would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under Alternative A, ongoing activities related to the IPFs (continued commercial shipping and commercial fishing; ongoing port maintenance and upgrades; periodic channel dredging; maintenance of piers, pilings, seawalls, and buoys; and the use of small-scale, onshore renewable energy) would have **minor** impacts and **minor** beneficial impacts on demographics, employment, and economics.

Cumulative Impacts of Alternative A. Planned activities for coastal and marine activity other than offshore wind include development of diversified, small-scale, onshore renewable energy sources and peaker plants; ongoing onshore development at or near current rates; continued increases in the size of commercial vessels; potential port expansion and channel deepening activities; and efforts to protect against potential increased storm damage and sea level rise. The demographic, employment, and economic impacts of these planned activities other than offshore wind would be **minor** and **moderate** beneficial, driven primarily by the continued operation of existing marine industries, especially commercial fishing, recreation/tourism, and shipping; increased pressure for environmental protection of coastal resources; the need for port maintenance and upgrades; and the risks of storm damage and sea level rise.

Regional offshore wind development other than the proposed Project is anticipated to generate increased investment within the geographic analysis area in ports, shipping, and logistics capability (both land and marine), component laydown and assembly facilities, job training, and other services and infrastructure necessary for offshore wind construction and operations. If U.S. supply chains develop as anticipated, additional manufacturing and servicing businesses would result, either in the geographic analysis area, or at other locations in the United States. While it is not possible to estimate the extent of job growth and economic output within the geographic analysis area, jobs and investment would result in notable and measurable benefits to employment, economic output, infrastructure improvements, and community services, especially job training, that would occur as a result of future offshore wind development. If the proposed Project is not built, the specific commitments included in the applicant's Host Community Agreement (HCA) with the Town of Barnstable (authorized October 21, 2021) would not be realized (COP Volume I, Section 4.1; Epsilon 2023). However, other offshore wind projects in the RI/MA Lease Areas would enact similar commitments in the geographic analysis area.

Many of the jobs generated by offshore wind projects are temporary construction jobs. The combination of these jobs over multiple activities and projects would create notable benefits during construction of these projects. This would particularly be the case as the domestic supply chain for offshore wind evolves over time. Offshore wind projects also support long-term operations jobs (lasting up to 33 years); long-term tax revenues; long-term economic benefits of improved ports and associated industrial land areas; diversification of marine industries, especially in areas currently dominated by recreation and tourism; and growth in a skilled marine construction workforce.

Offshore wind construction and operations could disrupt the surrounding communities and ecosystems through disturbance of fish and marine mammal species and displacement of commercial or for-hire fishing vessels, potentially resulting in conflict over other fishing grounds, increased operating costs, and lower revenue for marine industries and supporting businesses. The long-term presence of offshore wind structures would also affect these marine industries due primarily to increased navigational constraints and risks, as well as potential gear entanglement and loss.

The overall cumulative impacts of ongoing and planned activities in the geographic analysis area would result in **minor** impacts and **moderate** beneficial impacts on demographics, employment, and economics.

3.11.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following primary proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on demographics, employment, and economics:

- The number and position of WTGs installed;
- The extent to which the applicant hires local residents and obtains supplies and services from local vendors;
- The port(s) selected to support construction, installation, and decommissioning;
- The port(s) selected to support operations in addition to Vineyard Haven Harbor and the MCT; and
- The design parameters that could impact commercial fishing and recreation and tourism as impacts on these activities affect employment and economic activity.

3.11.2.3 Impacts of Alternative B – Proposed Action on Demographics, Employment, and Economics

This section identifies potential impacts of Alternative B on demographics, employment, and economics. When analyzing the impacts of Alternative B on demographics, employment, and economics, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for demographics, employment, and economics.

Impacts of Phase 1

Impacts include increased population and housing demand due to Phase 1 workforce needs; job creation; and the economic effects of tax revenues, payroll, and other expenditures; and other funds provided by the applicant in connection with Phase 1. Other impacts include economic activity generated within the geographic analysis area through spending and taxes paid by proposed Project employees or vendors; and spending by governments.

Economic impacts may occur in the recreation, tourism, and commercial fishing sectors as discussed below in the analysis of individual IPFs. Impacts on recreation and tourism (Section 3.15) could affect the economic health of businesses and individuals that serve tourists and seasonal residents. Impacts on commercial fisheries (Section 3.9) may in turn affect the economic health, as well as the cultural identity and values—and therefore the well-being—of individuals and communities that identify as "fishing" communities.

The beneficial impacts on employment and the economy under Phase 1 are highly dependent on assumptions regarding the percent of workers, materials, equipment, vessels, and services that can be locally sourced. The applicant's economic impact study estimates that Phase 1 would directly support the following employment in Connecticut alone (COP Volume III, Section 7.1; Epsilon 2023):

- Construction: Phase 1 would support approximately 770 direct FTEs in Connecticut during pre-construction, construction, and installation. Additionally, spending during this period is expected to result in the creation of 495 indirect and induced jobs.
- Operations: Phase 1 is expected to employ 70 FTEs annually, for a total of 2,100 job years (1 job year is the equivalent of one person working for 1 year) assuming a 33-year life. It is anticipated that 80 percent of these jobs would be based in Bridgeport, Connecticut. Phase 1 would create approximately 90 additional indirect and induced jobs annually (2,700 FTE jobs over 33 years). In total, Phase 1 is expected to support 160 annual direct, indirect, and induced FTE jobs (4,800 FTE job years) (COP Appendix III-L; Epsilon 2023).
- While the COP does not provide information on decommissioning impacts, this analysis assumes that decommissioning of Phase 1 would likely have a similar composition and size of the workforce as construction of Phase 1 (COP Volume III, Section 7.1; Epsilon 2023).

Jobs created would require workers from a variety of backgrounds with varying skill and educational levels, ranging from environmental scientists and engineers to ironworkers and machine operators. The applicant expects approximately 80 percent of the 770 direct FTE jobs during Phase 1 would be located in Connecticut (COP Appendix III-L, Section II; Epsilon 2023). The estimated direct, indirect, and induced impacts of Phase 1 would result in $16.4 million in annual labor income and $17 million in annual expenditures during operations (COP Appendix III-L, Section III; Epsilon 2023).

In addition to job creation, growth of local businesses, and tax revenues, the applicant has committed to providing the following economic benefits for Phase 1 (COP Volume III, Section 4.1; Epsilon 2023):

- **Nantucket Offshore Wind Community Fund:** Contribution of $3 million at the financial close of Phase 1. Proceeds would support the Town and County of Nantucket, the Maria Mitchell Association, and the Nantucket Preservation Trust to support projects related to protecting and preserving cultural and historic resources, climate adaptation, coastal resiliency, and other initiatives.
- **HCA with Town of Barnstable**: Funding to the Town of Barnstable to offset potential impacts associated with onshore activities. The HCA for Phase 1 has not been executed but would likely be similar to the HCA approved in 2018 for Vineyard Wind 1 (Town of Barnstable 2018).
- **Supply Chain Network Initiative:** Investment of $9 million for "projects and initiatives to accelerate the development of the offshore wind supply chain and businesses" (COP Volume III, Section 7.1.2; Epsilon 2023), focused in Connecticut. This includes up to $5 million for workforce education, training, and recruitment.
- Other economic and community benefits are listed in COP Volume III (Section 4.1; Epsilon 2023) and in Appendix III-O (Epsilon 2023).

Phase 1 would affect demographics, employment, and economics through the following primary IPFs during construction, operations, and decommissioning. Except where otherwise noted, the impacts of Phase 1 decommissioning for each IPF would be the same as for construction.

Cable emplacement and maintenance: Emplacement of Phase 1 offshore export, inter-array, and inter-link cables would disturb approximately 442 acres of seafloor, which could temporarily impact commercial/for-hire fishing businesses during cable installation and infrequent maintenance. Cable installation would reduce income and increase costs for vessels that need to relocate away from work areas and disrupt fish stocks near the installation locations. Cable emplacement would have larger impacts on fixed gear fisheries, which are highly territorial. It would be more difficult for fixed gear operators to adapt to removal of gear during cable installation. Therefore, in the context of reasonably foreseeable environmental trends, installation of Phase 1 cables would have localized, short-term, and minor impacts on employment and economics due to impacts on the commercial/for-hire fishing business.

The presence of up to 35 acres of hard cable protection would have larger impacts on fixed gear fisheries, which are highly territorial and would need to avoid hard protection areas. Therefore, Phase 1 would have localized, long-term, and minor impacts on demographics, employment, and economics, due to impacts on the commercial/for-hire fishing business.

Climate change: Phase 1 would result in a small reduction in or avoidance of emissions from power generation resulting in a long-term and negligible beneficial impact on demographics, employment, and economics.

Land disturbance: Phase 1 would require onshore cable installation and substation construction in Barnstable County. The disturbance of businesses near the Phase 1 onshore cable route and substation construction site would result in localized, short-term, and minor impacts on demographics, employment, and economics. Land disturbance during operations would be limited to infrequent unplanned repairs of underground cables. These activities would be similar in nature to the activities described for construction but would affect a more limited area, for a shorter amount of time. Therefore, Phase 1 operations would have short-term and negligible impacts on demographics, employment, and economics due to land disturbance.

Lighting: Nighttime construction of Phase 1 would require lighting for vessels in transit and at offshore construction work areas. Phase 1 vessel lighting is not anticipated to impact visitor-oriented businesses or other businesses; therefore, lighting from Phase 1 would have short-term and negligible impacts.

The permanent aviation safety lighting required for Phase 1 WTGs could be visible at night from beaches and coastal locations on Martha's Vineyard and Nantucket, possibly affecting employment and economics in these areas if the lighting discourages visits or vacation home rental or purchases in coastal locations where Phase 1 WTG lighting is visible. The applicant has committed to voluntarily implement ADLS, which would limit the frequency and duration of aviation safety lighting to less than 0.1 percent of annual nighttime hours. Nighttime operations would require lighting for occasional operational vessels in transit. This lighting would be similar to and indistinguishable from lighting employed on vessels already visible offshore at night. Overall, Phase 1 operational lighting is not anticipated to affect visitor-oriented businesses or other businesses and would, therefore, have a localized long-term, intermittent, and negligible impact on demographics, economics, and employment.

Noise: The contribution of Phase 1 to noise from G&G survey activities, operations, pile driving, trenching, and vessels would affect certain marine business activities associated with commercial/for-hire fishing, marine sightseeing, and recreational boating. These impacts would occur during the 2-year Phase 1 construction process, but impacts would be limited to active construction locations. As a result, Phase 1 would have intermittent, short-term, and negligible to minor impacts on visitors, workers, and residents from noise.

The impact of noise on demographics, employment, and economics during operations would be substantially less than the short-term noise created during construction (Mooney et al. 2020). Therefore, Phase 1 would have negligible noise impacts on demographics, employment, and economics.

Port utilization: Phase 1 construction would diversify jobs and revenues in the geographic analysis area's Ocean Economy sector. In particular, Phase 1 would enlarge and require new skills within the marine construction sector. It would also support demand for marine transportation and service workers for tug and other vessel charters, dockage, fueling, inspection/repairs, provisioning, and crew work (Borges et al. 2017a). These jobs within the Ocean Economy sector would be concentrated in Connecticut (reflecting the applicant's Phase 1 economic incentives in that state) but could also be created in states with other port facilities described in Section 3.11.1. Phase 1 could temporarily compete with the commercial fishing industry for marine workers and services during construction, potentially increasing labor and service costs and encouraging vessel owners to use services in ports not supporting offshore wind development. Compared to the overall GDP of Connecticut, Massachusetts, and other states where construction activities may occur, Phase 1 construction would have short-term and minor beneficial impacts on demographics, employment, and economics.

The applicant anticipates that the operations land-based facilities would use the Port of Bridgeport and an existing industrial marina facility in Vineyard Haven that provides marine vessel services and houses multiple businesses. Other ports could also be used for operations activities. As shown in Section 3.11.1, Fairfield County (Port of Bridgeport) has a concentration of manufacturing, construction, and professional jobs. Duke's County (Vineyard Haven Harbor) has a high proportion of seasonal housing, as well as an older population and higher proportion of employment in visitor services than the Massachusetts statewide average. The operations facility at the Port of Bridgeport would support the county's existing economic strengths, while the facility at Vineyard Haven would help to diversify the island's economy by providing a source of skilled, year-round jobs. Therefore, Phase 1 would have long-term and minor beneficial impacts on demographics, employment, and economics.

Presence of structures: Up to 64 foundations (including up to 2 ESPs, with the remainder for WTGs) constructed for Phase 1 could affect commercial and for-hire recreational fishing businesses during construction, resulting from the need to avoid new structures and hard protection for foundations and cables. Construction areas, increased vehicle traffic, and increased vessel traffic could affect businesses involved with shore-based supporting services and could result in increased costs and reduced income for all businesses dependent on the Ocean Economy. The impacts of Phase 1 construction on demographics, employment, and economics would be continuous, short term, and minor due to impacts on marine-based businesses.

As described in Section 3.16, portions of all Phase 1 WTGs could theoretically be visible from south-facing coastal areas and elevated locations on Martha's Vineyard and Nantucket. As discussed in Section 3.15, views of WTGs could have impacts on businesses serving the recreation and tourism industry. The presence of structures of Phase 1 could have both adverse and beneficial impacts on economics due to property value impacts and viewshed impacts on recreational and tourist businesses. Considering the distance from shore and limited visibility of the offshore structures from coastlines, elevated locations, residences, and businesses, operation of Phase 1 would have negligible impacts on economics due to property value impacts and viewshed impacts on recreational and tourist businesses.

The 64 foundations, and approximately 109 acres of hard protection for Phase 1 WTG and ESP foundations and cable protection could affect commercial fisheries and for-hire recreational fishing due gear entanglement, damage, and loss, navigational hazards (risk of allisions and collisions), fish aggregation, habitat alteration, effort displacement, and space use conflicts (Section 3.9). Individual recreational fishing and sightseeing could experience similar impacts (Section 3.15, Recreation and Tourism). As a result, Phase 1 operations would have a long-term and moderate impact on demographics, employment, and economics due to impacts on commercial and for-hire recreational fishing, for-hire recreational boating, and associated businesses.

Traffic: Phase 1 would generate vessel traffic in ports described in Section 3.11.1 supporting proposed Project construction and would result in an average of 30 and a maximum of 60 vessels operating in the SWDA and OECC simultaneously (COP Appendix III-I; Epsilon 2023). Increased vessel traffic would increase the use of port and marine businesses, including tug services, dockage, fueling, inspection/repairs, and provisioning. This would result in continuous, short-term, and minor beneficial impacts during construction. Phase 1 vessel traffic could also cause temporary, periodic congestion within and near ports, leading to potential delays and an increased risk for collisions between vessels, which would result in economic costs for vessel owners. As a result, Phase 1 vessel traffic would also have continuous, short-term, and minor impacts on demographics, employment, and economics during construction.

As described in Section 3.13, vessel traffic for Phase 1 operations would be substantially less than for construction. Operations traffic would be focused on the Port of Bridgeport and Vineyard Haven Harbor but could also use other ports described in Section 3.11.1. The vessel traffic generated by Phase 1 would result in negligible beneficial impacts during operations and minor beneficial impacts during decommissioning due to activities at ports. Similar to construction, vessel traffic associated with Phase 1 could also result in temporary, periodic congestion within and near ports and would have negligible to minor impacts during operations.

Other considerations: Phase 1 would marginally contribute to energy security and resiliency for the geographic analysis area, providing economic benefit through a stable supply of energy. In addition, the applicant would coordinate OECR installation with the Town of Barnstable's planned installation of a municipal sewer line along the OECR "to minimize disruption and defray some of the town's sewer line roadwork costs" (COP Appendix III-O; Epsilon 2023). Therefore, Phase 1 would have long-term, localized, and minor beneficial impacts on demographics, employment, and economics.

Impacts of Phase 2

The overall economic impacts of Phase 2 would be similar to those described for Phase 1 but would be larger due to the larger scale of Phase 2 (i.e., 1,200 to 1,500 MW of capacity installed for Phase 2, compared to 804 MW installed for Phase 1). The applicant has not prepared a detailed economic analysis for Phase 2. This EIS assumes that much of the economic activity for Phase 2 would likely be split between the state(s) that issue the Phase 1 and 2 PPAs and Connecticut, where Phase 1 and Phase 2 operations activities would occur.

The applicant's economic impact study estimates that Phase 2 would directly support the following employment (COP Volume III, Section 7.1; Epsilon 2023):

- Phase 2, construction: Phase 2 would support approximately 1,064 direct FTEs during pre-construction and construction. Additionally, spending during this period is expected to result in the creation of 678 indirect and induced jobs.
- Phase 2, operations and decommissioning: Phase 2 is expected to employ 101 FTEs annually, for a total of 3,030 job years (1 job year is the equivalent of one person working for 1 year) assuming a 33-year life. Indirect and direct impacts from Phase 2 are estimated to create 129 additional indirect and induced jobs annually, resulting in 3,870 FTE job years during operations.

Overall, Phase 2 would generate at least $234 million in direct labor income and $325 million in total direct expenditures (excluding payroll) (COP Appendix III-L, Section III; Epsilon 2023). In addition to job creation, growth of local businesses, and tax revenues, the applicant has committed to providing the following economic benefits for Phase 2 (COP Volume III, Section 4.1; Epsilon 2023):

- **Nantucket Offshore Wind Community Fund:** Contribution of $3 million at the financial close of Phase 2, supporting the same purposes as described for Phase 1.
- **HCA with Town of Barnstable**: Funding to the Town of Barnstable to offset potential impacts associated with onshore activities. The HCA for Phase 2 has not been executed but would likely be similar to the HCA developed for Phase 1, as well as the HCA approved in 2018 for Vineyard Wind 1 (Town of Barnstable 2018).
- Other economic and community benefits listed in COP Volume III (Section 4.1; Epsilon 2023) and in Appendix III-O (Epsilon 2023).

If the applicant includes the SCV as part of the final proposed Project design, some or all of the impacts on demographics, employment, and economics from the Phase 2 OECC through Muskeget Channel would not occur. BOEM will provide a more detailed analysis of the impacts of the SCV on demographics, employment, and economics in a supplemental NEPA analysis.

Phase 2 would affect demographics, employment, and economics through the primary IPFs discussed below during construction, operations, and decommissioning. Operations and decommissioning impacts from Phase 2 IPFs would be the same as or indistinguishable from Phase 1. Phase 2 would include more WTGs and ESPs and a greater area of hard protection for foundations and cables; however, these differences would not meaningfully change the impact determinations for the IPFs discussed for Phase 1. Other operations and decommissioning impacts for Phase 2 would be identical to Phase 1.

Cable emplacement and maintenance: Phase 2 would result in 732 acres of seafloor disturbance from offshore export, inter-array, and inter-link cable emplacement. The impact of cable emplacement on commercial and recreational fisheries, commercially important marine species, and recreational activities is expected to be the same as Phase 1. Therefore, Phase 2 would have short-term and minor impacts on demographics, employment, and economics. Impacts from the SCV would be similar to impacts discussed for Phase 1 from cable emplacement and maintenance but would occur in Bristol County, Massachusetts.

Land disturbance: As described in detail in Section G.2.7, the potential Phase 2 landfall site at Dowses Beach would be located within the paved parking area for the beach and pier, while the potential landfall site at the end of Wianno Avenue would disrupt a road stub that may also be used for parking. Onshore installation and construction of these landfalls and associated OECRs would temporarily disturb neighboring land uses and reduce beach or waterfront parking and activities during construction; however, construction would not occur during the peak summer season, except where specifically authorized by the Town of Barnstable (COP Volume III Section 4.2, Table 4.2-1; Epsilon 2023). Construction disturbances would be temporary, lasting approximately 15 months for OECR installation (excluding the June through August peak tourist season); however, the applicant would complete construction at any one location along the OECR route in a shorter time period (days or weeks) (COP Volume I, Section 3.1.1.3; Epsilon 2023).

As a result, the impacts of Phase 2 land disturbance on demographics, employment, and economics would be short term and minor. Land disturbance from SCV construction would be similar to impacts discussed for Phase 1, but impacts would occur in Bristol County, Massachusetts.

Lighting: Construction lighting for Phase 2 would be similar to that for Phase 1 but farther from shore and, thus, less visible. As a result, Phase 2 lighting would have short-term, intermittent, and negligible impacts on demographics, employment, and economics. Impacts from the SCV would be similar to impacts discussed for Phase 1 from lighting but would occur in Bristol County, Massachusetts.

Noise: The construction noise impacts of Phase 2 would be similar to those described for Phase 1. Therefore, Phase 2 would have intermittent, short-term, and negligible to minor impacts on visitors, workers, and residents from noise. Impacts from the SCV would be similar to impacts discussed for Phase 1 from noise but would occur in Bristol County, Massachusetts.

Port utilization: Phase 2 (with or without the SCV) would use the same ports as Phase 1 and would, thus, have minor beneficial impacts on demographics, employment, and economics.

Presence of structures: Phase 2 would add up to 89 stationary structures to the SWDA during construction, as well as 253 acres of hard protection for foundations and cables. The impacts of constructing Phase 2 structures would be similar to those discussed for Phase 1. As a result, the presence of structures during Phase 2 construction would have short-term and minor impacts on demographics, employment, and economics due to impacts on marine-based businesses. Impacts from the SCV would be similar to impacts discussed for Phase 1 from presence of structures but would occur in Bristol County, Massachusetts.

Traffic: Phase 2 is anticipated to have the same level of vessel traffic as Phase 1 and would, thus, have similar impacts. As a result, Phase 2 would have continuous, short-term, and minor beneficial impacts on demographics, employment, and economics during construction due to increased Ocean Economy activity. Phase 2 could also have a continuous, short-term, and minor impact due to increased congestion and safety risks. Vessel traffic from SCV construction would be similar to impacts discussed for Phase 1, but impacts would occur in Bristol County, Massachusetts.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-8 in Appendix G would contribute to impacts on demographics, employment, and economics through the primary IPFs of cable emplacement and maintenance, port utilization, the presence of structures, and traffic. Other offshore wind projects would each have land disturbance impacts, but these impacts would be unlikely to occur in the same geographic area or timeframe as Alternative B and are, thus, not considered as cumulative impacts. Cumulative impacts would primarily occur through increased investment within the geographic analysis area in ports, shipping, and logistics capability (both land and marine), component laydown and assembly facilities, job training, and other services and infrastructure necessary for offshore wind construction and operations.

Up to seven offshore wind projects in the RI/MA Lease Areas (including the proposed Project) could be under construction simultaneously in 2025. The construction of offshore wind structures and hard protection from ongoing and planned activities would have short-term and moderate impacts on commercial fishing operations and support businesses such as seafood processing. However, ongoing and planned activities would result in minor impacts and moderate beneficial impacts on employment and economics.

Conclusions

Impacts of Alternative B. Alternative B would have **minor** beneficial impacts on employment and economics due to job creation, expenditures on local businesses, tax revenue and grant funds provided by the applicant, and the support for additional regional offshore wind development that would result from construction of Alternative B. Construction would provide jobs and revenue but, considering the short duration of the construction period, would have a minor beneficial impact on employment and economics. Employment and expenditures during operations would be long term, lasting 33 years, but would be of modest magnitude, limiting the beneficial impact. Tax revenues and grant funds likewise would be modest in magnitude (compared to overall host-state GDP) but would provide a beneficial impact for public expenditures and development of the local job force and supply chain for offshore wind. Decommissioning of Alternative B would also have **minor** beneficial impacts on employment and economics due to the construction activity necessary to remove the wind facility structures and equipment. Upon completion of decommissioning, the jobs and economic activity generated by operations would cease and Alternative B would no longer produce employment and other revenues.

The IPFs associated with Alternative B would result in moderate impacts on commercial/for-hire fishing businesses. Impacts on individual and community well-being in fishing communities are anticipated to be directly correlated to the level of impact anticipated on the commercial fishing industry. These impacts would be concentrated in communities identified as having medium to high commercial fishing engagement and reliance. Impacts on commercial fishing during construction would impact not only the commercial fishing industry itself, but also the onshore businesses that depend upon the local seafood supply, including seafood markets and processing. Overall, Alternative B would have moderate impacts on employment and economic activity in the commercial fishing and onshore seafood sectors. Although commercial fishing is a small component of the regional economy, it is important to the economy and identity of local communities within the region.

The IPFs associated with Alternative B would also result in moderate impacts on certain recreation and tourism businesses. As noted in Section 3.15, construction and operation of Alternative B may have moderate impacts on recreation and tourism in the geographic analysis area. Overall, these impacts on recreation and tourism would have **moderate** impacts on employment and economic activity for this component of the geographic analysis area's economy.

Cumulative Impacts of Alternative B. The cumulative impacts associated with ongoing and planned activities, including Alternative B, on demographics, employment, and economics in the geographic analysis area would be **moderate** and **moderate** beneficial. The primary factors for the beneficial impact ratings include impacts associated with investment in offshore wind, job creation and workforce development, and port utilization. The primary factors for adverse impacts include cable emplacement and maintenance, the presence of structures, vessel traffic, and land disturbance. Alternative B would contribute to the overall impact rating primarily through impacts from vessel traffic, the presence of structures (WTGs and ESPs), and new hiring and economic activity. Moderate impacts are anticipated due to impacts on commercial and for-hire recreational fishing (Section 3.9), but these impacts would only be a component of the overall impacts on this resource.

Impacts would not be expected to disrupt normal or routine demographic characteristics, employment, or economic activity in the geographic analysis area—or that, in the case of temporary economic activity specifically associated with construction, any such changes would generally revert to pre-construction conditions following construction completion. In addition, ongoing and planned activities, including Alternative B, would have moderate beneficial impacts on demographics, employment, and economics due to a notable and measurable benefit from construction- and operations-stage employment and economic improvement.

3.11.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Demographics, Employment, and Economics

When analyzing the impacts of Alternative C on demographics, employment, and economics, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for demographics, employment, and economics. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. These differences would not result in meaningfully different impacts compared to those of Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on demographics, employment, and economics would align with those of Alternative B: **moderate** and **minor** beneficial. Cumulative impacts of Alternative C on demographics, employment, and economics would be **moderate** and **moderate** beneficial. The impact ratings for Alternative C would align with those of Alternative B because any potential differences in the impacts associated with Alternative C would occur outside of the geographic analysis area for demographics, employment, and economics.

3.11.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Demographics, Employment, and Economics with the Western Muskeget Variant Contingency Option

Impacts on demographics, employment, and economics from the Preferred Alternative would align with those of Alternative B: **moderate** and **minor** beneficial. Cumulative impacts of the Preferred Alternative on demographics, employment, and economics would be **moderate** and **moderate** beneficial. The impact ratings for the Preferred Alternative would align with those of Alternative B because any potential differences in the impacts associated with the Preferred Alternative would occur outside of the geographic analysis area for demographics, employment, and economics.

3.12 Environmental Justice

3.12.1 Description of the Affected Environment

3.12.1.1 Geographic Analysis Area

This section discusses the existing conditions in the geographic analysis area for environmental justice, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.12-1. Specifically, this includes the counties where proposed offshore infrastructure is located, counties in closest proximity to the SWDA, and counties containing one of the 19 potential ports used for proposed Project construction, operations, or decommissioning (Table 3.12-1): Barnstable, Bristol, Dukes, Nantucket, and Essex counties, Massachusetts; Providence and Washington counties, Rhode Island; Fairfield and New London counties, Connecticut; Kings, Richmond, Rensselaer, Albany, and Suffolk counties, New York; and Gloucester County, New Jersey.

Table 3.12-1: Port Facilities by County

County	Potential Port Usage, Construction, Operations, and Decommissioning (Site Type)[a]
Bristol County, Massachusetts	Port of New Bedford (E) Brayton Point Commerce Center (P) Fall River terminal facilities (P)
Dukes County, Massachusetts	Vineyard Haven Harbor (E)
Essex County, Massachusetts	Salem Offshore Wind Port (P)
Fairfield County, Connecticut	Port of Bridgeport (E)
New London County, Connecticut	New London State Pier (E)
Gloucester County, New Jersey	Paulsboro Marine Terminal (E)
Albany County, New York	New York State Offshore Wind Port (P) Port of Coeymans (E)
Kings County, New York	GMD Shipyard (E) South Brooklyn Marine Terminal (E)
Rensselear County, New York	New York State Offshore Wind Port (P)
Richmond County, New York	Homeport Pier (P) Arthur Kill Terminal (P)
Suffolk County, New York	Shoreham site (P) Greenport Harbor (E)[b]
Providence County, Rhode Island	ProvPort (E) South Quay Terminal (G)
Washington County, Rhode Island	Port of Davisville (E)

Source: COP Volume III; Epsilon 2023

ProvPort = Port of Providence
[a] Site types include the following:
E: This includes existing ports or industrial terminals that may be expanded to serve the offshore wind industry.
P: This includes industrial facilities proposed for redevelopment to serve offshore wind activities, regardless of the status of the proposed Project.
G: This includes Greenfield sites that have not been previously developed.
[b] This site is for operations only.

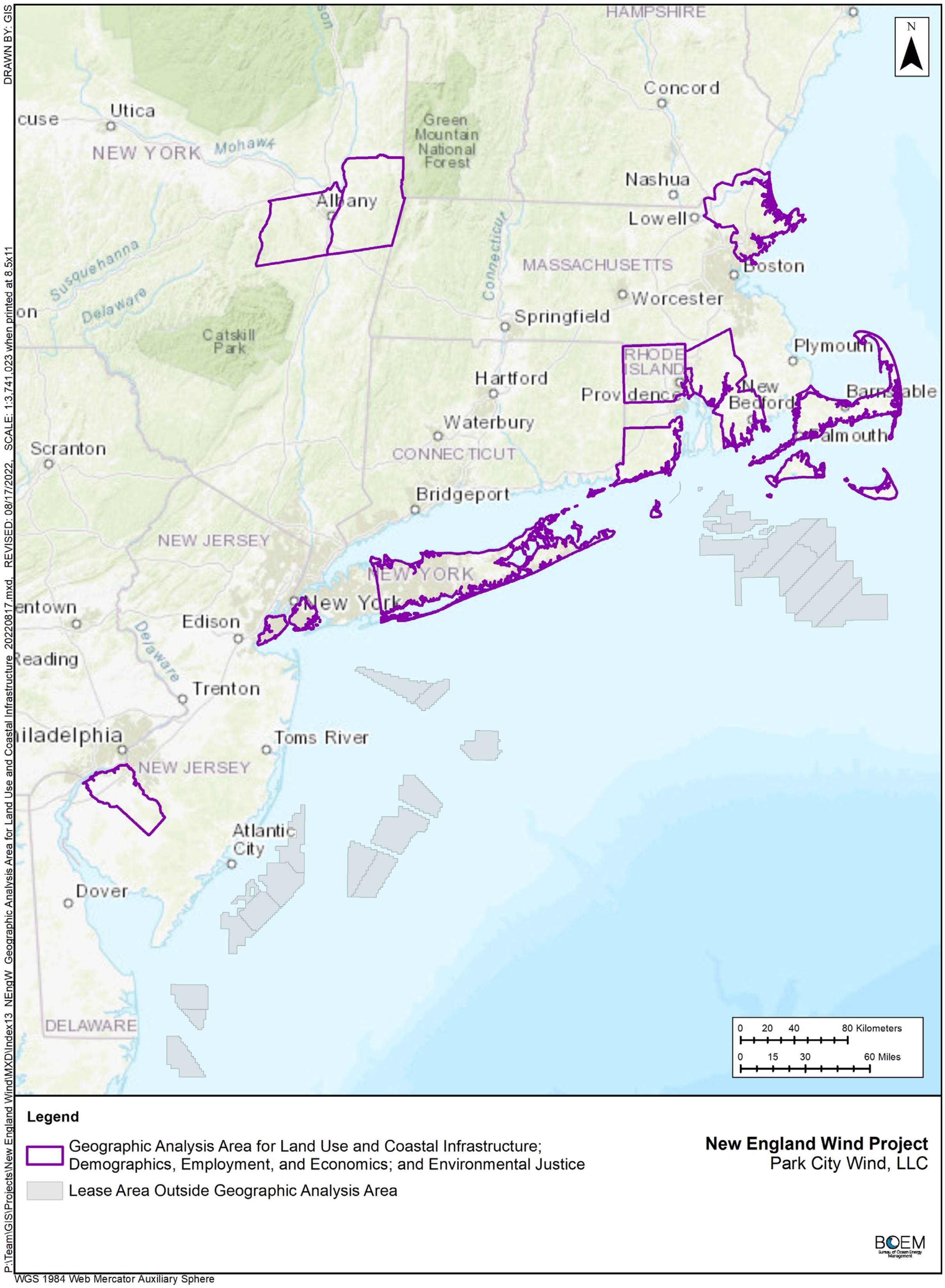


Figure 3.12-1: Geographic Analysis Area for Environmental Justice

3.12.1.2 Background

As described by USEPA, environmental justice is "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or policies" (USEPA 2021b).

EO 12898, Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (EO 12898). Potential environmental justice impacts are identified by determining whether there is or would be an impact on the natural or physical environment that disproportionately and adversely affects a minority population, low-income population or Native American tribe, including ecological, cultural, human health, economic, or social impacts; and whether the impacts appreciably exceed those on the general population or other appropriate comparison group (CEQ 1997). Beneficial impacts are not environmental justice impacts; however, this section identifies beneficial impacts on environmental justice communities, where appropriate.

EO 12898 directs federal agencies to consider the following issues with respect to environmental justice as part of the NEPA process (CEQ 1997):

- The racial and economic composition of affected communities;
- Health-related issues that may amplify project impacts on minority or low-income individuals; and
- Public participation strategies, including community or tribal participation in federal and state public engagement processes.

The USEPA states that environmental justice analyses must address disproportionately high and adverse impacts on minority populations (defined as individuals who are non-White, or who are White and have Hispanic ethnicity) when minority populations represent more than 50 percent of the population of an affected area, or when the percentage of minority or low-income populations in the affected area is "meaningfully greater" than the minority percentage in the "reference population." USEPA defines reference population as the population of a larger area in which the affected population resides (i.e., a county, state, or region, depending on the geographic extent of the analysis area). Low-income populations are those that fall within the annual statistical poverty thresholds from the U.S. Census Bureau's Population Reports, Series P-60 on Income and Poverty (USEPA 2016). In addition to federal environmental justice guidance, 13 states have independently codified their own laws for addressing environmental justice (Bruce 2021), including 5 in the geographic analysis area: Massachusetts, Rhode Island, Connecticut, New Jersey, and New York. All of these states contain ports that the proposed Project may use.

Analysis of environmental justice populations in this section relies primarily on data from the U.S. Census Bureau, as well as the USEPA's EJSCREEN tool. In addition, environmental justice populations in each state reflect state data tailored to each particular state's environmental justice assessment criteria, which can be more rigorous than federal criteria. Discussions of Massachusetts' and other state environmental justice policies and communities are provided below. Figures 3.12-2 through 3.12-15 show communities within the geographic analysis area that meet state or federal environmental justice criteria. These include communities near the ports that could potentially be used for proposed Project construction, operations, or decommissioning. The applicant is not conducting any port expansion activity specifically to support the proposed Project. Evaluations of any such expansions, including environmental justice analysis, would be part of the permitting process for specific expansions.

Environmental justice impacts are characterized for each IPF as negligible, minor, moderate, or major using the four-level classification scheme outlined in Section 3.3, Definition of Impact Levels. A determination of whether impacts are "disproportionately high and adverse" in accordance with EO 12898 is provided in the conclusion section for each alternative.

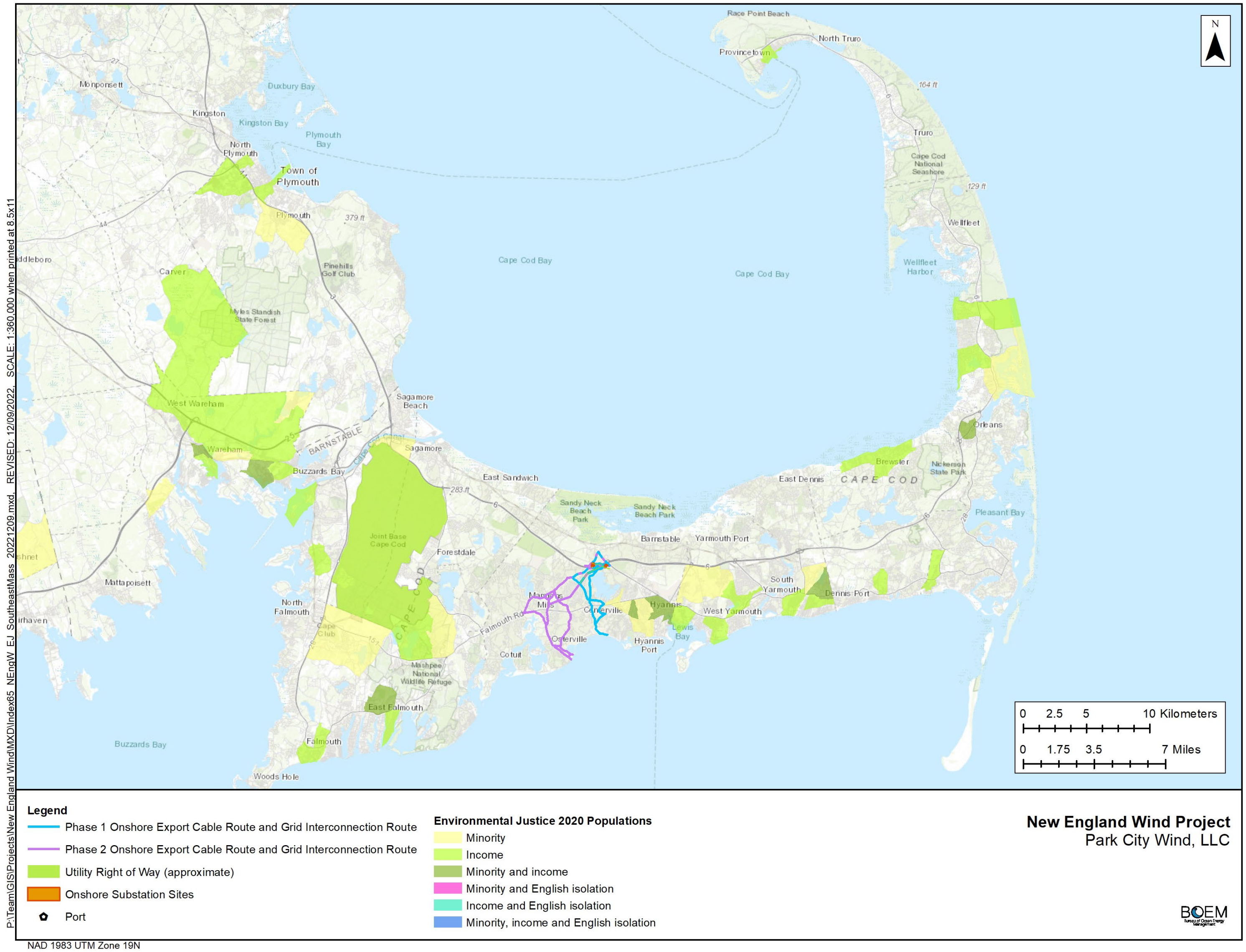
3.12.1.3 Massachusetts

Massachusetts Senate Bill (SB) 9 "creates a next-generation roadmap for the state's climate policy. This establishes new goals for reducing emissions and increases environmental justice protections by requiring environmental impact reports for projects that impact air quality and are located near certain communities" (Commonwealth of Massachusetts 2021b). Massachusetts identifies an environmental justice community as U.S. Census block groups that meet one of more of the following criteria (EEA 2021a):

- The annual median household income is no more than 65 percent of the statewide annual median household income;
- Minorities comprise 40 percent or more of the population;
- Twenty-five percent or more of the households lack English language proficiency, also known as English isolation;
- Minorities comprise 25 percent or more of the population, and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income; or
- Is a geographic portion of a neighborhood designated by the Massachusetts Secretary of Energy and Environmental Affairs as an environmental justice population in accordance with law.

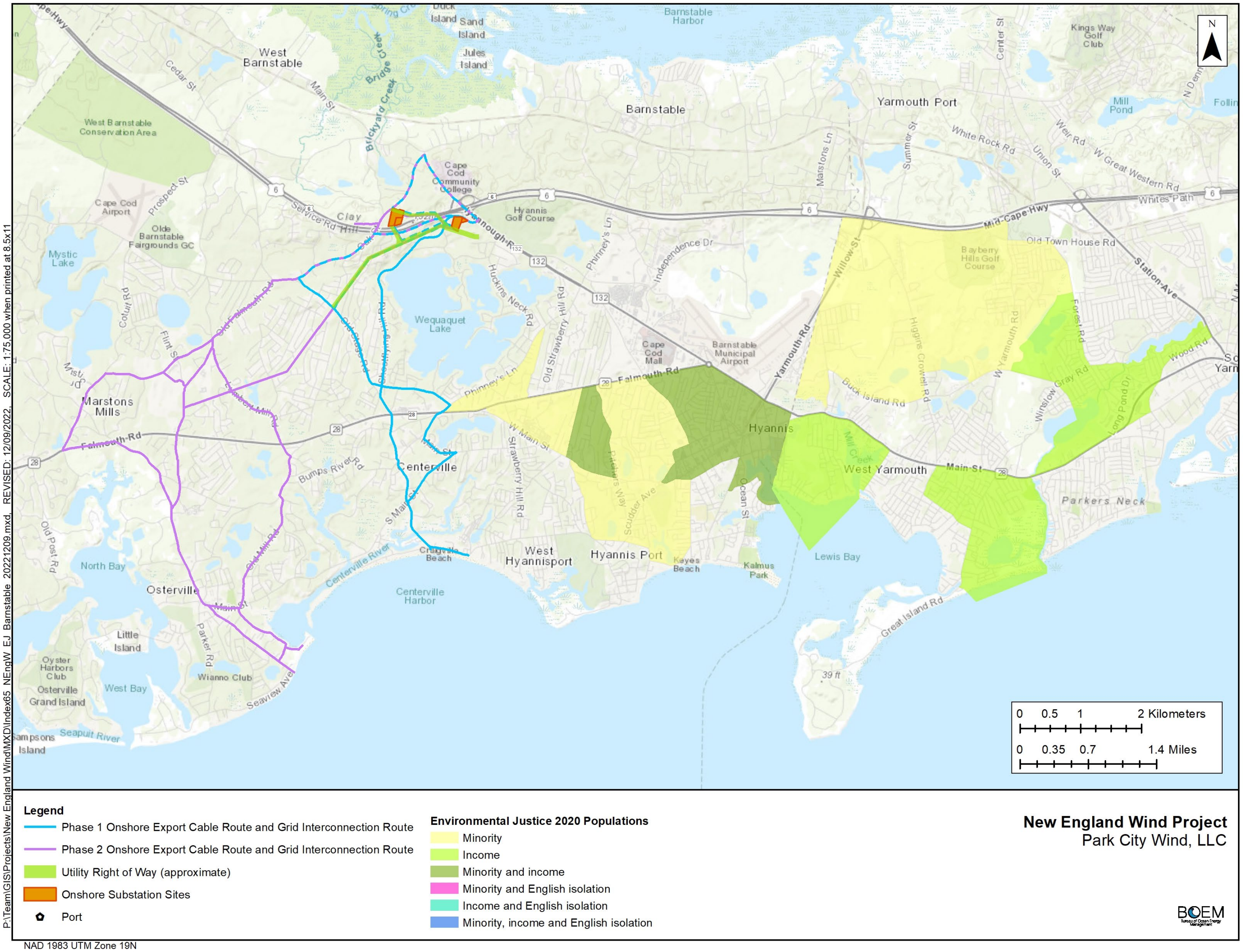
The term English isolation refers to a household that meets U.S. Census criteria for "linguistic isolation," specifically households where no one over the age of 14 speaks only English or English very well (EEA 2021a).

Environmental justice communities in the Massachusetts portion of the geographic analysis area (primarily census block groups that meet criteria for income and/or minority status) are clustered around larger cities and towns near the potential cable landing sites and potential ports in Hyannis, Salem, Somerset (Brayton Point), and New Bedford (the MCT). Environmental justice communities meeting the minority population criterion are present in south-central Nantucket County near Cisco and the Nantucket airport. In Dukes County, communities meeting the income and minority/English isolation criteria for environmental justice are present near Vineyard Haven, and a minority (Native American) population is present near Aquinnah. Additional environmental justice communities occur on Cape Cod and are scattered throughout southeastern Massachusetts (EEA 2021b).



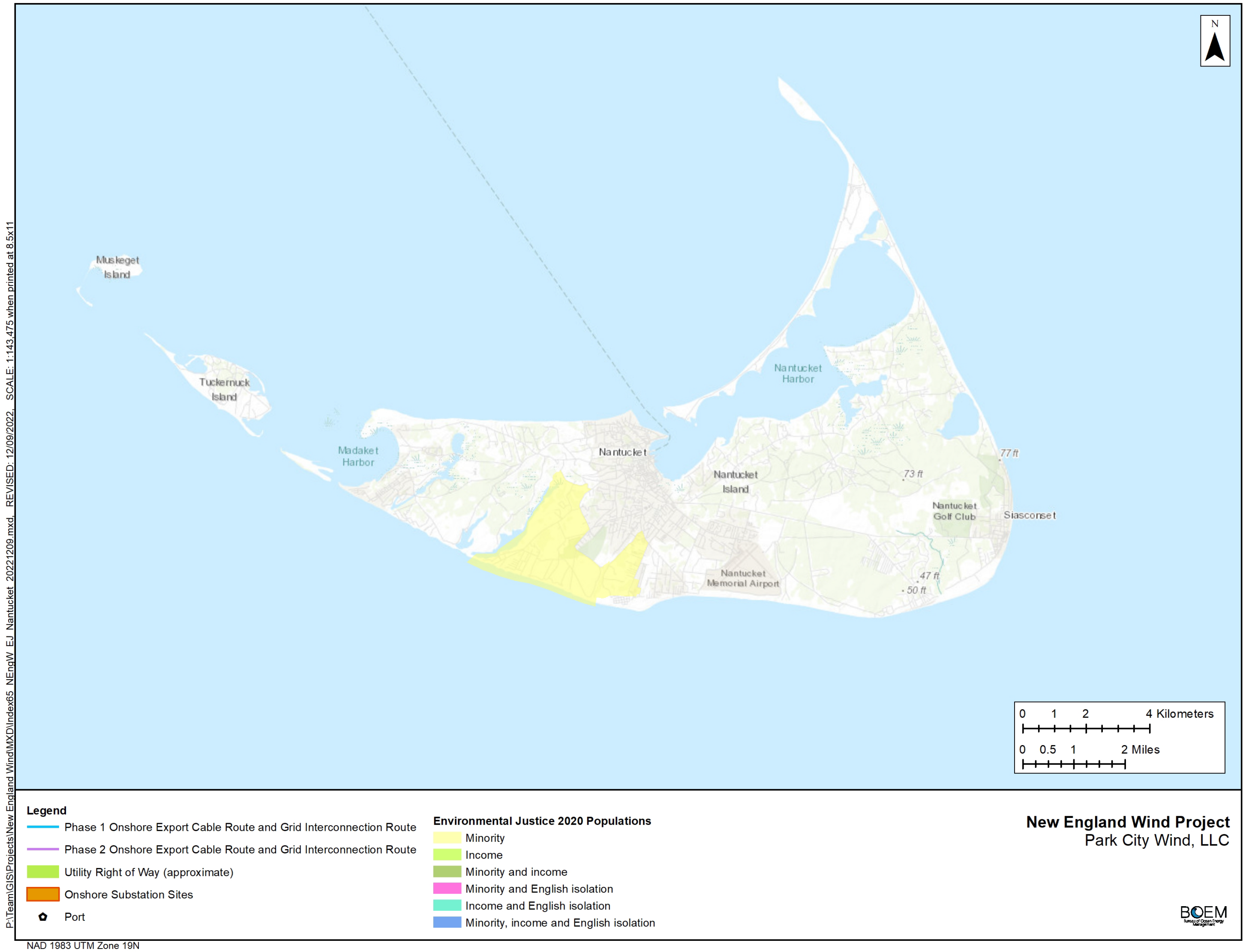
Source: Commonwealth of Massachusetts 2022

Figure 3.12-2: Environmental Justice Communities in Southeast Massachusetts



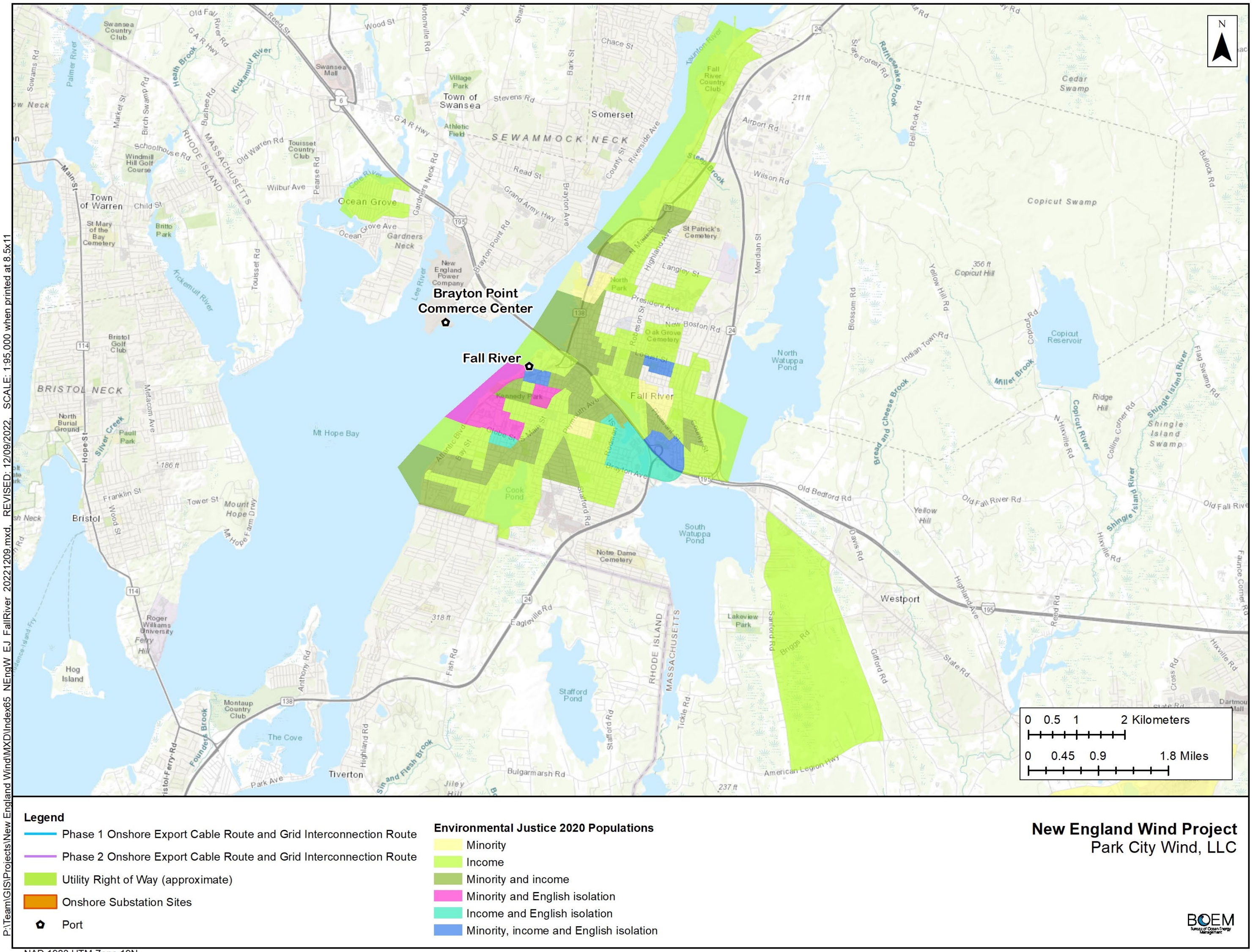
Source: Commonwealth of Massachusetts 2022

Figure 3.12-3: Environmental Justice Communities near Barnstable, Massachusetts



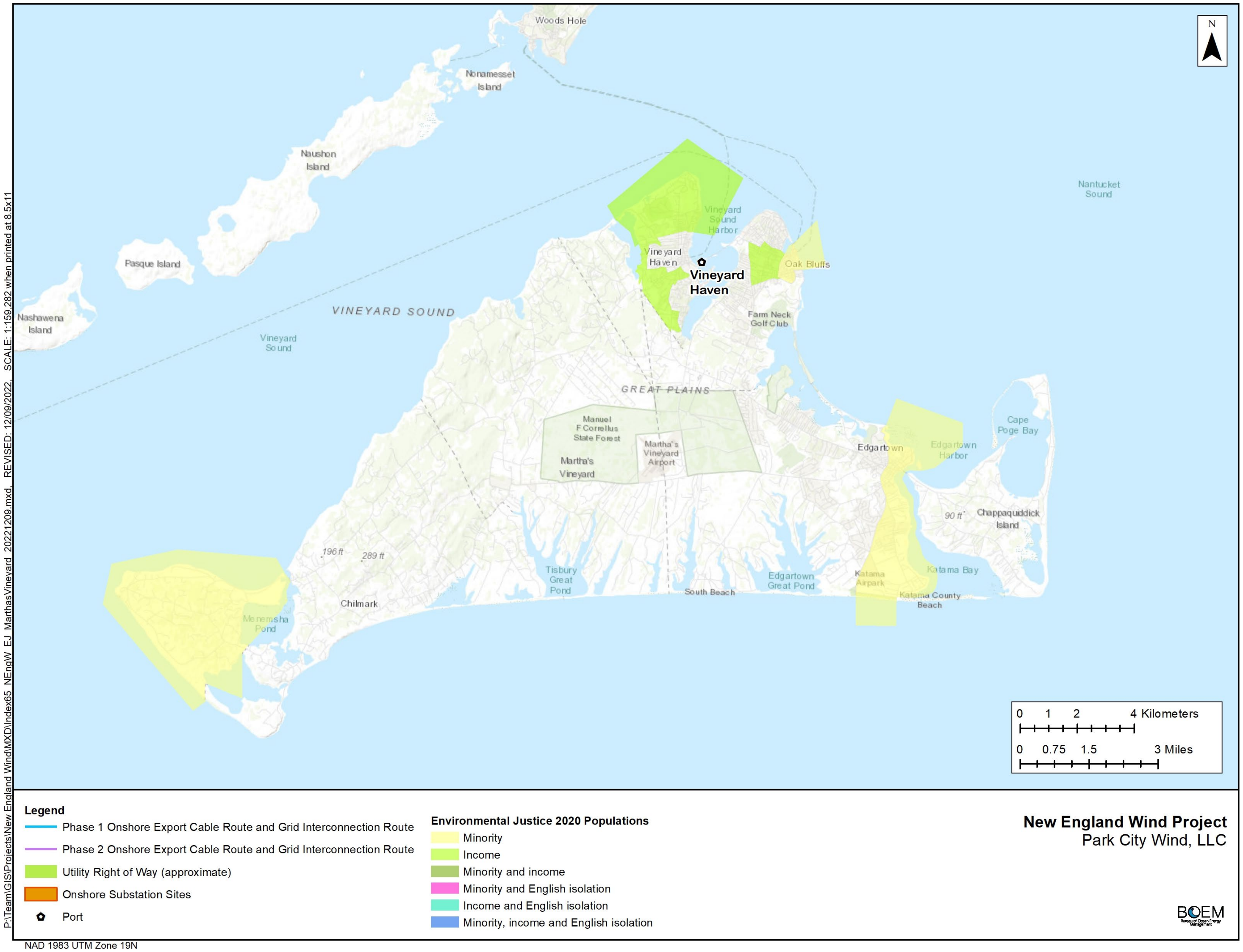
Source: Commonwealth of Massachusetts 2022

Figure 3.12-4: Environmental Justice Communities on Nantucket, Massachusetts



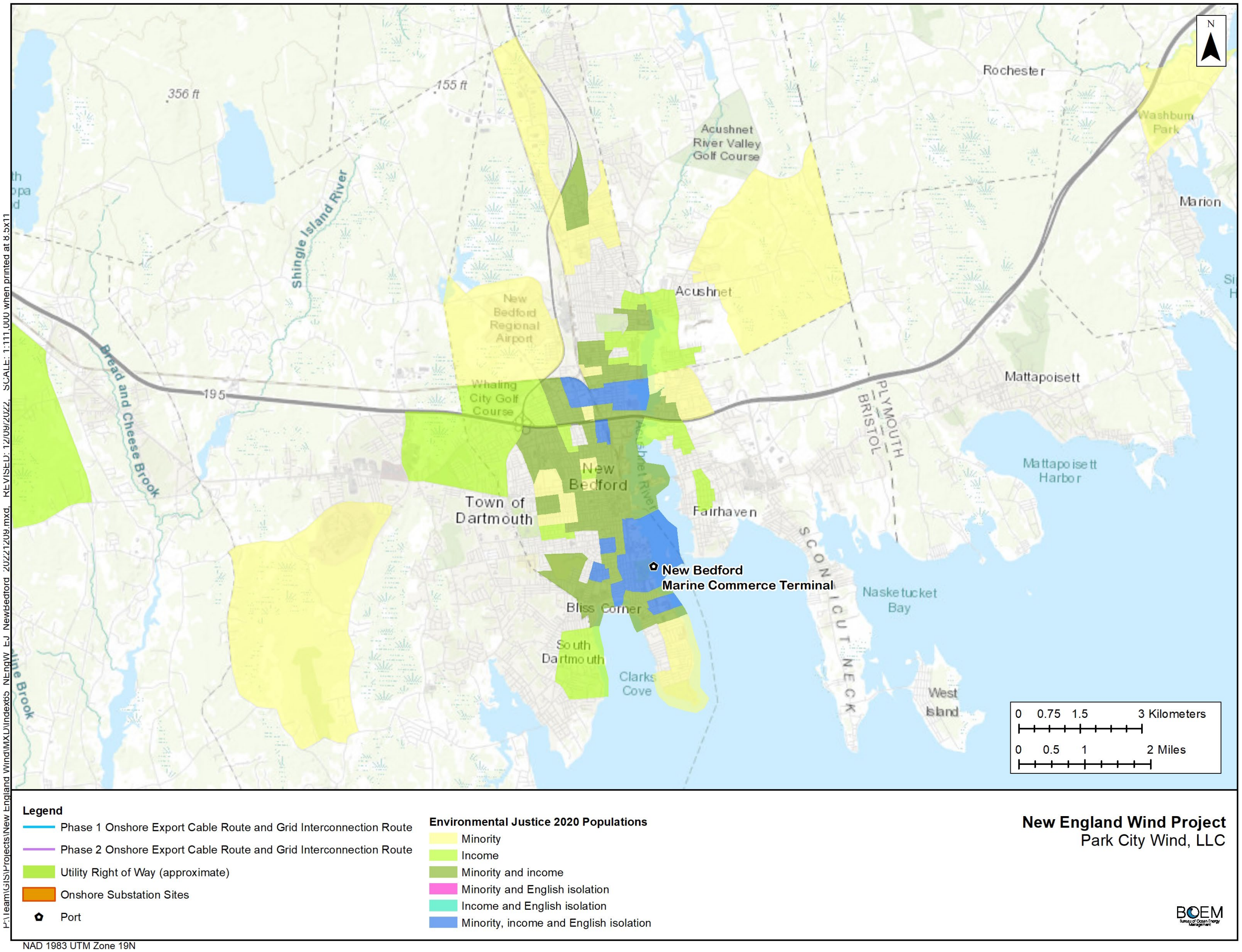
Source: Commonwealth of Massachusetts 2022

Figure 3.12-5: Environmental Justice Communities near Fall River, Massachusetts



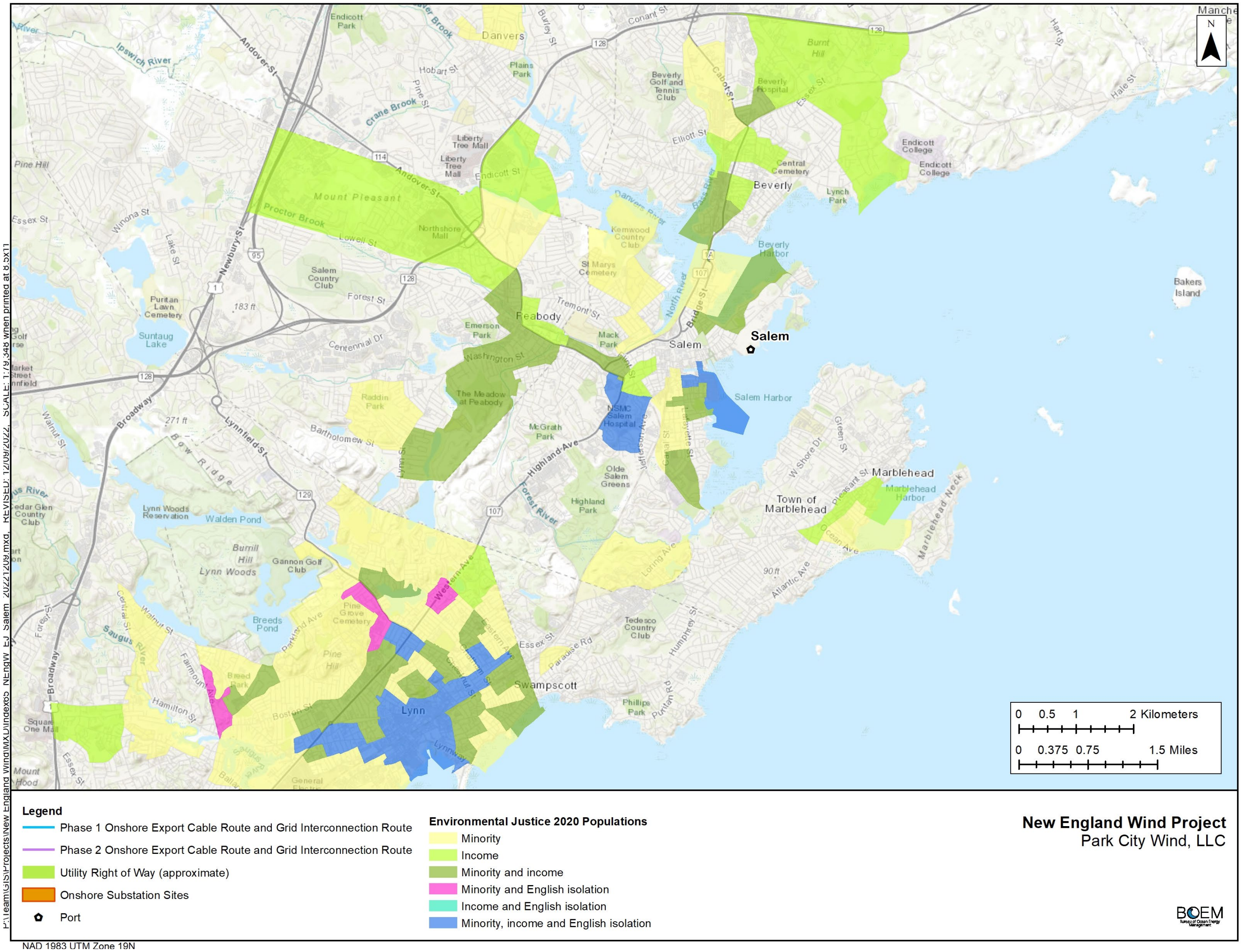
Source: Commonwealth of Massachusetts 2022

Figure 3.12-6: Environmental Justice Communities on Martha's Vineyard, Massachusetts



Source: Commonwealth of Massachusetts 2022

Figure 3.12-7: Environmental Justice Communities near New Bedford, Massachusetts



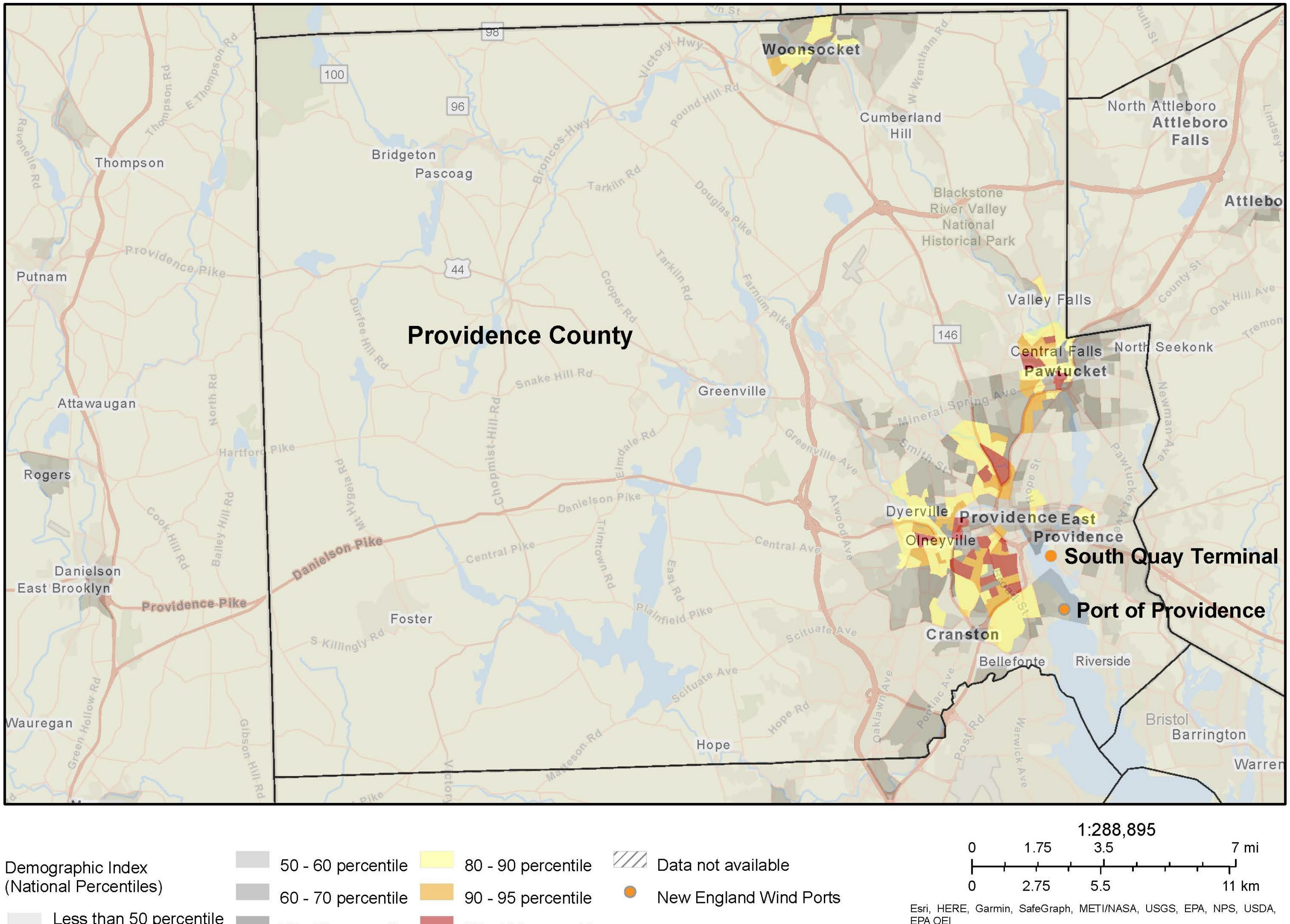
Source: Commonwealth of Massachusetts 2022

Figure 3.12-8: Environmental Justice Communities near Salem, Massachusetts

3.12.1.4 Rhode Island

Rhode Island SB 78 requires “an equitable transition to net-zero emissions and directs state agencies to address recommendations to protect populations most at risk of pollution, displacement, and energy burden” (State of Rhode Island 2021). Rhode Island’s Department of Environmental Management uses these same environmental justice quantifiers as the federal government but references minority and low-income status to state data. Any census block group with a minority or low-income population percentage that ranks in the top 15 percent of census block groups statewide is considered an environmental justice area of focus. Environmental justice communities meeting income criteria are present within and near ProvPort and Quonset Point (Davisville), while ProvPort also meets minority criteria. The South Quay Terminal is across the Providence River from (but within 1 mile of) the environmental justice communities near ProvPort.

Figure 3.12-9 shows the EJSCREEN mapping of Providence. The demographic index mapped is a composite score, combining minority and low-income populations to produce a single index. Areas in the 80th percentile and above indicate that their minority and/or low-income populations are significant, with only 20 percent of census block groups in the nation having equal or greater minority or low-income populations.

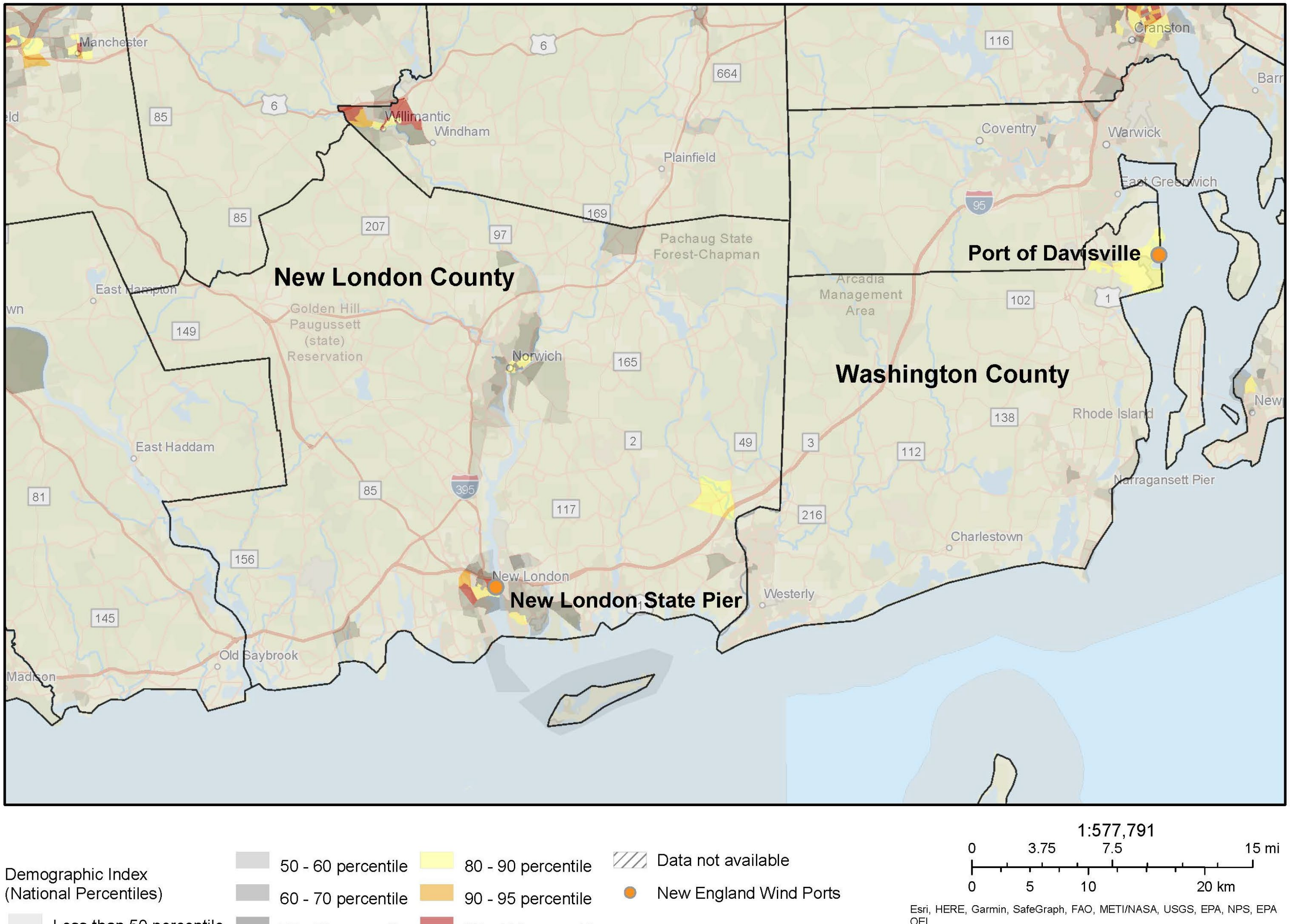


Source: USEPA 2022b

Figure 3.12-9: Environmental Justice Communities in Providence County, Rhode Island

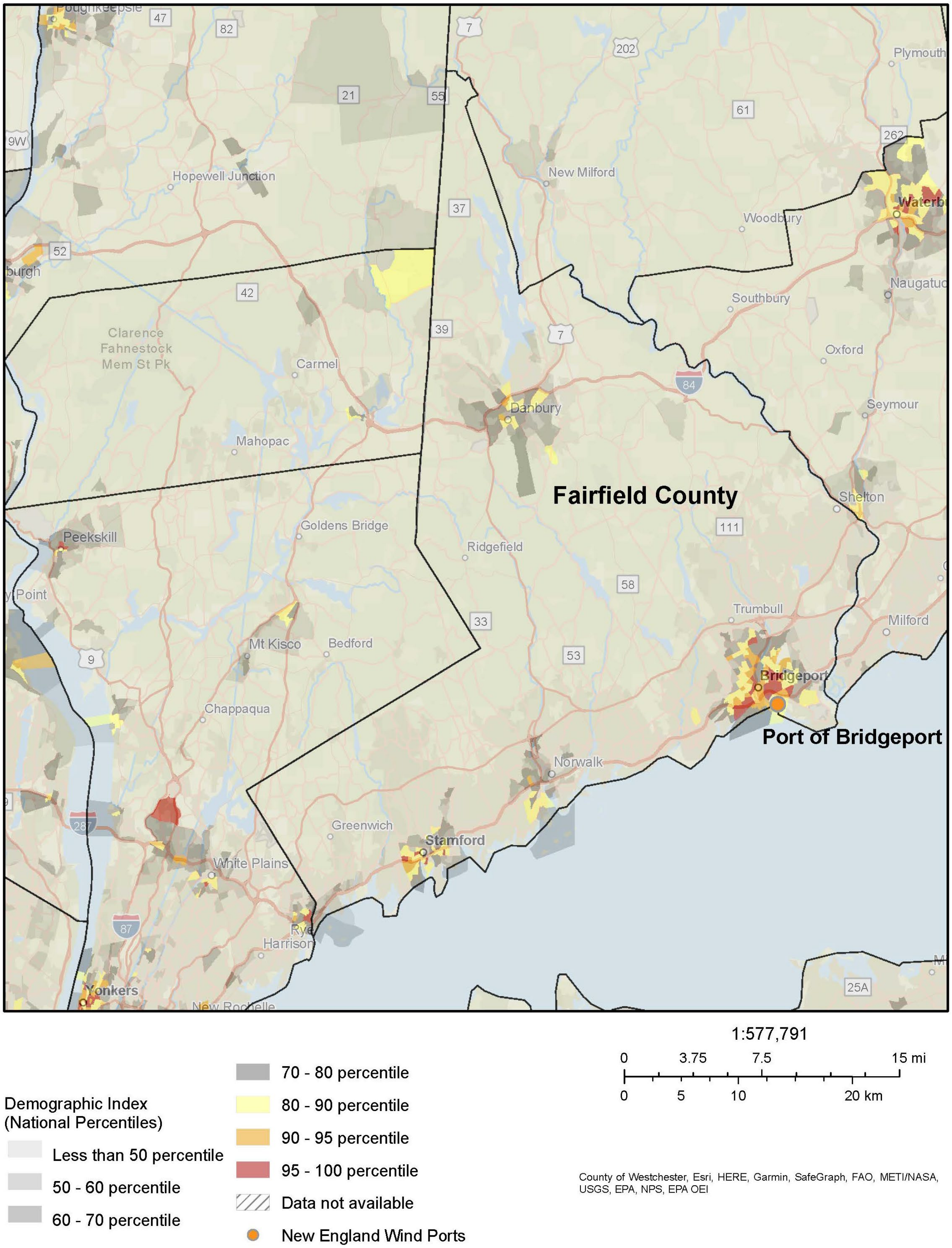
3.12.1.5 Connecticut

Public Act 20-6, An Act Concerning Enhancement to State's Environmental Justice Law of Connecticut, states that an environmental justice community is defined as a "census block group, as determined in accordance with the most recent U.S. Census, for which [30 percent] or more of the population consists of low-income persons who are not institutionalized and have an income below two hundred percent of the federal poverty level" (State of Connecticut 2020). Environmental justice communities meeting minority and income criteria in the Connecticut portion of the geographic analysis area are found near all three port facilities: Barnum Landing and Seaview Avenue on Bridgeport Harbor in Bridgeport and New London State Pier in New London.



Source: USEPA 2022b

Figure 3.12-10: Environmental Justice Communities in Washington County, Rhode Island, and New London County, Connecticut



Source: USEPA 2022b

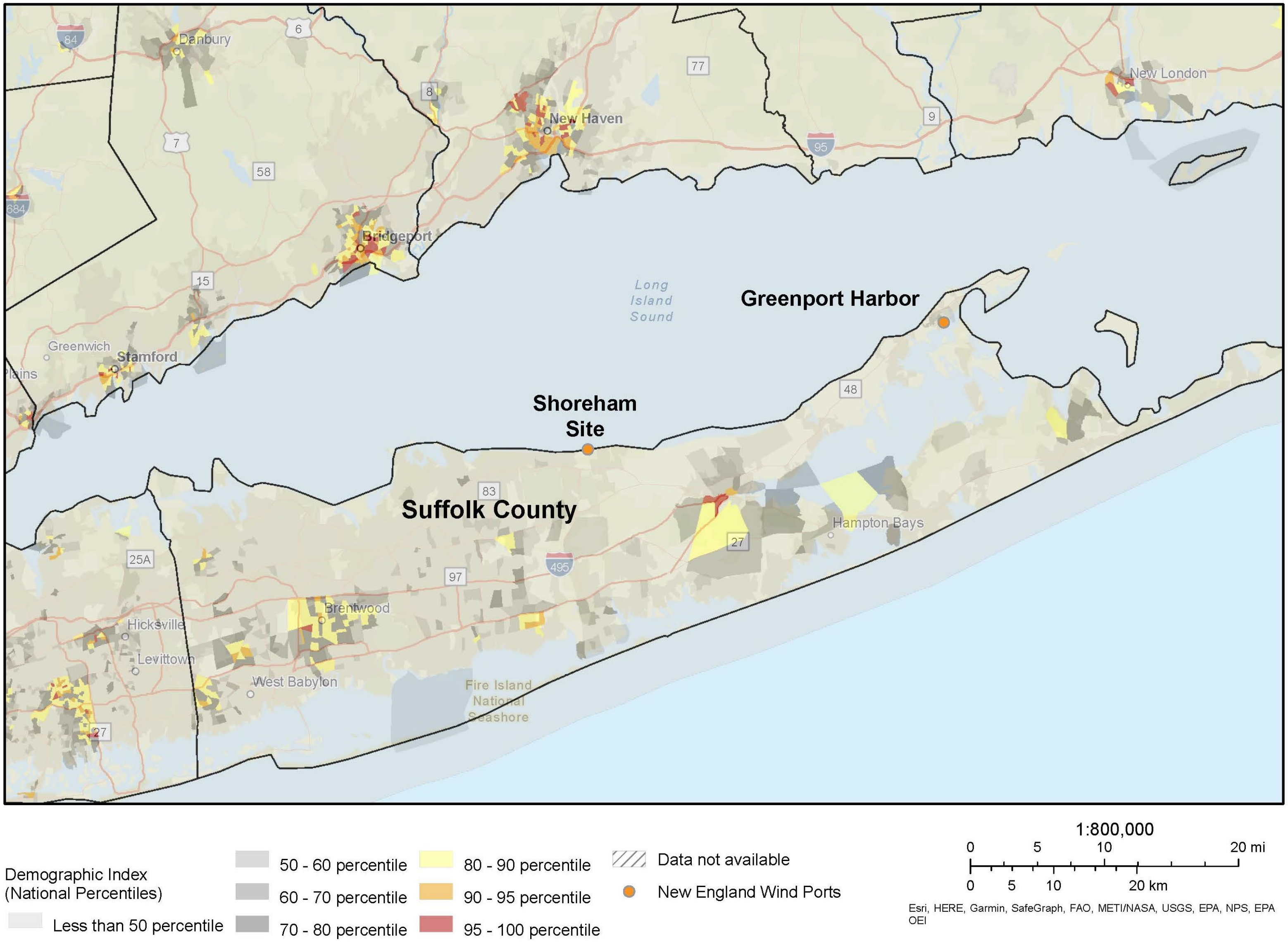
Figure 3.12-11: Environmental Justice Communities in Fairfield County, Connecticut

3.12.1.6 New York

New York identifies environmental justice communities based on the following criteria (NYDEC 2003):

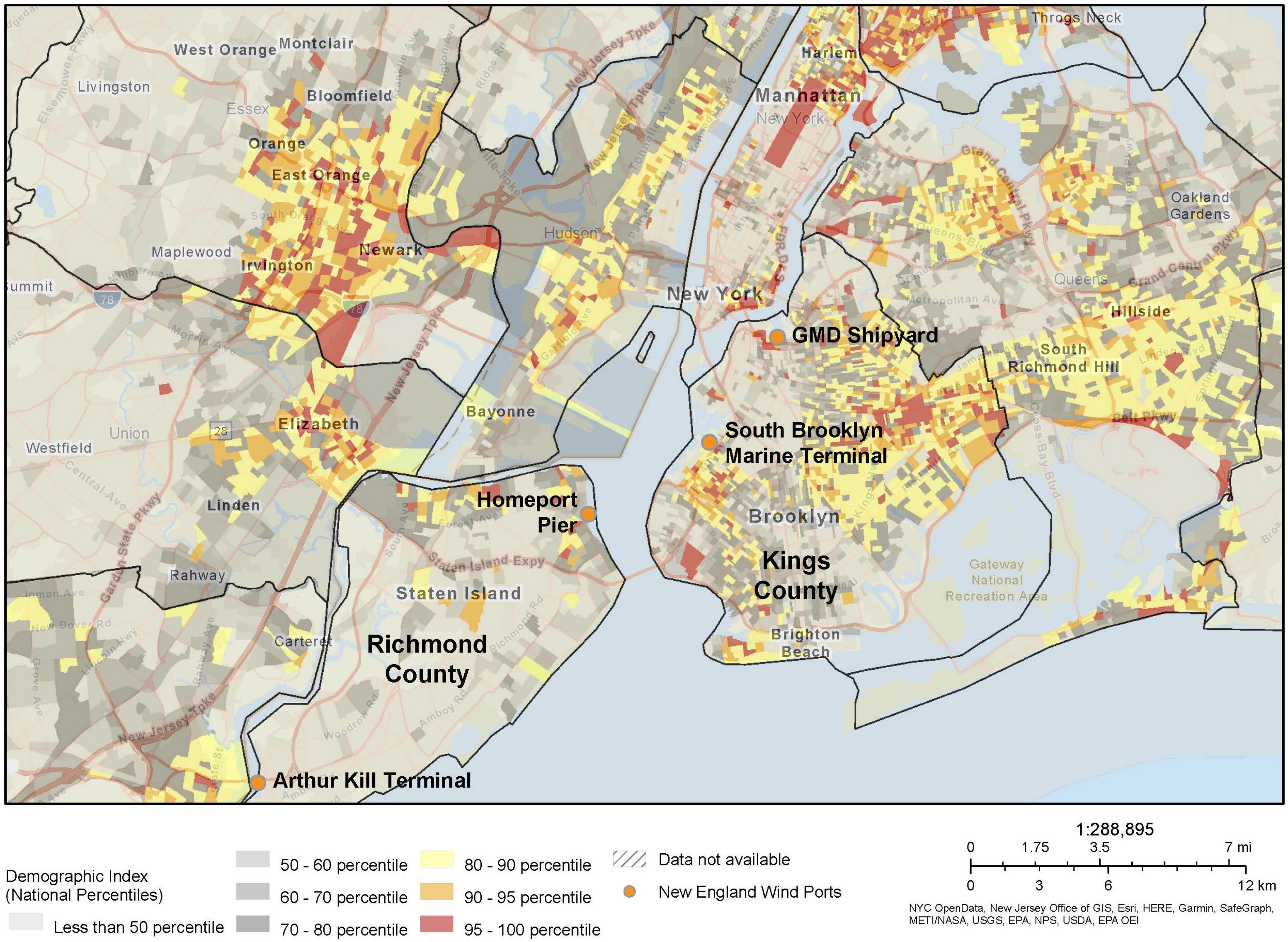
- Low-income community: a census block group, or contiguous area with multiple census block groups, having a low-income population equal to or greater than 23.59 percent of the total population.
- Low-income population: a population with an annual income that is less than the poverty threshold established by the U.S. Census Bureau.
- Minority community: a census block group, or contiguous areas with multiple census block groups, having a minority population equal to or greater than 51.1 percent of the total population in an urban area and 33.8 percent of the total population in a rural area.
- Minority population: means a population that is identified or recognized by the U.S. Census Bureau as Hispanic, African-American or Black, Asian and Pacific Islander, or Native American.

The New York City ports (GMD Shipyard, South Brooklyn Marine Terminal, Homeport Pier, and the proposed Arthur Kill Terminal) are all in or within 1 mile of communities that meet environmental justice criteria for minority status and income. The Port of Albany and New York Offshore Wind Port are within 1 mile of a portion of the City of Albany that meets minority and income criteria (although the ports themselves are not within those communities).



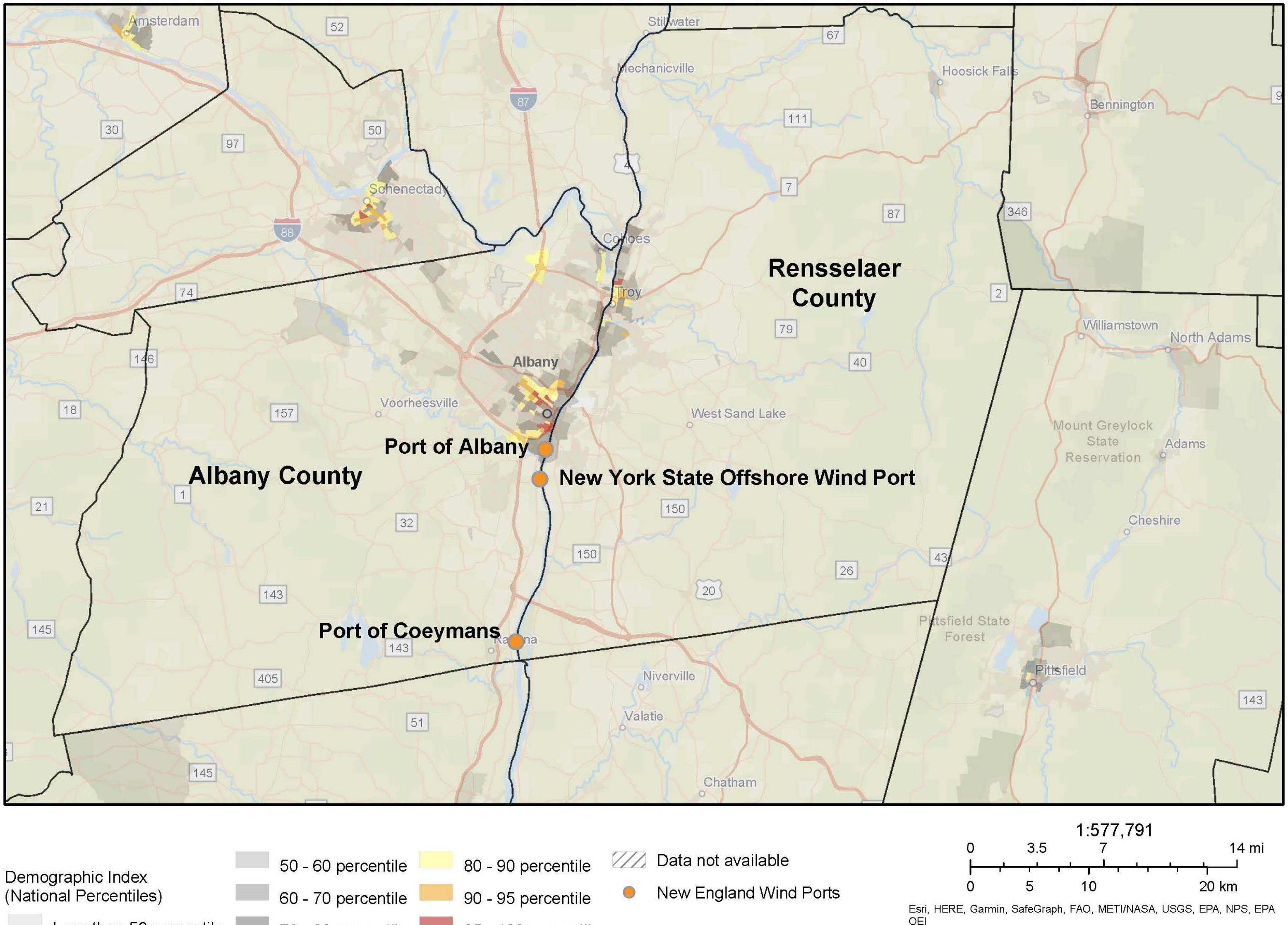
Source: USEPA 2022b

Figure 3.12-12: Environmental Justice Communities in Suffolk County, New York



Source: USEPA 2022b

Figure 3.12-13: Environmental Justice Communities in Richmond and Kings Counties, New York



Source: USEPA 2022b

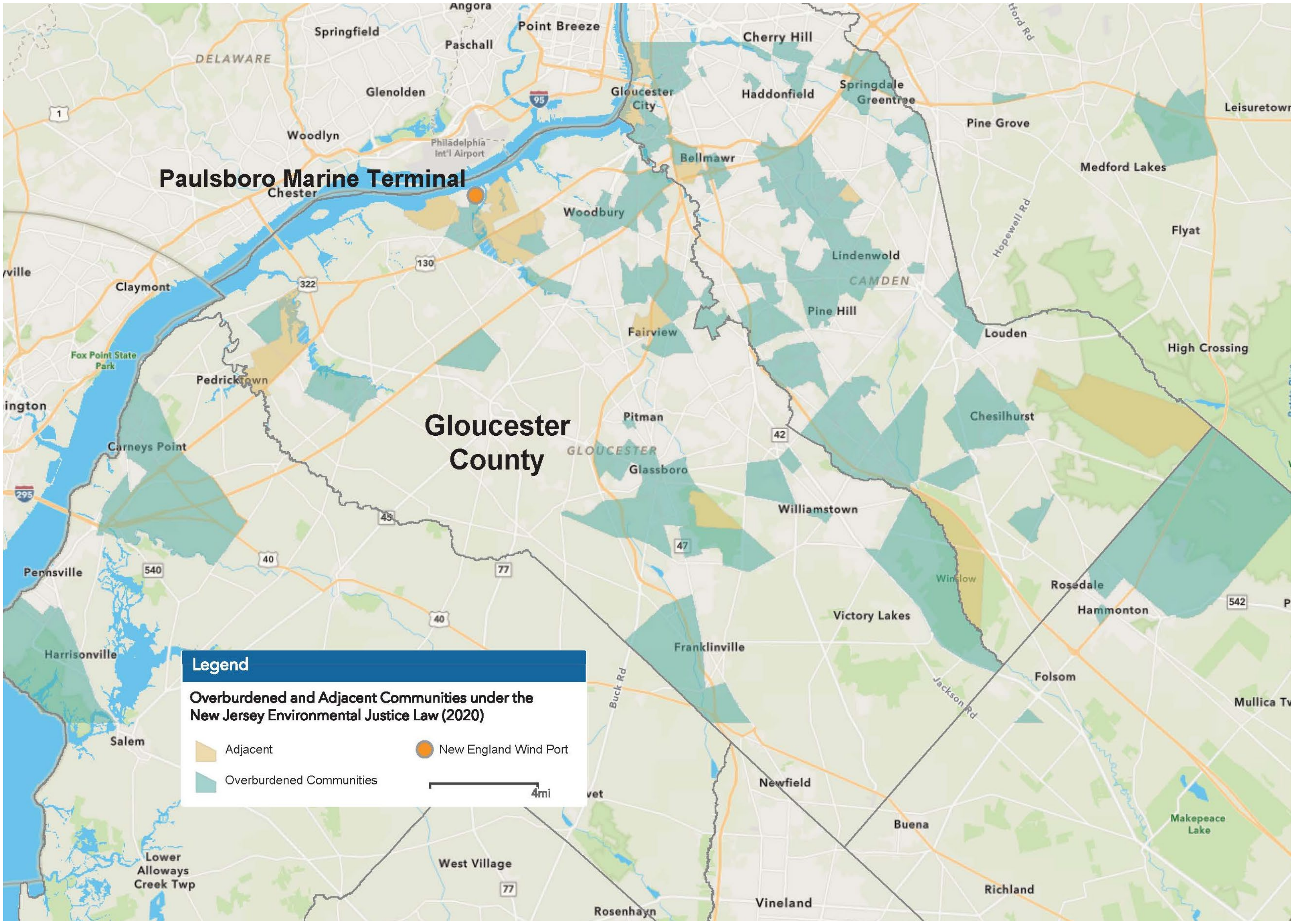
Figure 3.12-14: Environmental Justice Communities in Albany and Rensselaer Counties, New York

3.12.1.7 New Jersey

New Jersey SB 232 requires the New Jersey Department of Environmental Protection to "identify the state's overburdened communities and imposes new requirements on permits for certain facilities located within the same census tract as these communities, including facilities that are major sources of air pollution, incinerators, sludge processing facilities, sewage treatment plants, and landfills" (State of New Jersey 2020). In New Jersey, the term "overburdened" community is synonymous with the term "environmental justice community," and refers to a location where:

- At least 35 percent of the households qualify as low-income households (at or below twice the poverty threshold as determined by the U.S. Census Bureau);
- At least 40 percent of the residents identify as minority or as a member of a state-recognized tribal community; or
- At least 40 percent of the households have limited English proficiency (based on U.S. Census definitions).

A community that meets environmental justice criteria for income is adjacent to the Paulsboro port site.



Source: NJDEP 2022

Figure 3.12-15: Environmental Justice Communities in Gloucester County, New Jersey

3.12.1.8 Other Communities

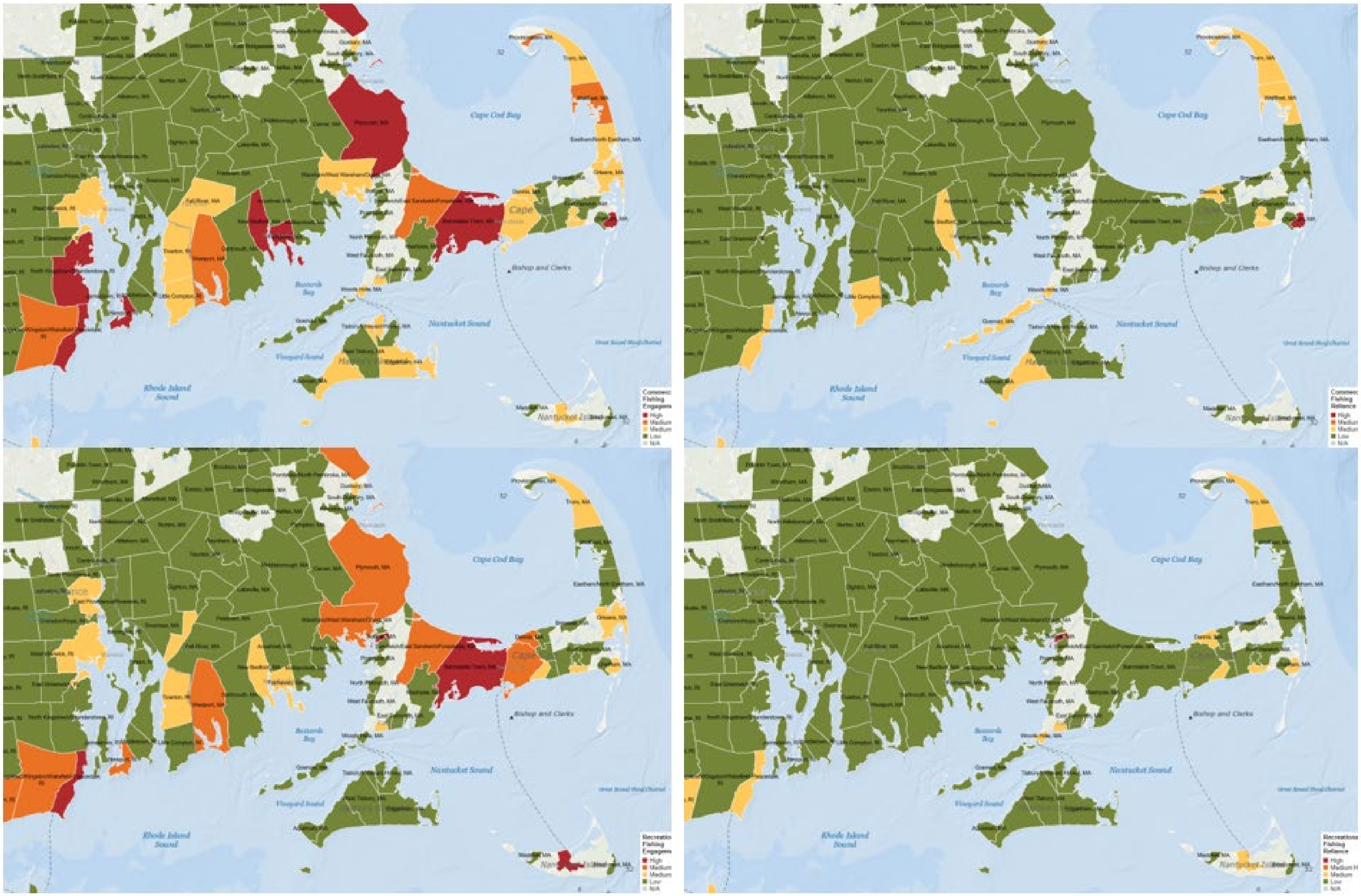
In addition to the geographic locations of environmental justice communities, low-income workers are found within the commercial fishing industry, service industries that support tourism, and other supporting industries. Ongoing development supports employment and economic development that may benefit some lower income workers, as discussed in Section 3.11, Demographics, Employment, and Economics. Offshore projects would provide continuing support for employment in the "ocean economy" sector, including, but not limited to, marine trades, vessel and port maintenance, and related industries.

Fishing industries generally provided higher wages and income than the tourist and recreation components of the ocean economy (Borges et al. 2017b). Commercial fishing is within the "living resource" sector of NOAA's Coastal Economy index, which also includes seafood processing, seafood markets, aquaculture, and fish hatcheries. Other low-income and minority workers may be employed in commercial fishing and supporting industries that provide employment on commercial fishing vessels, at seafood processing and distribution facilities, and in trades related to vessel and port maintenance, or operation of marinas, boat yards, and marine equipment suppliers and retailers. As discussed in Section 3.11, average wages for living resource sector employees were higher than the county average for all workers in Barnstable, Bristol, Dukes, Essex, and Nantucket counties in Massachusetts. Living resource wages were also higher than the average wage in Washington and Providence counties in Rhode Island, as well as all the counties in New York and New Jersey (Section 3.11).

The average wage obscures the range of income levels, which include higher income workers (ship's captains and managers), as well as lower-level or unskilled workers who earn substantially less than the average wage, including some self-employed individuals. Many lower-level workers in the living resource sector likely qualify as low-income and would, thus, be vulnerable to disruptions to employment in the commercial fishing industry.

NOAA's social indicator mapping (Figure 3.12-16) identifies environmental justice populations in the geographic analysis area that also have a high level of fishing engagement or fishing reliance. The fishing engagement and reliance indices portray the importance or level of dependence on commercial or recreational fishing of coastal communities. Engagement measures the presence of commercial or recreational fishing through fishing activity, as shown through permits, fish dealers, and vessel landings. Reliance measures the presence of commercial or recreational fishing in relation to the population size of a community through community fishing activity (NOAA 2022g).

The Town of Barnstable, Massachusetts, would house physical components of the proposed Project. Barnstable has a high level of both commercial and recreational fishing engagement but low levels of both commercial and recreational fishing reliance. Environmental justice communities in Barnstable meet state and federal criteria for minority populations alone, low-income populations alone, and both minority and low-income populations (NOAA 2022g).



Source: NOAA 2022g

Figure 3.12-16: National Oceanic and Atmospheric Administration Social Indicator Mapping, Southeast Massachusetts and Vicinity

The Port of Bridgeport, Connecticut would be the base for proposed Project operations activities, including vessel traffic. Bridgeport has low levels of engagement and reliance for both commercial and recreational fishing (NOAA 2022g).

NOAA has also developed social indicator mapping related to gentrification pressure (NOAA 2022g). The gentrification pressure indicators measure factors that, over time, may indicate a threat to the viability of a commercial or recreational working waterfront. Gentrification indicators are related to housing disruption, retiree migration, and urban sprawl and are detailed as follows:

- Housing disruption represents factors that indicate a fluctuating housing market where some displacement may occur due to rising home values and rents including changes in mortgage values. A high rank means more vulnerability for those in need of affordable housing and a population more vulnerable to gentrification.
- Retiree migration characterizes communities with a higher concentration of retirees and elderly people in the population including households with inhabitants over 65 years, population receiving social security or retirement income, and level of participation in the work force. A high rank indicates a working waterfront population that is more vulnerable to gentrification due to retirees seeking the amenities of coastal living.
- Urban sprawl describes areas experiencing gentrification through increasing population density, proximity to urban centers, home values, and the cost of living. A high rank indicates a population more vulnerable to gentrification.

Mapping for gentrification indices shows that the Town of Barnstable has medium to high levels of housing disruption. For both retiree migration and urban sprawl, the levels are medium to low pressure.

Environmental justice analyses must also address impacts on Native American tribes. Federal agencies should evaluate "interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action," and “recognize that the impacts within… Indian tribes may be different from impacts on the general population due to a community’s distinct cultural practices” (CEQ 1997). Factors that could lead to a finding of significance to environmental justice populations include loss of significant cultural or historical resources and the impact’s relation to other cumulatively significant impacts (USEPA 2016).

The geographic analysis area for environmental justice includes the Chappaquiddick Island TCP, which includes the western portion of Martha’s Vineyard. In addition, the Nantucket Sound TCP and Vineyard Sound and Moshup’s Bridge TCP include coastal areas of Martha’s Vineyard and Nantucket, as well as areas of open water. BOEM has invited the following federally recognized tribes with ancestral associations to lands within the geographic analysis area to participate in government-to-government consultation and the NHPA Section 106 consultation process: the Delaware Tribe of Indians, the Mashantucket (Western) Pequot Tribal Nation, the Mashpee Wampanoag Tribe of Massachusetts, the Mohegan Tribe of Connecticut, the Delaware Nation, the Narragansett Indian Tribe, the Shinnecock Indian Nations, and the Wampanoag Tribe of Gay Head (Aquinnah). Section 3.10, Cultural Resources; and Appendix J, Finding of Adverse Effect for the New England Wind Project Construction and Operations Plan, and the Cumulative Historic Properties Visual Effects Assessment (BOEM 2022d) describe the proposed Project’s impacts on tribal resources.

3.12.2 Environmental Consequences

Definitions of potential impact levels for environmental justice are provided in Table 3.12-2.

Table 3.12-2: Impact Level Definitions for Environmental Justice

Impact Level	Impact Type	Definition
Negligible	Adverse	Adverse impacts on environmental justice populations would be small and unmeasurable.
	Beneficial	Beneficial impacts on environmental justice populations would be small and unmeasurable.
Minor	Adverse	Adverse impacts on environmental justice populations would be small and measurable but would not disrupt the normal or routine functions of the affected population.
	Beneficial	Environmental justice populations would experience a small and measurable improvement in human health, employment, facilities or community services, or other economic or quality-of-life improvement.
Moderate	Adverse	Environmental justice populations would have to adjust somewhat to account for disruptions due to notable and measurable adverse impacts.
	Beneficial	Environmental justice populations would experience a notable and measurable improvement in human health, employment, facilities or community services, or other economic or quality-of-life improvement.
Major	Adverse	Environmental justice populations would have to adjust to significant disruptions due to notable and measurable adverse impacts. The affected population may experience measurable long-term impacts.
	Beneficial	Environmental justice populations would experience a substantial long-term improvement in human health, employment, facilities or community services, or other economic or quality-of-life improvement.

3.12.2.1 Impacts of Alternative A – No Action Alternative on Environmental Justice

When analyzing the impacts of Alternative A on environmental justice, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for environmental justice (Table G.1-9 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for environmental justice described in Section 3.12.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on environmental justice include regional demographic and economic trends. While the proposed Project would not be built under Alternative A, ongoing activities, future non-offshore wind activities, and future offshore wind activities would continue to sustain and support growth of the geographic analysis area's diverse economy, based on anticipated population growth and ongoing development of businesses and industry. Environmental impacts of these economic activities would continue to affect environmental justice communities. Tourism, recreation, and ocean economy activities, which employ individuals who meet environmental justice criteria, would continue to be important to the economies of the coastal areas, especially Barnstable, Nantucket, Washington, and Dukes counties. Marine industries such as commercial fishing and shipping would continue to be active and important components of the regional economy. Counties in the geographic analysis area would continue to seek to diversify their economies, protect environmental resources, and maintain or increase their year-round population, thus affecting existing environmental justice communities and populations.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on environmental justice include continued operation of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Ongoing operation of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 and

South Fork Wind Project, along with planned offshore wind activities, would affect environmental justice through the primary IPFs described below.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). In addition to the regional economic impact of a growing offshore wind industry, future offshore wind development would affect environmental justice through the following IPFs.

Air emissions: Increased port activity would generate short-term, variable increases in air emissions. As stated in Section G.2.1, Air Quality, the largest emissions for regulated air pollutants would occur during construction from diesel construction equipment, vessels, and commercial vehicles. Emissions at offshore locations would have regional impacts, with no disproportionate impacts on environmental justice communities.

Environmental justice communities near ports could experience disproportionate air quality impacts depending on the ports that are used, ambient air quality, and the increase in emissions at any given port. As described in Appendix E, up to six other offshore wind projects could be under construction simultaneously in 2025, and all projects in the RI/MA Lease Areas would be constructed between 2023 and 2030. The ports designated for use during construction of these other projects have not been identified but may include some of the ports identified for potential use during proposed Project construction. As described in Section 3.12.1, many of these ports are near environmental justice communities.

During construction, Alternative A emissions of criteria pollutants for criteria pollutants nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter smaller than 10 microns (PM_{10}), particulate matter smaller than 2.5 microns ($PM_{2.5}$), sulfur dioxide (SO_2), and volatile organic compounds would equal 42,821 tons over the total life of the projects (Section G.2.1). Construction emissions of nitrogen oxide (NO_x) and CO are primarily due to diesel construction equipment, vessels, and commercial vehicles. The CO_2 emissions make up the largest percentage of total construction emissions, resulting in about 2.5 million tons of CO_2 emissions for the projects within the air quality geographic analysis area (other than the proposed Project).The geographic analysis area for air quality (Figure G.2.1-1) is larger than the geographic analysis area for environmental justice. Thus, a large portion of the emissions would be generated along the vessel transit routes and in the OECC and SWDA rather than at ports near environmental justice communities. Emissions would vary spatially and temporally during construction stages for overlapping projects. Emissions from vessels, vehicles, and equipment operating in ports could affect environmental justice communities adjacent or close to those ports. Emissions attributable to Alternative A affecting any neighborhood have not been quantified; however, it is assumed that emissions from Alternative A at ports would comprise a small proportion of total emissions from those facilities and a small proportion of the total emissions affecting nearby environmental justice communities, regardless of source. The air emissions impacts of Alternative A would be greater if multiple offshore wind projects or non-offshore wind projects simultaneously use the same port for construction staging and could be less intense in any single environmental justice community if construction activity is distributed among several ports.

Future offshore wind projects within the air quality geographic analysis area would overlap during operations, but operations would contribute fewer criteria pollutant emissions compared to construction and decommissioning and would come largely from commercial vessel traffic and emergency diesel generators. The largest emissions would be NO_x (3,340 tons per year) and CO (780 tons per year). The other criteria pollutants would each account for approximately 50 to 100 tons per year of operations emissions (Section G.2.1). Operations air emissions would overall be short term, intermittent, widely dispersed, and generally contribute to small and localized air quality impacts. The ports used for operations at future offshore wind projects have not been identified but may include some of the ports used for construction.

The power generation capacity of offshore wind could potentially lead to lower regional air emissions by displacing fossil fuel plants for power generation, resulting in potential reduction in regional GHG emissions (Section G.2.1). Nationwide, exposure to fine particulate matter from fossil fuel electricity generation in the United States varies by income and race, with average exposures highest for Black individuals, followed by non-Hispanic White individuals. Exposures for other groups (i.e., Asian, Native American, and Hispanic) were somewhat lower. Exposures were higher for lower income populations than for higher income populations, but disparities were larger by race than by income (Thind et al. 2019). Although not specific to power generation, average population-weighted $PM_{2.5}$ and NO_2 concentrations in Massachusetts were highest for urban non-Hispanic Black populations and urban Hispanic populations, respectively (Rosofsky et al. 2017).

Exposure to air pollution is linked to health impacts, including respiratory illness, increased health care costs, and mortality. A 2016 study for the Mid-Atlantic region found that offshore wind could produce measurable benefits measured in health costs and reduction in loss of life due to displacement of fossil fuel power generation (Buonocore et al. 2016). Environmental justice populations in Massachusetts have disproportionately high exposure to air pollutants, likely leading to disproportionately high adverse health consequences. Accordingly, offshore wind generation analyzed under Alternative A would have potential benefits for environmental justice populations through reduction or avoidance of air emissions and associated reduction or avoidance of adverse health impacts. Operation of other offshore wind projects in the RI/MA Lease Areas would displace or avoid emissions from fossil fuel power generation and could potentially avoid \$4.64 to \$10.32 billion in annual health costs and 463 to 971 annual deaths (Section G.2.1).

Cable emplacement and maintenance: Cable emplacement for offshore wind projects in the RI/MA Lease Areas (other than the proposed Project) would affect approximately 21,975 acres of seafloor (Appendix E), all of which would be in open waters outside of the counties included in the geographic analysis area for environmental justice. Assuming future projects use offshore and onshore installation procedures similar to those described for the proposed Project (COP Volume I, Sections 3.3.1 and 4.3.1; Epsilon 2023), cable emplacement could displace other marine activities for a period of 1 day to several months within offshore cable installation areas. Cable installation and maintenance would have localized, temporary, short-term impacts on the revenue and operating costs of commercial and for-hire fishing businesses (Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing). Commercial fishing operations may temporarily be less productive during cable installation or repair, resulting in reduced income and also leading to short-term reductions in business volumes for seafood processing and wholesaling businesses that depend on the commercial fishing industry. Although commercial and for-hire fishing businesses could temporarily adjust their operating locations to avoid revenue loss, the impacts would be greater if multiple cable installation or repair projects are underway offshore of the environmental justice geographic analysis area at one time. Business impacts could affect environmental justice populations due to the potential loss of income or jobs by low-income workers in the commercial fishing industry. In addition, cable installation and maintenance could temporarily disrupt subsistence fishing, resulting in short-term and localized impacts on low-income residents and tribal members who rely on subsistence fishing as a food source, as well as tribal members for whom fishing and clamming is also a cultural practice.

Cable emplacement could damage submerged ancient landforms that may have cultural significance to Native American tribes as part of ancient and ongoing tribal practices and as portions of a landscape occupied by their ancestors (Section 3.11). Disturbance and destruction of even a portion of an identified submerged landform could degrade or even eliminate the value of these resources as potential repositories of archaeological knowledge and cultural significance to tribes. If these landforms are disturbed during offshore cable emplacement, the impact on the cultural resource would be permanent, resulting in a disproportionately large and adverse impact on the affected Native American tribes.

Maintenance activities for other offshore wind projects could potentially overlap temporally and spatially with Phase 1 cable maintenance activities, but such overlaps would be rare.

Land disturbance: Offshore wind development would require onshore cable installation, substation construction or expansion, and possibly expansion of shore-based port facilities. Depending on siting, land disturbance could result in temporary, localized, variable disturbances of neighborhoods and businesses near cable routes and construction sites due to typical construction impacts such as increased noise, dust, traffic, and road disturbances. Potential short-term and variable impacts on environmental justice communities could result from land disturbance, depending on the particular location of onshore construction for each offshore wind project.

Lighting: The view of nighttime aviation warning lighting required for offshore wind structures could have impacts on economic activity in locations where lighting is visible, by affecting the decisions of tourists or visitors in selecting coastal locations to visit. Service industries that support tourism are a source of employment and income for low-income workers. Impacts on tourism are anticipated to be localized, not industry-wide (Section 3.15, Recreation and Tourism), and would, thus, have little impact on environmental justice populations. Lighting on WTGs could also affect cultural and historic resources, including views of night sky and the ocean that are important to Native American tribes. Section 3.10 evaluates visual resources impacts on historic and cultural resources.

As additional offshore wind projects become operational, the nighttime lighting would be visible from a greater number of coastal locations. The aviation hazard lighting from approximately 903 WTGs could potentially be visible from beaches and coastal areas in the environmental justice geographic analysis area, depending on vegetation, topography, weather, and atmospheric conditions. Aviation hazard lighting is evaluated as part of the discussion of visual impacts on recreation and tourism in Section 3.11. The impacts on recreation- and tourism-related economic activity, if any, would be long term and continuous and could, in turn, have impacts on environmental justice populations, specifically low-income employees of tourism-related businesses. The visual impact of nighttime lighting would contribute to the disproportionately adverse visual impact on cultural resources important to Native American tribes, described under the presence of structures IPF. BOEM assumes that ongoing and planned offshore wind projects would also include ADLS, which would substantially reduce the amount of time aviation hazard lighting is used (Section 3.16, Scenic and Visual Resources).

Noise: Noise from site assessment G&G survey activities, pile driving, trenching, and vessels is likely to result in temporary revenue reductions for commercial fishing and marine recreational businesses that operate in the areas offshore from the geographic analysis area for environmental justice populations. Construction noise, especially site assessment G&G surveys and pile driving, would affect fish and marine mammal populations, with impacts on commercial and for-hire fishing and marine sightseeing businesses. The severity of impacts would depend on the proximity and temporal overlap of offshore wind survey and construction activities, as well as the location of noise-generating activities in relation to preferred locations for commercial/for-hire fishing and marine tours.

The localized impacts of offshore noise on fishing could also affect subsistence fishing by low-income residents and tribal members. In addition, noise would affect some for-hire fishing businesses or marine sightseeing businesses, as these visitor-oriented services are likely to avoid areas where noise is being generated due to the disruption for the customers.

Impacts of offshore noise on marine businesses would be short term and localized, occurring during surveying and construction, with no noticeable impacts during operations and only periodic and short-term impacts during maintenance. Noise impacts during surveying and construction would be more widespread when multiple offshore wind projects are under construction at the same time. The impacts of offshore noise on marine businesses and subsistence fishing would have short-term and localized impacts on low-income workers in marine-dependent businesses, as well as residents or tribal members who practice subsistence fishing and clamming, resulting in impacts on environmental justice populations. It is anticipated that most offshore construction activities would take place in the summer due to more favorable weather conditions. Thus, commercial/for-hire fisheries and marine sightseeing businesses most active in the summer would likely be impacted more than those active during the winter.

Onshore construction noise would temporarily inconvenience visitors, workers, and residents near sites where onshore cables, substations, or port improvements are installed to support offshore wind. Impacts would depend on the location of onshore construction in relation to businesses or environmental justice communities. Impacts on environmental justice communities would be short term and intermittent and would be similar to impacts from common onshore utility construction activity in the geographic analysis area not associated with offshore wind projects.

Noise generated by offshore wind construction activity at ports would potentially impact environmental justice communities near the ports described in Section 3.12.1. The noise impacts from increased port utilization would be short term and variable, limited to the construction period, and would increase if a port is used for multiple offshore wind projects during the same time period. Noise impacts would be reduced where intervening buildings, roads, or topography lessen the intensity of noise in nearby residential neighborhoods or if ports implement noise reduction mitigations for motorized vehicles and equipment.

Port utilization: Impacts on environmental justice communities near ports in the geographic analysis area (Section 3.12.1) would result from increased air emissions and noise generated by port utilization or expansion. Aside from these impacts, actual use and expansion of ports resulting from offshore wind would have beneficial impacts on employment at ports. Improvements and expansions to support offshore wind development are underway or completed at several ports in the geographic analysis area (Section 3.11). Port utilization for offshore wind would have short-term beneficial impacts for environmental justice populations during construction and decommissioning, resulting from employment opportunities, the support for other local businesses by the port-related businesses, and employee expenditures. Beneficial impacts would also result from port utilization during offshore wind operations, but these impacts would be of a lower magnitude.

Presence of structures: The WTGs, ESPs, and hard protection for cables associated with other offshore wind projects would affect employment and economic activity generated by marine-based businesses (Sections 3.9 and 3.11). Commercial fishing businesses would need to adjust routes and fishing grounds to avoid offshore work areas during construction and WTGs and ESPs during operations. Concrete cable protection and scour protection could result in gear loss and would make some fishing techniques unavailable in locations where cable protection exists. For-hire recreational fishing businesses would also need to avoid construction areas and offshore structures. Businesses that serve HMS recreational fishing are more likely to be affected because these fisheries are more likely to occur within wind development areas (whereas other fisheries tend to occur closer to shore). Sailing races (including, but not limited to, the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race) may need to be re-routed, potentially affecting the shore-based businesses that serve these interests.

A decrease in revenue, employment, and income within commercial fishing and marine recreational industries is likely to impact low-income workers, resulting in impacts on environmental justice populations. The impacts during construction would be short term and increase in magnitude when multiple offshore construction areas exist at the same time. As many as six offshore wind projects (excluding the proposed Project) could be under construction simultaneously in the waters offshore from the geographic analysis area in 2025. Impacts during operations would be long term and continuous but may lessen in magnitude as business operators adjust to the presence of offshore structures and as any temporary marine safety zones needed for construction are no longer needed.

In addition to the potential impacts on marine activity and supporting businesses, the fish aggregation and reef effects of WTGs and ESPs are anticipated to provide new opportunity for subsistence and recreational fishing, as well as attraction for recreational sightseeing businesses, potentially benefiting subsistence fishing and low-income employees of marine-dependent businesses.

Views of offshore WTGs could affect individual locations and businesses serving the recreation and tourism industry, based on visitor decisions to select or avoid certain locations. Because the service industries that support tourism are a source of employment and income for low-income workers, impacts on tourism would also result in impacts on environmental justice populations. Portions of all 903 WTGs associated with Alternative A could potentially be visible from south-facing shorelines and elevated areas, including lands and resources of significance to Native American tribes, as well as other areas that meet environmental justice criteria (Figures 3.12-3 through 3.12-5), depending on vegetation, topography, weather, and atmospheric conditions. Due to the significance of the resources to Native American tribes, views of WTGs from Alternative A would have a disproportionate and adverse impact. These WTGs, however, would not dominate offshore views, even when weather and atmospheric conditions allow clear views (Section 3.16). The impact of visible WTGs on recreation and tourism is likely to be limited to individual decisions by some visitors and is unlikely to affect most shore-based tourism businesses or the geographic analysis area's tourism industry as a whole (Section 3.11). Therefore, views of offshore WTGs are not anticipated to disproportionately impact other environmental justice populations, specifically low-income employees of tourism-related businesses.

Views of WTGs would affect cultural resources, including the Gay Head Lighthouse, as well as the Chappaquiddick Island, Vineyard Sound and Moshup's Bridge, and Nantucket Sound TCPs that are important to Native American tribes. BOEM has consulted with Native American tribes for whom views within TCPs are culturally important, as part of the review under the NHPA Section 106 (Section 3.10).

Traffic: Offshore wind construction, decommissioning, and, to a lesser extent, operations would generate increased vessel traffic. The volume of vessel traffic during construction would complicate marine navigation in the offshore construction areas and create the potential for vessel congestion, reduced capacity, and competition for docks and berths within and near the ports that support offshore wind construction. Temporary impacts on commercial fishing or recreational boating would affect all local boaters and would not have disproportionate impacts on residents or businesses within areas identified as environmental justice communities; however, the impact may be of greater magnitude for individuals who fish for subsistence (or as part of tribal practices) or members of environmental justice communities who depend on jobs in commercial/for-hire fishing or marine recreation (including seafood processing and packing industries) for their livelihood. Simultaneous development of multiple offshore wind projects could increase port-related vessel congestion, although impacts could be reduced by appropriate port planning and preparation. Accordingly, vessel traffic generated by offshore wind project construction would have short-term and variable impacts on environmental justice communities due to the impacts on jobs, income, and subsistence fishing resulting from impacts on marine businesses, port congestion, and availability of berths. The magnitude of impact would depend on the navigation patterns and the extent of facility preparation and planning at each port. In addition to the temporary impacts related to navigation and port availability, the increased need for marine transportation to support offshore wind could have beneficial impacts on environmental justice populations through the provision of jobs and support of businesses.

Conclusions

Impacts of Alternative A. Under Alternative A, environmental justice communities would continue to be affected by existing regional trends and respond to current and future environmental and societal activities. Notable ongoing trends include continued coastal development and gentrification of coastal communities; the continued importance of commercial shipping, commercial and recreational fishing, seafood processing, and tourism industries as employment sources for low-income residents; air emissions, noise, lighting, and traffic associated with onshore construction and land uses; periodic port and coastal infrastructure maintenance and upgrades; periodic channel dredging; and the use of small-scale onshore renewable energy. While the proposed Project would not be built under Alternative A, ongoing activities related to the IPFs, such as those listed above, would have **minor** adverse impacts and **minor** beneficial impacts on environmental justice communities from additional employment and reductions in emissions from fossil fuel-generated power plants.

Cumulative Impacts of Alternative A. Planned activities for coastal and marine activity other than offshore wind include development of diversified, small-scale, onshore renewable energy sources and peaker plants; ongoing onshore development at or near current rates; continued increases in the size of commercial vessels; potential port expansion and channel deepening activities; and efforts to protect against potential increased storm damage and sea level rise. The cumulative impacts on environmental justice communities would be **minor**, both adverse and beneficial, driven primarily by additional employment, the continued operation of existing marine industries, especially commercial fishing, recreation/tourism, and shipping; increased pressure for environmental protection of coastal resources; the need for port maintenance and upgrades; and the risks of storm damage and sea level rise.

3.12.2.2 Relevant Design Parameters and Potential Variances in Impacts

Impacts on environmental justice communities would occur when the proposed Project's impacts on other resources, such as air quality, water quality, employment and economics, cultural resources, recreation and tourism, commercial fishing, or navigation, are felt disproportionately within environmental justice communities, due either to the location of these communities in relation to the proposed Project or to their higher vulnerability to impacts. The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of impacts on environmental justice:

- Two different maximum-case scenarios for environmental justice:
  - The maximum-case scenario for income and employment would be 130 WTGs (the maximum number of WTGs allowed in the PDE), which would have the maximum impact on vessel traffic for commercial and recreational fishing and boating and related industries that provide employment for low-income workers; and
  - The maximum-case scenario for visual impacts, including visual impacts that affect businesses that employ workers from environmental justice communities, as well as visual impacts on cultural resources of significance to Native American tribes, would be 130 of the largest (and tallest) WTGs, each with maximum vertical blade tip height of 1,171 feet MLLW and maximum nacelle-top height of 725 feet MLLW. Use of the tallest WTGs would increase the number and portion of WTGs visible from cultural resources.

- The time of year construction occurs. The applicant would likely schedule onshore construction to take place after Labor Day and before Memorial Day, outside of the busiest tourist season on Cape Cod, Martha's Vineyard, and Nantucket (COP Volume I, Section 3.3.1; Epsilon 2023). If the schedule were to shift such that construction of the cable landfalls and OECRs occurred during the tourist season, the proposed Project would have substantially larger impacts on land use, employment and economics, and recreation and tourism, which could disproportionately affect environmental justice communities; and
- The ports chosen for construction support and the improvements needed at those ports to support offshore wind activity, including the proposed Project.

3.12.2.3 Impacts of Alternative B – Proposed Action on Environmental Justice

This section identifies the potential impacts of Alternative B on environmental justice. When analyzing the impacts of Alternative B on environmental justice, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for environmental justice.

Impacts of Phase 1

Phase 1 would affect environmental justice through the following primary IPFs during construction, operations, and decommissioning.

Air emissions: Emissions at offshore construction locations would have regional impacts, with no disproportionate impacts on environmental justice communities. However, environmental justice communities near ports, the OECRs, and onshore substation site could experience disproportionate air quality impacts, depending on the ports that are used, ambient air quality, and the increase in emissions at any given port.

As discussed in Section 3.12.1 and shown on Figures 3.12-2 through 3.12-15, all of the Phase 1 construction ports except the Shoreham site and Port of Coeymans are near or within environmental justice communities. As discussed in detail in Section G.2.1, communities near Vineyard Haven Harbor, the Port of Bridgeport, the New London State Pier, the Paulsboro Marine Termina, and the ports in Kings, Richmond, and Suffolk counties, New York (Table 3.12-1) are in designated nonattainment and/or maintenance areas for one or more criteria pollutants. Phase 1's contributions to increased air emissions at ports identified for potential use for construction activities near environmental justice communities (i.e., county-level emissions) are not available. Also, as discussed in Section G.2.1, overall air emissions impacts would be minor during Phase 1 construction, with the greatest quantity of emissions produced within the SWDA and by vessels transiting from ports to the SWDA. As a result, air emissions from Phase 1 would have negligible impacts on environmental justice communities near the ports and onshore proposed Project facilities.

Other offshore wind projects using ports within the geographic analysis area for environmental justice populations would overlap with Phase 1 construction and generate short-term air quality impacts at ports, in transit between ports and offshore construction areas, and within the offshore construction areas for each other offshore wind project. As shown in Figures 3.12-2 through 3.12-15, most of the 19 ports listed in Table 3.12-1 are adjacent to or near communities that meet state or federal environmental justice criteria. As discussed in Section 3.13, Navigation and Vessel Traffic, and Section G.2.7, Land Use and Coastal Infrastructure, some ports in the region are being expanded, and other new ports have been proposed to serve the offshore wind industry as a whole. The applicant has not stated which ports would be used for Phase 1 (or Phase 2) construction, or the level of activity at any single port. No port expansions would occur as a direct result of Phase 1 (COP Volume I, Section 3.2.2.5; Epsilon 2023). Most air emissions would occur at offshore locations rather than at the ports. As a result, the air quality impacts of Phase 1 construction would be negligible for any single community and negligible to minor overall.

Net reductions in criteria air pollutant emissions due to Phase 1 operations would result in long-term benefits to communities (regardless of environmental justice status) by displacing or avoiding emissions from fossil fuel-generated power plants. Based on the overall health benefits of Alternative A, as discussed in Section G.2.1, displacing 804 MW of fossil fuel power generation with an equivalent amount of offshore wind power generation from Phase 1 could potentially avoid $169 to $377 million in annual health costs and 17 to 35 annual deaths that would otherwise have resulted from air emissions. As noted under Alternative A, minority and low-income populations are disproportionately impacted by emissions from fossil fuel power plants nationwide and by higher levels of air pollutants. Therefore, Phase 1 could benefit environmental justice communities by displacing fossil fuel power-generating capacity within or near the geographic analysis area. As a result, operations of Phase 1 would have negligible to minor beneficial impacts on environmental justice communities throughout the geographic analysis area.

Cable emplacement and maintenance: Cable emplacement for Phase 1 would temporarily impact commercial/for-hire fishing businesses, marine recreation, and subsistence fishing during cable installation. Phase 1 cable emplacement would have short-term, localized, and minor impacts on marine businesses (commercial fishing or recreation businesses) and subsistence fishing (Section 3.11). Construction of offshore components for Phase 1 would, therefore, have a short-term and minor impact on low-income workers in marine businesses. BOEM is evaluating the following mitigation and monitoring measure to address impacts on environmental justice, as described in detail in Table H-2 of Appendix H, Mitigation and Monitoring. The Final EIS lists the mitigation and monitoring measures that BOEM would require as a condition of COP approval:

- Continue to engage with environmental justice communities (including, but not limited to, federally recognized Native American tribes) within the geographic analysis area to increase awareness of, and potential participation in, proposed fishing compensation, trust, and innovation funds.

This mitigation and monitoring measure could marginally reduce impacts on tribe members in the commercial or recreational fishing industries; however, the magnitude of these impacts would remain minor.

Cable emplacement would disrupt submerged ancient landforms that hold cultural significance for Native American tribes. Marine geophysical remote sensing studies performed for Phase 1 identified 26 submerged landform features (stream channel, lake, and estuarine landscape features) within the SWDA and OECC (Section 3.10). While HRG and geotechnical studies for the proposed Project did not find any direct evidence of pre-contact period Native American cultural materials, the submerged landforms are considered culturally significant by regional Native American tribes as portions of a landscape occupied by their ancestors. Disturbance and destruction of even a portion of an identified submerged landform could threaten the value of these resources as potential repositories of archaeological knowledge and cultural significance to tribes. Construction of Phase 1 would result in large-scale, permanent impacts on 25 submerged landforms. With implementation of a treatment plan agreed to by all parties, Section 3.10 concludes that impacts on submerged landforms would be major, due to reduced value and integrity of the submerged landscapes. As a result, cable emplacement would also result in major environmental justice impacts on the Native American tribes that consider the submerged landscapes to be part of their ancient and ongoing tribal practices and as portions of a landscape occupied by their ancestors.

During NHPA Section 106 consultation for Vineyard Wind 1 (BOEM 2021b), the state-recognized Chappaquiddick Wampanoag Tribe raised concerns regarding sediment plumes, coastal erosion, and cable installation from Vineyard Wind 1 on natural and cultural resources on Chappaquiddick Island. In particular, concerns were raised about potential increase in shoreline erosion along Chappaquiddick Island at the eastern end of Martha's Vineyard, which could impact traditional hunting, fishing, and shellfishing. The Phase 1 OECC would be at approximately 3,900 feet offshore from the Chappaquiddick Island shoreline at its closest point. Section 3.4, Benthic Resources, concludes that the impacts of cable emplacement on sediment deposition and burial would be minor, based on the applicant's modeling of the potential distribution of suspended sediment during dredging and cable installation (COP Appendix III-A; Epsilon 2023). The sediment model indicated that sediment deposition greater than 0.04 inch would be mostly limited to within approximately 492 feet of the cable centerline (COP Appendix III-A; Epsilon 2023). Accordingly, cable emplacement from Phase 1 would have a negligible impact on fishing and shellfishing practices of the state-recognized Chappaquiddick Wampanoag Tribe due to coastal erosion and sediment deposition on Chappaquiddick Island.

Onshore construction includes installation of the onshore cable, primarily within public road and utility ROWs, and substation construction within a designated industrial area. Air emissions from onshore construction of Phase 1 would be temporary and variable, with negligible impacts on environmental justice communities.

Cable emplacement and maintenance during Phase 1 operations would temporarily affect commercial/for-hire fishing businesses, marine recreation, and subsistence fishing during infrequent cable maintenance activities. These maintenance activities would have short-term, localized, and minor impacts on marine businesses (commercial fishing or recreation businesses) and subsistence fishing (Section 3.11) and would, therefore, have a short-term and negligible impact on low-income workers in marine businesses.

Cables emplaced during construction would continue to affect cultural resources, especially submerged landform features. Additional ground-disturbing activities associated with maintenance could result in additional disturbance and destruction of potential shipwrecks or identified submerged landform features, resulting in potentially major impacts on Native American tribes that consider the submerged landscapes part of their ancient and ongoing tribal practices and as portions of a landscape occupied by their ancestors.

Land disturbance: One route option for the Phase 1 OECR would pass through a census block group in Centerville (about 1.5 miles north of the Phase 1 cable landing sites) that meets environmental justice criteria for minority population status (Figure 3.12-3), and the majority of the Phase 1 OECR would be within 1 mile of block groups that meet low-income and/or minority environmental justice criteria (Figure 3.12-5). Construction of the OECR would temporarily disturb neighboring land uses through construction noise, vibration, and dust, as well as delays in travel along the impacted roads. All block groups (and the communities they contain) would equally experience these impacts, regardless of environmental justice status, and access to neighborhoods would be maintained. Construction of landfall sites would occur outside of peak summer tourist season (i.e., Memorial Day to Labor Day) and only affect a portion of the parking lots at Craigville Beach or Covell's Beach. Accordingly, land disturbance from the onshore construction of Phase 1, including the OECR and landfall sites, would have temporary and negligible impacts on environmental justice communities. Phase 1's onshore land disturbance activities are not anticipated to overlap in location with other offshore wind projects.

During operations, the onshore transmission cable infrastructure, including cable landfall sites and onshore cables, would be underground and primarily within roads and utility ROWs, while the substation would operate within an industrial area. As a result, operations and occasional maintenance or repair operations from Phase 1 would have negligible impacts and would not result in disproportionate impacts on environmental justice communities.

Lighting: Phase 1 would not include nighttime onshore construction, except as specifically permitted or requested by local permitting authorities (COP Volume I, Section 3.3.1.1.1; Epsilon 2023). Nighttime construction of Phase 1 would require lighting for vessels in transit and at offshore construction work areas. Phase 1 vessel lighting would not have measurable impacts; therefore, lighting from Phase 1 would have short-term and negligible impacts. Vessel lighting from other offshore wind projects would have similar impacts as Phase 1 but at different locations and times. If lighting from vessels occurred simultaneously, the impacts on environmental justice communities from ongoing and planned activities, including Phase 1, would also be short term and negligible.

Aviation hazard lighting on WTGs could be visible from coastal locations on Martha's Vineyard and Nantucket, depending on vegetation, topography, weather, and atmospheric conditions. Nighttime lighting would affect views of the horizon and the night sky from locations with historic and cultural importance to Native American tribes (Section 3.10). Because the proposed Project would use ADLS, aviation hazard lighting would be activated less than 0.1 percent of annual nighttime hours per year (Section 3.16). As a result, the lighting of offshore structures from Phase 1 would result in a long-term, intermittent, and negligible impact on environmental justice communities due to the negligible impact on views important to Native American tribes and the recreation/tourism economic sector that provides employment for low-income workers.

Noise: Noise from Phase 1 construction (primarily pile driving) during offshore wind development would have short-term impacts on fish (Section 3.6, Finfish, Invertebrates, and Essential Fish Habitat) and marine mammals (Section 3.7, Marine Mammals). These increased impacts would affect the fishing and sightseeing businesses that rely on these species, resulting in impacts on employment, income, and subsistence fishing (Section 3.11). Phase 1 site assessment G&G survey activities, operations and maintenance, pile driving, trenching, and vessels would have short-term, intermittent, and negligible impacts on visitors, workers, and residents. Therefore, Phase 1 construction noise would have short-term and negligible impacts on the members of environmental justice populations who rely on subsistence fishing or employment and income from marine businesses. Similarly, offshore construction noise would have negligible impacts on cultural practices of and values held by Native American tribes related to fish, shellfish, or marine mammal populations. Appendix H details mitigation plans, including the use of PAM buoys or autonomous PAM devices to record ambient noise before, during, and after construction, for at least 2 years of operations to monitor impacts. Data and reports from the PAM and other monitoring plans and reports will be shared with federally recognized Native American tribes that are engaged in government-to-government consultation on the proposed Project.

Although no port expansion is proposed in connection with the proposed Project, noise generated by Phase 1 activity at ports would potentially have disproportionately high impacts on environmental justice communities near ports (Section 3.12.1), especially if no sound buffering exists between the port and those communities. As a result, noise from Phase 1 would have short-term, variable, and negligible to minor impacts on environmental justice communities near the ports. Noise from onshore construction of Phase 1 (for the substation and onshore cable route) would be temporary and variable, with negligible impacts on environmental justice communities.

Noise from Phase 1 operations would be similar to construction except for the absence of pile driving, which would occur infrequently during planned or unplanned maintenance activities. Noise from Phase 1 operations would, therefore, have negligible impacts on environmental justice communities. Noise from Phase 1 decommissioning is expected to have similar types of noise impacts, except for the absence of pile driving. Noise from Phase 1 decommissioning would, therefore, have negligible impacts on environmental justice communities.

Port utilization: As stated above, Phase 1 construction would use as many as 19 ports in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey (Section 3.12.1). Several of these ports are within, surrounded by, or near (i.e., within 1 mile of) populations that meet environmental justice criteria based on race/ethnicity, income, and/or linguistic isolation (COP Volume III, Section 7.2; Epsilon 2023). Use and (in some cases) expansion of these ports for offshore wind activity is generally consistent with existing and designated future land use and other plans for these sites (Section G.2.7) and generally would not displace or adversely affect residents or existing businesses.

Phase 1 does not include expansion of any specific port but would use ports that have expanded or would expand to support the offshore wind energy industry. Contributions of Phase 1 to increased utilization of ports may have beneficial impacts on environmental justice communities due to increased employment opportunities and business activity. BOEM could require the applicant, as a condition of COP approval, to prepare a local hiring plan similar to the plan developed for Vineyard Wind 1 (BOEM 2021b). Such a plan could enhance local hiring, possibly including hiring of low-income or minority residents of the geographic analysis area. The additional requirement described in Appendix A, Required Environmental Permits and Consultations, to coordinate with the federally recognized Mashpee Wampanoag Tribe of Massachusetts and Wampanoag Tribe of Gay Head (Aquinnah) during implementation of the local hiring plan, when possible and appropriate, could result in increased employment opportunities for members of these tribes. The impacts of Phase 1 on environmental justice communities from increased port utilization could result from temporary air emissions and noise during construction and would be negligible, in addition to the potential minor beneficial impacts of new hiring and economic activity for local businesses.

Phase 1 operations would include operations facilities and activities at Bridgeport, Vineyard Haven, and potentially Greenport Harbor, all of which are within or near potential environmental justice communities. Impacts associated with port utilization during Phase 1 operations would be similar to the construction impacts but would only occur in the operations ports. Operations activities in these ports would contribute positively to employment opportunities and economic activity within or near environmental justice communities and would have no disproportionate or adverse impacts on low-income or minority populations. As a result, Phase 1 operations would have localized, long-term, and negligible impacts on environmental justice populations near operations ports due to air and noise emissions, as well as minor beneficial impacts on environmental justice populations due to hiring and economic activity.

Presence of structures: Construction of WTGs, ESPs, and hard cover for cables would result in both adverse and beneficial impacts on marine businesses and subsistence fishing. Beneficial impacts would be generated by the reef effect of offshore structures, which could provide additional opportunity for subsistence fishing, tour boats, and for-hire recreational fishing businesses. Adverse impacts would result from navigational complexity within the SWDA, disturbance of customary routes and fishing locations, and the presence of scour protection and cable hard cover, leading to possible equipment loss and limited commercial fishing methods. Overall, the offshore structures for Phase 1 would have minor to moderate impacts on marine businesses (Sections 3.15 and 3.16), resulting in long-term, continuous, and minor impacts on environmental justice populations due to the impact on low-income workers in marine industries and low-income residents and tribal members who rely on subsistence fishing.

Portions of all of Phase 1's WTGs could potentially be visible from coastal locations on Martha's Vineyard, Nantucket, and mainland Cape Cod, depending on vegetation, topography, and atmospheric conditions. The impact of visible WTGs on recreation and tourism is anticipated to be minor, and the impact is unlikely to meaningfully affect the recreation and tourism industry as a whole (Section 3.15). Views of WTGs associated with Phase 1 are, therefore, anticipated to have a negligible impact on environmental justice populations based on the minimal anticipated impact on low-income employees of the recreation and tourism economic sector.

The impacts of offshore wind activities on maritime views along the southern coasts of Martha's Vineyard, Nantucket, Cape Cod, and nearby islands would be experienced equally by all populations; however, the visible presence of offshore wind structures would have disproportionate impacts on certain Native American tribes, due to the cultural significance of some ocean views. Visual impacts on certain views with cultural significance to Native American tribes are addressed in detail through the NHPA Section 106 consultation and tribal consultation, as discussed in Section 3.10 and Appendix J. Phase 1 WTGs would adversely affect the Gay Head Lighthouse and the Chappaquiddick Island, Vineyard Sound and Moshup's Bridge, and Nantucket Sound TCPs (Section 3.10). Views from the Gay Head Cliffs and Aquinnah Cultural Center (near the Gay Head Lighthouse property) and portions of the Chappaquiddick Island TCP have historic and cultural significance for the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe, respectively. The scale, extent, and intensity of these impacts would be partially mitigated by environmental and atmospheric factors such as clouds, haze, fog, sea spray, vegetation, and wave height that would partially or fully screen the WTGs from view during various times throughout the year (BOEM 2022d). In addition, Phase 1 would only affect southern views from these resources. To further minimize and mitigate Phase 1's impacts, Vineyard Wind has voluntarily committed to using ADLS and non-reflective pure white (RAL Number 9010) or light gray (RAL Number 7035) paint on offshore infrastructure to minimize daytime visual impacts.

The final minimization and mitigation of adverse impacts would be determined through completion of BOEM's NHPA Section 106 review process and included as conditions of COP approval, but Section 3.10 concludes that the visual impact on the historic resources would be moderate. Accordingly, Phase 1, with the mitigation listed above, would have a long-term, continuous, disproportionately adverse, and moderate impact on Native American tribes including the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe.

Traffic: Phase 1 construction would generate vessel traffic within and near the ports described in Section 3.12.1. Vessel traffic associated with Phase 1 construction would have a short-term and minor impact on commercial and for-hire recreational fishing (Section 3.11) due to increased vessel traffic near ports and at the SWDA. Based on the minor impacts on commercial and for-hire recreational fishing, construction of Phase 1 would have a short-term and negligible impact on low-income residents or tribal members involved in the commercial fishing industry or subsistence fishing.

Vessel traffic from Phase 1 and in combination with other offshore wind projects would also have minor beneficial impacts on environmental justice communities through increased employment and economic activity for marine transportation and supporting businesses.

Section 2.3 describes the non-routine activities associated with the Phase 1. Spills from maintenance or repair vessels or activities requiring repair of WTGs, equipment, or cables would generally require intense, temporary activity associated with oil spill response (COP Appendix I-F; Epsilon 2023) or to address emergency conditions. The presence of unexpectedly frequent vessel activity in Bridgeport, Vineyard Haven Harbor, or Greenport Harbor, and in offshore locations over the OECC or near individual WTGs or ESPs, could temporarily prevent or deter subsistence or commercial fishing or for-hire recreational fishing, or tourist activities near the site of a given non-routine event. As a result, the impacts of non-routine activities resulting from Phase 1 on environmental justice populations would be minor. The impacts of unplanned vessel traffic from other offshore wind projects would be similar to those described for Phase 1, spread across the RI/MA Lease Areas and geographic analysis area for environmental justice.

Impacts of Phase 2

The environmental justice impacts of Phase 2 construction, operations, and decommissioning would be similar to, but marginally more extensive than, those described for Phase 1 for IPFs related to air emissions, lighting, cable emplacement and maintenance, port utilization, the presence of structures, and vessel traffic. The Phase 2 OECR would not cross any block groups that meet state or federal environmental justice criteria but would generally be in a similar location and have similar impacts on environmental justice communities as the Phase 1 OECR. While Phase 2 would involve more WTGs and ESPs, a greater length of inter-array cables, and a different OECR in Barnstable, the incremental differences in activity between Phase 2 and Phase 1, as well as the combined impact of Phase 1 and Phase 2 together, would not change any of the adverse or beneficial impact magnitudes described for Phase 1 construction except for land disturbance, as described below.

If the applicant includes the SCV as part of the final proposed Project design, some or all of the impacts on environmental justice communities from Phase 2 in Barnstable County, Massachusetts, may not occur, while additional impacts could occur in Bristol County, Massachusetts. BOEM will provide a more detailed analysis of the impacts of the SCV on environmental justice in a supplemental NEPA analysis, if the SCV is selected.

Land disturbance: If the Dowses Beach Landfall Site is selected, Phase 2 construction would cause disturbance during installation of the cable onshore/offshore transition vaults, as well as HDD or trenching in preparation for joining the onshore and offshore cables (COP Volume III, Section 7.5.2.1.1; Epsilon 2023). Construction would prevent the use of part of the beach parking lot and discourage (but not prevent) use of the accessible viewing/fishing pier at Dowses Beach. These impacts would be temporary but unavoidable during construction. The applicant would not perform activities at the landfall site during the months of June through September, unless authorized by the Town of Barnstable (COP Volume III, Section 75.2.1.3; Epsilon 2023). Onshore construction would have temporary, localized, and minor impacts on environmental justice.

The Phase 2 onshore export cables and splice vaults would be remotely monitored and require infrequent maintenance, typically completed by accessing the cables through manholes, which could cause temporary disturbance in the Dowses Beach parking lot (COP Volume III, Section 7.5.2.2.1; Epsilon 2023). During operations, the land disturbance impacts of the Phase 2 OECR on environmental justice populations would, therefore, be negligible.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-9 in Appendix G would contribute to impacts on environmental justice through the primary IPFs of cable emplacement and maintenance and the presence of structures. These impacts would primarily occur through impacts on cultural practices and values of Native American tribes resulting from views of WTGs, as well as damage to submerged ancient landforms; impacts on shellfish and fish that are targeted by commercial, recreational, subsistence, and tribal fishing; and impacts on recreation and tourism activities.

The cumulative impacts on environmental justice would be moderate, including some disproportionately adverse impacts on Native American tribes. Impacts on environmental justice communities near ports and onshore construction areas due to air emissions and noise would be minor.

Conclusions

Impacts of Alternative B. Alternative B would have **moderate** impacts and **minor** beneficial impacts on environmental justice populations within the geographic analysis area from additional employment and reductions in emissions from fossil fuel-generated power plants. This includes certain disproportionately adverse impacts on Native American tribes. During installation of the onshore cables and substation, the IPFs associated with Alternative B would result in negligible impacts on environmental justice communities due to air emissions and noise at ports and onshore construction sites. During both construction and operations, the impacts on low-income employees of marine industries and supporting businesses (commercial fishing, support industries, marine recreation, and tourism) from all IPFs would be minor from disruption of marine activities during offshore cable installation and the impacts on commercial and for-hire fishing resulting from the long-term presence of offshore structures. Damage to ancient submerged landforms resulting from offshore construction would result in major disproportionate impacts on Native American tribes in the region, who consider remnant ancient submerged landscape features to be TCP resources representing places where their ancestors lived. Coastal views of offshore structures would have impacts on cultural resources important to the federally recognized Wampanoag Tribe of Gay Head (Aquinnah) and the state-recognized Chappaquiddick Wampanoag Tribe, with moderate impacts on these tribes. Alternative B would have overall **moderate** impacts on all environmental justice populations.

Cumulative Impacts of Alternative B. The cumulative impacts on environmental justice in the geographic analysis area would be **moderate** and **minor** beneficial from additional employment and economic activity and reductions in emissions from fossil fuel-generated power plants. Impacts on low-income employees of marine industries and supporting businesses (commercial fishing, support industries, marine recreation and tourism) would be minor, based on the anticipated temporary disruption of marine activities due to offshore cable installation and construction noise and increased vessel traffic during construction, as well as long-term impacts on the marine-dependent businesses resulting from the long-term presence of offshore structures. Impacts on cultural resources significant to Native American tribes would include disproportionately adverse, and moderate impacts on culturally important ocean views and major impacts resulting from damage to submerged landforms during cable emplacement. Potentially beneficial impacts on environmental justice populations would result from port utilization and vessel traffic and the resulting employment and economic activity. Beneficial impacts could also result if wind energy displaces fossil fuel energy generation in locations that improve air quality and health outcomes for environmental justice populations. Impacts on environmental justice communities would occur when Alternative B's adverse impacts on other resources, such as air quality, water quality, employment and economics, cultural resources, recreation and tourism, commercial fishing, or navigation, are felt disproportionately within environmental justice communities, due either to the location of these communities in relation to Alternative B or to their higher vulnerability to impacts.

3.12.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Environmental Justice

When analyzing the impacts of Alternative C on environmental justice, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for environmental justice. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. These differences would not result in meaningfully different impacts compared to Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on environmental justice would be the same as those of Alternative B: **moderate** and **minor** beneficial. The cumulative impacts of Alternative C on environmental justice would also be **moderate** and **minor** beneficial.

3.12.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Environmental Justice with the Western Muskeget Variant Contingency Option

Impacts on environmental justice from the Preferred Alternative would be the same as Alternative B: **moderate** and **minor** beneficial. The cumulative impacts of the Preferred Alternative on environmental justice would also be **moderate** and **minor** beneficial.

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3.13 Navigation and Vessel Traffic

3.13.1 Description of the Affected Environment

3.13.1.1 Geographic Analysis Area

This section discusses existing navigation and vessel traffic in the geographic analysis area for navigation and vessel traffic, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.13-1. The geographic analysis area for navigation and vessel traffic extends within 12.4 miles of the RI/MA Lease Areas, the proposed Project OECC, and the area between the RI/MA Lease Areas and the ports of New Bedford, Montauk, and Brayton Point in Bristol County, Massachusetts; ProvPort in Providence County, Rhode Island; and the Port of Davisville (Quonset Point) in Washington County, Rhode Island. These ports have been identified as suitable to support the offshore wind industry in Massachusetts and Rhode Island. Table G.1-10 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor (or Lower) Impacts, describes existing conditions and potential impacts, based on the IPFs assessed of ongoing and future offshore activities other than offshore wind, which is discussed below.

3.13.1.2 Existing Navigation and Vessel Traffic

The coastal areas offshore Massachusetts, Rhode Island, and the rest of New England support a variety of vessel traffic, from cargo to tanker traffic, between major shipping and commercial ports from Boston to New York City. The area also supports commercial and private (recreational) fishing vessels, ferries, and other private recreational activities. Commercial and private vessel traffic make up the largest demographic for activities in the affected environment; however, other types of commercial traffic, including tanker, tug-and-barge and other commercial activities, are not uncommon. The most substantial vessel traffic in and around the SWDA occurs in four primary geographic areas: Narragansett Bay, Buzzards Bay, Nantucket Sound, and the area between Woods Hole and Vineyard Haven. The most prevalent vessel route pattern through the SWDA and much of the geographic analysis area is a roughly southeast-to-northwest course (Figure 3.13-2) (COP Appendix III-I; Epsilon 2023). Generally, BOEM does not anticipate any substantial changes to navigation and vessel traffic patterns in the geographic analysis area over the course of the next 30 years, except in response to offshore wind development, as discussed below.[35] Navigational safety considerations include factors such as crew alertness, vessel seaworthiness, sea conditions, and accessibility to search and rescue (SAR) assets. As discussed below, adding construction vessels and structures such as WTG and ESPs to open waters (as well as increased activity in port areas) can increase crew fatigue and navigational complexity, increasing allision and collision risk. Further, the presence of structures could complicate SAR response for vessels that become imperiled by allision, collision, or other incidents.

[35] A review of the 2016 through 2019 vessel traffic data shows that the prevalent vessel route pattern remains southeast to northwest, consistent with the Navigational Risk Assessment (COP Appendix III-I; Epsilon 2023).

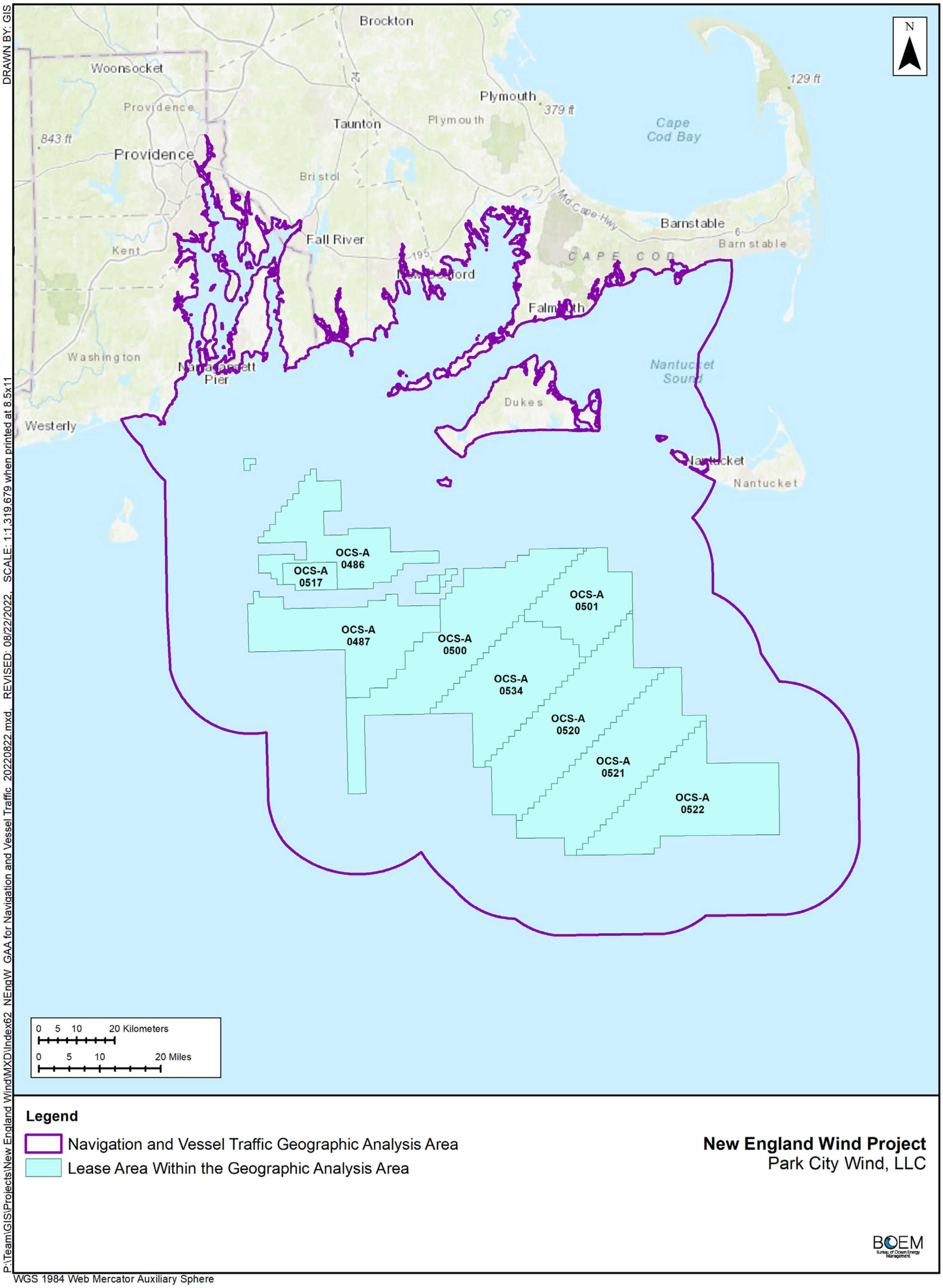


Figure 3.13-1: Geographic Analysis Area for Navigation and Vessel Traffic

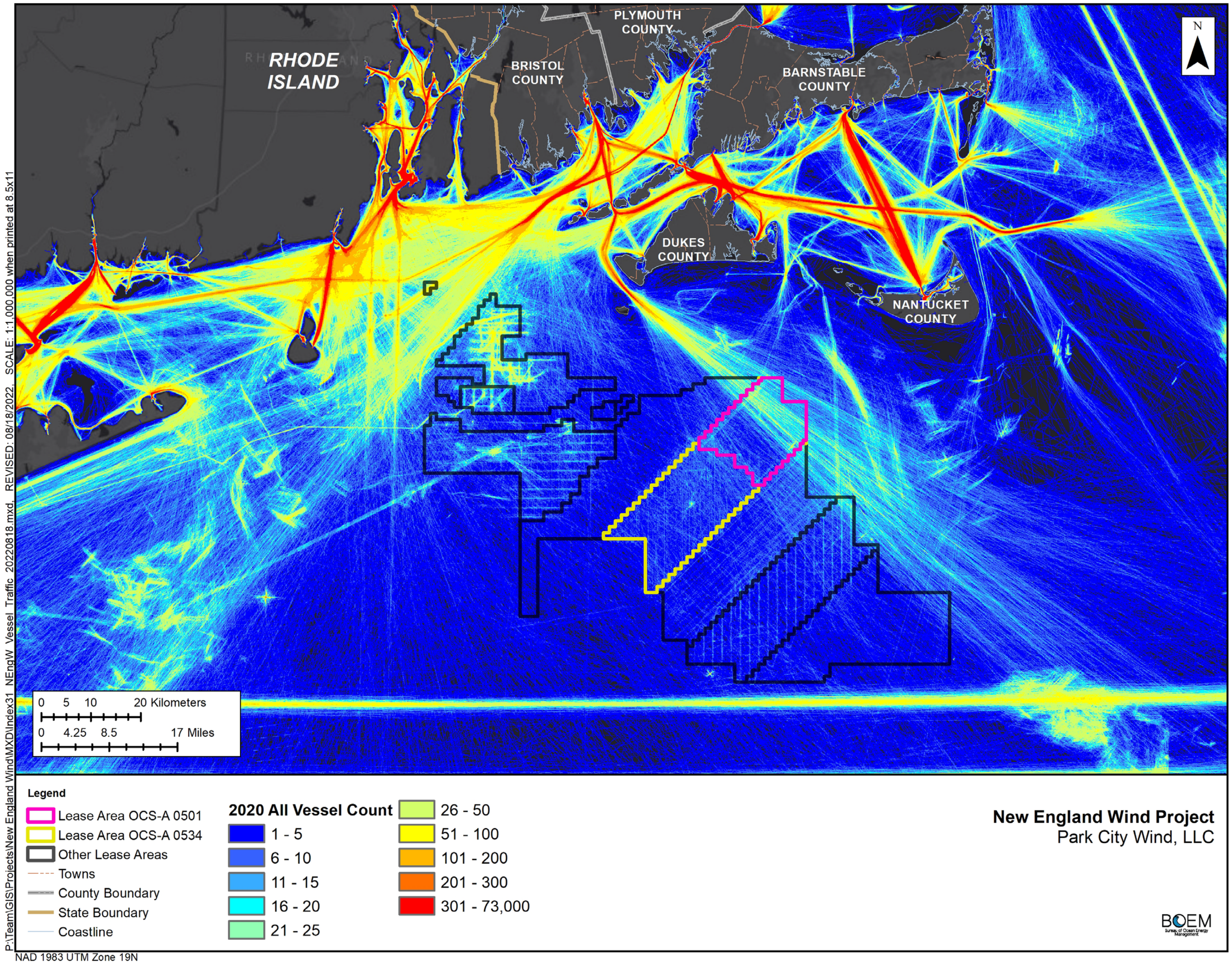


Figure 3.13-2: Vessel Traffic, 2020

This section discusses navigation and vessel traffic characteristics and potential impacts on the waterways and adjacent water approaches for the area specified within the SWDA, the MCT, and other port and operations facilities. Information presented in this section draws upon the NSRA for the proposed Project (COP Appendix III-I; Epsilon 2023), which was prepared to comply with guidelines in the USCG's Navigation and Vessel Inspection Circular 01-19 (USCG 2019).

Proposed Project facilities would be located within and off the coast of Massachusetts, potentially supported by ports in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey.[36] Within the SWDA and the surrounding area, vessel traffic is primarily seasonal, with approximately 87 percent of all annual SWDA area traffic occurring between Memorial Day and Labor Day (COP Appendix III-I; Epsilon 2023). This is primarily due to high seasonal activity by recreational vessels and commercial fishing vessels. Cargo vessel traffic is less seasonal. The coastal areas of these states support high volumes of vessel traffic. This includes cargo, tanker, and other heavy vessel traffic to and from major ports in Boston and New York City (NOAA 2022h), as well as commercial and recreational fishing, ferries, and other recreational vessel activity (Section G.2.6, Non-Tidal Waters and Wetlands, and Section 3.14, Other Uses [National Security and Military Use, Aviation and Air Traffic, Offshore Cables and Pipelines, Radar Systems, Scientific Research and Survey, and Marine Minerals]). Figure 3.13-2 presents regional vessel traffic. General traffic patterns within the SWDA are relatively stable. Tankers, cargo, and passenger vessels generally follow steady southwest-to-northeast courses and transect the middle and southern sections of the SWDA, while towing/tug-barge vessels are distributed throughout the SWDA. However, AIS maps for 2020 show that a moderate volume of sailing, fishing, and other unspecified vessels traverse the geographic analysis area (Northeast Regional Ocean Council 2022). In relation to the location of typical transit routes south of the lease area and geographic analysis area, 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. Essentially, vessel traffic in the lease area is widespread and generally without concentrated areas that would absolutely necessitate identification of formal routing measures.

Vessel Traffic

Table 3.13-1 summarizes the number and type of vessels recorded within 7.5 miles of the SWDA, the area studied in the applicant's NSRA (COP Appendix III-I; Epsilon 2023). Commercial fishing vessels[37] and recreational vessels comprised more than 75 percent of the AIS tracks recorded in 2016 and 2019. The SWDA is frequented by commercial fishermen, however; data analysis show that the SWDA is primarily used by commercial fishermen engaged in activities such as transiting through the area, gillnetting, or trawling (COP Volume III, Section 4.1.7, Appendix III-I; Epsilon 2023). Analysis on the relative duration of trawling within the confines of the SWDA revealed that for the trawl tracks that cross the SWDA, 25 percent of all time spent trawling is actually spent in the SWDA (COP Appendix III-I; Epsilon 2023). A summary of AIS fishing vessel traffic through the SWDA is presented in Table 3.13-2.

[36] The applicant could also use ports in Canada; however, these areas are outside the scope of this analysis.

[37] There is some double counting of vessels between transiting and fishing. For the purposes of this analysis, it is assumed that fishing vessels with speeds less than 4 knots are trawling, while those with speeds greater than 4 knots are transiting the SWDA. Some fishing vessels have speeds both above and below 4 knots while in the SWDA and are counted as both in transit and trawling.

Table 3.13-1: Vessel Types Within the Southern Wind Development Area Based on 2016–2019 Automatic Identification System Data

Vessel Type	Number of Unique Vessels	Percentage of Unique Vessels (%)
Cargo vessels	112	13
Tankers	85	10
Passenger vessels	17	2
Tug-barge vessels	12	1
Military vessels	7	1
Naval sail training vessels	2	0
Recreational vessels	325	39
Fishing vessels, in transit	228	27
Fishing vessels, fishing	92	11
Other vessels	42	5
Total (2016-2019)[a]	**842**	**100**

Source: COP Appendix III-I; Epsilon 2023
[a] The number of unique vessels sums to more than the total shown, due to double counting transiting and fishing vessels.

Table 3.13-2: Summary of Automatic Identification System Fishing Vessel Traffic through the Southern Wind Development Area (2016–2019)

Vessel Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Number of Tracks													
Fishing	0	0	2	3	14	14	36	199	287	25	2	2	582
Transiting	12	21	25	51	103	120	142	156	142	50	23	23	403
All vessels	33	30	38	70	170	251	325	397	282	79	31	18	1,689
Average Tracks per Day													
Fishing	0.0	0.0	0.0	0.0	0.1	0.1	0.3	1.6	2.4	0.2	0.0	0.0	0.4
Transiting	0.1	0.2	0.2	0.4	0.8	1.0	1.1	1.3	1.2	0.4	0.2	0.1	0.6
All vessels	0.3	0.3	0.3	0.6	1.4	2.1	2.6	3.2	2.4	0.6	0.3	0.1	1.2
Average Days Between Tracks[a]													
Fishing	31.0	28.0	31.0	30.0	8.9	8.6	3.4	0.6	0.4	5.0	30.0	31.0	2.5
Transiting	10.3	5.3	5.0	2.4	1.2	1.0	0.9	0.8	0.8	2.5	5.2	10.3	1.7
All vessels	3.8	3.7	3.3	1.7	0.7	0.5	0.4	0.3	0.4	1.6	3.9	6.9	0.9

Source: COP Appendix III-I; Epsilon 2023

[a] The average days between tracks is the reciprocal of average tracks per day.

The NSRA study assumes that fishing vessels typically have an overall length of 60 to 80 feet, and there are likely a number of fishing vessels less than 65 feet long (the minimum vessel length for which AIS transponders are required, per 33 CFR § 164.46) that transit through the SWDA but do not transmit AIS data. It is estimated that 40 to 60 percent of the commercial fishing fleet is represented in the AIS data. Overall, available data indicate relatively low levels of fishing effort in the SWDA (COP Appendix III-I; Epsilon 2023). It is likely that non-AIS commercial and recreational vessels navigate through the SWDA and across the OECC. The MARIPARS completed by the USCG in 2020 considered non-AIS vessel traffic in the study but could not evaluate it extensively for the purpose of assessing navigation and use of the waterway in the wider RI/MA Lease Areas (USCG 2020). The MARIPARS found that non-AIS vessel transit tracks did not vary significantly from AIS-equipped vessels.

Raw VMS data at the individual trip level were not available for analysis in the NSRA. The current NSRA includes VMS data and histograms, shown by species and are based on the 2015 and 2016 fishing seasons (the most recent publicly available data), as provided by NMFS and BOEM. These maps supplement the AIS data by identifying areas of fishing vessel concentration within the SWDA and surrounding area. The VMS maps in the NSRA include vessel activity density, vessel speed, and targeted fisheries within the SWDA and surrounding area.[38] The directional characteristics of the overall VMS data, for all VMS fisheries combined, are consistent with the AIS data presented in this section. The vessels actively transiting follow approximate northwest-to-southeast track orientations, while those vessels actively fishing are on east-to-northeast to west-to-southwest orientations. The analysis is generally consistent with the AIS data analysis summarized in this section (COP Appendix III-I; Epsilon 2023). Additional information on VMS data, specifically for commercial fisheries and for-hire recreational fishing, is provided in Section 3.9 and Section B.2 of Appendix B, Supplemental Information and Additional Figures and Tables.

Between 2016 and 2019, there was an annual average of 25,402 vessel crossings of the OECC (Table 3.13-3). Most of the vessel crossing traffic occurs between Martha's Vineyard and the mainland of Cape Cod. Overall, vessel traffic density along the OECC is relatively low, with the highest concentration of traffic midway through Nantucket Sound. A portion of these crossings would include regular ferries between Falmouth, Hyannis Port and other locations, and the islands of Martha's Vineyard and Nantucket. About 17.3 miles offshore, the OECC route would cross a navigation route for tug-and-barge (shown as tug-tow in Table 3.13-3), tanker, and fishing vessels. Recreational vessels have also been commonly recorded throughout this area (COP Figure 4.0-4, Appendix III-I; Epsilon 2023). It is likely that non-AIS commercial fishing and recreational vessels navigate across the OECC. In 2019, a daily average of 71 vessels crossed the OECC (COP Appendix III-I; Epsilon 2023).

Table 3.13-3: Offshore Export Cable Corridor Vessel Crossings by Type and Year (2016–2019)

Vessel Type	2016	2017	2018	2019
Fishing	10,402	10,674	9,459	10,277
Passenger	1,223	334	383	904
Cargo	8	14	34	14
Tanker	0	8	52	82
Recreational	6,252	8,313	8,567	8,625
Military	589	569	738	583
Tug-tow	602	915	846	786
Other	3,857	5,800	5,393	5,228

[38] Full or part-time multispecies, scallop, monkfish, surf clam/ocean quahog, herring, mackerel, and squid/butterfish are required to have an operational VMS unit, per 50 CFR §§ 648.9–648.10.

Vessel Type	2016	2017	2018	2019
Total	22,933	26,627	25,472	26,499
Average Crossings per Day	**63**	**73**	**70**	**73**

Source: COP Appendix III-I; Epsilon 2023

Available VMS data show that for trawlers smaller than 65 feet in length whose paths crossed the SWDA at some point, approximately 77 of total travel time was spent outside the SWDA, compared to 23 percent of total travel time within the SWDA (COP Appendix III-I; Epsilon 2023). The most prevalent vessel route pattern through the SWDA is a roughly northwest-to-southeast orientation. While the area north of the SWDA is more highly frequented by commercial fishermen, the data analysis showed that the SWDA is also used by commercial fishermen engaged in activities such as transiting through the area, gillnetting, or trawling. Section 3.15 discusses recreation and tourism, while Section 3.9 discusses commercial fisheries. The heaviest vessel traffic in the SWDA vicinity occurs in four primary areas: Narragansett Bay, Buzzards Bay, Nantucket Sound, and the area between Woods Hole and Vineyard Haven. Additionally, high-volume passenger ferry traffic occurs between Hyannis and Nantucket and Martha's Vineyard. Additional information and datasets, tables, and figures related to vessel traffic can be found in COP Section 7.8 (Volume III; Epsilon 2023) and in the NSRA (COP Appendix III-I, Section 6.0; Epsilon 2023). Section 3.9 provides economic information related to commercial fisheries.

Aids to Navigation

PATON and federal aids to navigation (ATON), including radar transponders, lights, sound signals, buoys, and lighthouses, are located throughout the waters and coastlines surrounding the proposed Project area. These aids serve as a visual reference to support safe maritime navigation. The USCG operates and maintains the ATONs. There are no USCG-maintained ATONs within the SWDA or OECC. There are two PATONs within the lease area (VWM-01 and VWM-02) near the northeastern extent of the lease area but none within the SWDA. The closest buoys to the SWDA are three buoys marking the transition between Muskeget Channel and Nantucket Sound, with the nearest buoy "MC" located approximately 8.1 miles north-to-northeast from the northern boundary of the lease area. A single buoy ("1") between Nomans Island and Gay Head is approximately 167 miles northwest from the northwestern end of the lease area. The nearest PATON to the lease is a single PATON ("DMON"), which is located southwest of Nomans Land and is approximately 17.3 miles northwest from the northwestern end of the SWDA. Additional SWDA PATONs include ("154"), approximately 17.3 miles northwest from the southwestern end of the SWDA, and unnamed PATON, approximately 13.8 miles southeast from the northeastern corner of the SWDA (COP Appendix III-I, Section 6.0; Epsilon 2023). The USCG administers the permits for PATONs on structures positioned in or near navigable waters of the United States.

Navigational Safety

The NSRA provides USCG data for historical SAR incidents from the Vineyard Wind 1 dataset, as well as the USCG (2020) MARIPARS analysis. The Vineyard Wind 1 dataset evaluated the areas between Block Island, Rhode Island, and the SWDA—an area encompassing approximately 1,350 square miles—between June 2006 and September 2016.[39] During this period, the USCG conducted 103 SAR missions in this region. Most of the reported incidents were related to equipment problems or failure (e.g., loss of engine power), medical issues, vessels taking on water, collision, capsizals, or disoriented vessels. Of the 103 reported incidents, approximately 43 percent occurred at night and 57 percent occurred during the day. Four of the reported incident cases were collisions, although none of the reported collisions were within a 11.5-mile radius of the SWDA (COP Appendix III-I; Epsilon 2023). Collisions in

[39] A Freedom of Information Act request for more recent SAR data has been submitted to the USCG, and data covering the period from 2005 to 2020 are expected in the near future.

or near the SWDA did not result in any deaths. Within 11.5 miles of the SWDA (inclusive of the SWDA itself), 20 incidents were reported over this 10-year period. Most were SAR missions, with some cases related to marine safety and law enforcement. Table 3.13-4 shows a breakdown of the cases by type.

Table 3.13-4: Search and Rescue and Other Navigation Safety Incidents in the Southern Wind Development Area, 2006–2016

Category	Number of Incidents	Type
SAR	16	Disabled or distressed vessel
Marine safety	2	Equipment failure
Law enforcement	2	Personal conflict

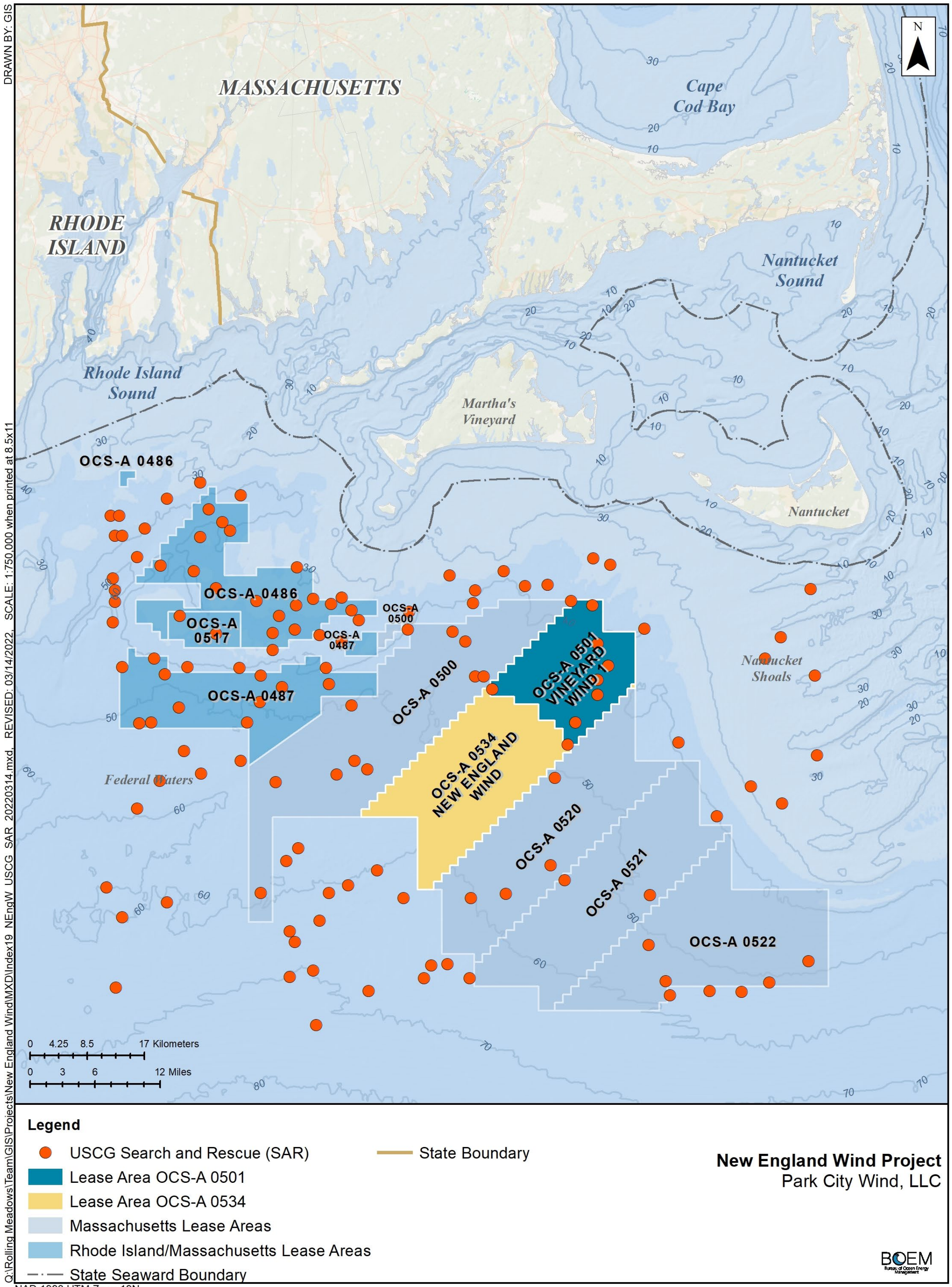
Source: COP Appendix III-I, Table 7.1; Epsilon 2023

SAR = search and rescue

Additional historical SAR data were analyzed by the USCG in the MARIPARS in the RI/MA Lease Areas vicinity for the period of 2005 through 2018 (USCG 2020). Figure 3.13-3 and 3.13-4 show the USCG SAR incidents and USCG rescue coverage areas, respectively. During this time, 133 separate incidents occurred—an annual average of approximately 9.5 incidents. None of these incidents were collisions. These data exclude responding USCG assets transiting through the SWDA to reach a SAR location outside of the RI/MA Lease Areas vicinity, as well as incidents that drifted into the confines of the SWDA or SAR cases that involved towing or other transportation through the SWDA.

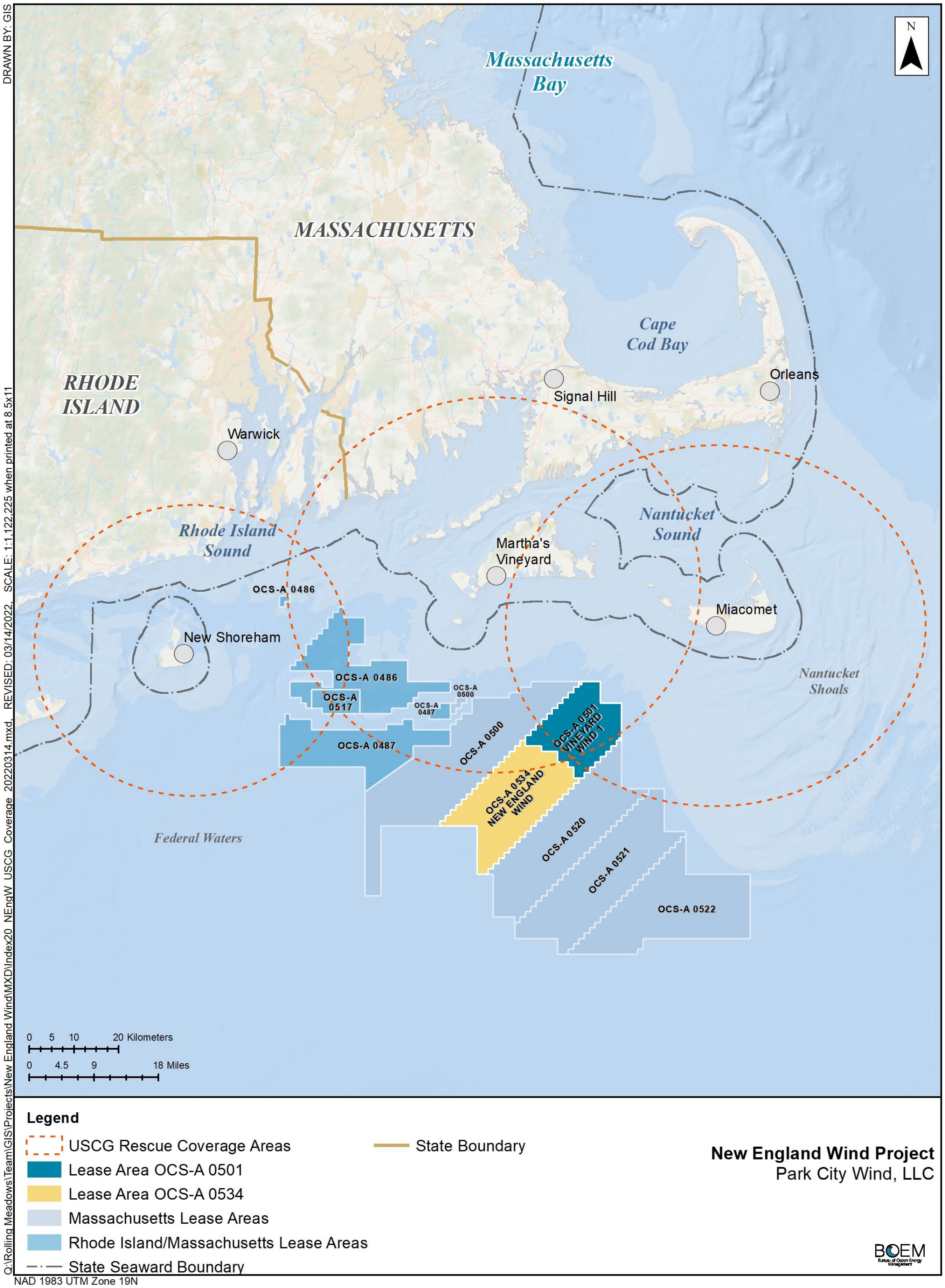
The Northeast Regional Ocean Council, the USCG First District, and marine trade associations conducted the Northeast Recreational Boater Survey in 2012 to characterize marine recreational boater activity in New England (Starbuck and Lipsky 2013). The survey collected feedback from over 12,000 owners of state-registered and federally documented vessels, including pleasure craft, commercial fishing, towing, and coastwise trade vessels in New England. According to the survey, New England boaters have an average of 30 years of boating experience, with over 65 percent of participants having previously completed navigational classes (Starbuck and Lipsky 2013). More than 58 percent of the 12,000 recreational boaters surveyed by the Northeast Regional Ocean Council stated it was “very or somewhat likely” that they could continue to enjoy recreational boating near offshore wind turbines (Starbuck and Lipsky 2013). The most common concerns identified by recreational boaters regarding allision and collision safety were “fellow boaters’ behavior,” including “inconsiderate actions by others” (74 percent), “lack of knowledge of navigation rules by others” (58 percent), and “use of alcohol by boat operators” (43 percent) (Starbuck and Lipsky 2013).

USCG’s Final MARIPARS, published in May 2020, evaluated vessel traffic through the lease areas and recommended all surface structures be aligned “along a standard and uniform grid pattern with at least three lines of orientation and standard spacing,” with north-to-south and east-to-west lanes 1.0- x 1.0-nautical-mile- (1.9-kilometer-, 1.15-mile-) wide and northwest-to-southeast or northeast-to-southwest lanes 0.6- (0.69-mile-) to 0.8-nautical-mile- (0.92-mile-) wide between structures (USCG 2020). The Final MARIPARS did not recommend implementation of any formal routing measures. The orientation of the structures within the SWDA would be placed at the recommended 1.0- × 1.0-nautical-mile (1.15- x 1.15-mile) east-to-west and north-to-south structure spacing to provide space for transiting vessels, as well as SAR and USCG assets. The structure grid pattern here is additionally aligned with the neighboring project proposals, which have also proposed 1.0- × 1.0-nautical-mile (1.15- x 1.15-mile) structure spacing.



USCG = U.S. Coast Guard

Figure 3.13-3: U.S. Coast Guard Search and Rescue Incidents



USCG = U.S. Coast Guard

Figure 3.13-4: U.S. Coast Guard Rescue Coverage Areas

Ports, Harbors, and Navigation Channels

Table 3.13-5 lists the ports that could be used for proposed Project construction, operations, and/or decommissioning. Point Judith in Washington County, Rhode Island, is also an important nearby port. These ports serve the commercial fishing industry (Section 3.9, Commercial Fisheries and For-Hire Recreational Fishing), passenger cruise lines, cargo, and other maritime activities. Of these, the largest deep draft port by volume is ProvPort (COP Volume I, Section 3.2.2.5 and 4.2.2.5; Epsilon 2023). The primary vessel traffic to and from most of these ports and the commercial shipping lanes to these ports are outside the SWDA (COP Appendix III-I; Epsilon 2023). However, the most common ports of transit for fishing vessels that tracked through the SWDA are New Bedford and Point Judith. Section 3.11, Demographics, Employment, and Economics, discusses economic activity at these ports.

Table 3.13-5: Port Facilities by County

County	Potential Port
Bristol County, Massachusetts	Port of New Bedford Brayton Point Commerce Center Fall River terminal facilities
Dukes County, Massachusetts	Vineyard Haven Harbor
Essex County, Massachusetts	Salem Offshore Wind Port
Fairfield County, Connecticut	Port of Bridgeport
New London County, Connecticut	Port of New London
Gloucester County, New Jersey	Paulsboro Marine Terminal
Albany County, New York	Port of Albany Beacon Island expansion Port of Coeymans
Kings County, New York	GMD Shipyard South Brooklyn Marine Terminal
Rensselaer County, New York	New York State Offshore Wind Port
Richmond County, New York	Homeport Pier Arthur Kill Terminal
Suffolk County, New York	Shoreham site Greenport Harbor
Providence County, Rhode Island	ProvPort South Quay Terminal
Washington County, Rhode Island	Port of Davisville

Source: COP Volume III; Epsilon 2023

ProvPort = Port of Providence

The relative traffic density within the SWDA is lower than the surrounding region, with the highest transiting density through the northeast section of SWDA with the vessel traffic along a northwest-to-southeast line of orientation (COP Appendix III-I; Epsilon 2023). Vessel traffic is concentrated between May and October, with July, August, and September having the highest vessel traffic each year. The vessel traffic varies by year, with 2016 having the highest number of unique vessels and vessel tracks, while 2018 had the lowest (Table 3.13-1). Between 2010 and 2016, cargo tonnage at area ports increased by 21.7 percent, while cargo vessel transits decreased by over 60 percent, reflecting increasing cargo vessel capacities. From 2017 to 2019, cargo tonnage at area ports decreased by 4.5 percent, while cargo vessel transits increased by over 19 percent. The decrease in cargo tonnage at area ports is likely attributed to the unavailability of 2017–2019 Hyannis Port cargo tonnage data; between 2010 and 2016, cargo tonnage at Hyannis Port made up approximately 4.2 percent of the total cargo tonnage reported for the area ports (USACE 2022a, 2022b).

Traffic patterns in the vessel traffic routes within the geographic analysis area are relatively stable; however, vessel size and vessel traffic volume and density in the geographic analysis area could be affected by coastal developments, market demands, and other factors (Northeast Regional Ocean Council 2022). In general, large non-fishing commercial vessels do not frequently transit through the SWDA;

most of these vessels transit along the marked fairways and channels. However, 2016 to 2020 AIS maps indicate that a substantial volume of sailing, fishing, and other vessels traverse this area (COP Appendix III-I; Epsilon 2023; Northeast Regional Ocean Council 2022).

3.13.2 Environmental Consequences

Definitions of potential impact levels for navigation and vessel traffic are provided in Table 3.13-6. There are no beneficial impacts on navigation and vessel traffic.

Table 3.13-6: Impact Level Definitions for Navigation and Vessel Traffic

Impact Level	Definition
Negligible	Impacts would be so small as to be unmeasurable.
Minor	Impacts would be avoided. Normal or routine functions associated with vessel navigation would not be disrupted.
Moderate	Impacts would be unavoidable. Vessel traffic would have to adjust somewhat to account for disruptions due to impacts of the Project.
Major	Vessel traffic would experience unavoidable disruptions to a degree beyond what is normally acceptable, including potential loss of vessels and life.

3.13.2.1 Impacts of Alternative A – No Action Alternative on Navigation and Vessel Traffic

When analyzing the impacts of Alternative A on navigation and vessel traffic, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for navigation and vessel traffic (Table G.1-10 in Appendix G). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for navigation and vessel traffic described in Section 3.13.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on navigation and vessel traffic would continue to follow current regional trends and respond to current and future environmental and societal activities.

While the proposed Project would not be built under Alternative A, ongoing activities, future non-offshore wind activities, and future offshore wind activities would have continuing short- and long-term impacts on existing navigation and vessel traffic, primarily through the presence of structures, port utilization, and additive proposed Project-related vessel traffic. The impacts of ongoing activities, especially presence of structures, port utilization, and vessel traffic, would be moderate. Seafloor areas within the SWDA and OECC route would remain available for future marine minerals leasing, location of future offshore energy projects, siting of future submarine cables and pipelines, and surface or submarine military vessel activity. The harbors proposed for construction, operations, or decommissioning would continue current operations. In addition to ongoing activities, planned activities other than offshore wind may also contribute to impacts on navigation and vessel traffic. Planned activities other than offshore wind include anchoring and gear utilization, port expansion, cable emplacement and maintenance, and SAR operations (Table G.1-17). The impacts of planned activities other than offshore wind would be negligible. The combination of ongoing and planned activities would result in moderate impacts on navigation and vessel traffic.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on navigation and vessel traffic include continued operation of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Ongoing operations of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 and

South Fork Wind Projects along with planned offshore wind activities, would affect navigation and vessel traffic through the primary IPFs described below.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind activities would affect navigation and vessel traffic through the following primary IPFs.

Anchoring and gear utilization: Future offshore wind developers are expected to coordinate with the maritime community and USCG to avoid laying export cables through any traditional or designated lightering/anchorage areas, meaning that any risk for deep draft vessels would come from anchoring in an emergency scenario, specifically in or near the Buzzards Bay and Narragansett Bay traffic separation scheme lanes. Generally, larger vessels accidently dropping anchor on top of an export cable (buried or mattress protected) to prevent drifting in the event of vessel power failure could result in damage to the export cable, risks associated with an anchor contacting an electrified cable, and impacts on the vessel operator's liability and insurance. Impacts on navigation and vessel traffic would be temporary and localized, and navigation and vessel traffic would fully recover following the disturbance. In total, BOEM estimates approximately 3,862 acres of seabed would be disturbed by anchoring associated with offshore wind activities. Considering the small size of the geographic analysis area compared to the remaining area of open ocean, as well as the likelihood that any anchoring risk would occur in an emergency scenario, it is unlikely that anchoring associated with offshore wind activities would affect navigation and vessel traffic.

Other planned activities in the geographic analysis area could contribute to anchoring and gear utilization impacts. Larger commercial vessels (specifically tankers) sometimes anchor outside major ports to transfer their cargo to smaller vessels for transport into port. These anchors have deeper ground penetration and are under higher stresses. Smaller vessels (commercial fishing or recreational vessels) would anchor for fishing and other recreational activities. All vessels may anchor if they lose power to prevent them from drifting and creating navigational hazards for other vessels or for drifting into structures. Ongoing activities and future non-offshore wind activities would contribute similar impacts, especially along the routes of potential cables, perhaps connecting Martha's Vineyard and/or Nantucket to the mainland.

Anchoring from activities other than offshore wind (i.e., commercial and recreational vessels) would continue. The decommissioning and removal of structures associated with future offshore wind projects would have the same impacts on anchoring and gear utilization as those described for construction.

Cable emplacement and maintenance: Based on the assumptions in Table E-1 in Appendix E, the 963 foundations (WTGs and ESPs) would require approximately 2,576 miles of inter-array and inter-link cables within the geographic analysis area for navigation and vessel traffic. The length of OECC cable routes cannot be determined; however, one OECC is assumed to extend between each offshore wind project and the approximate nearest shoreline. Emplacement and maintenance of cables for these offshore wind projects would generate vessel traffic and specifically add slower-moving vessel traffic above cable routes. Vessels not involved in cable emplacement or maintenance would need to take additional care when crossing cable routes during construction and operations activities. There would likely be simultaneous cable-laying activities from multiple projects based on the estimated construction timeline. As described in Appendix E, OECC, inter-array, and inter-link cables for up to seven offshore wind projects (including the proposed Project) could be under construction simultaneously in 2025. Concurrent construction of necessary cable infrastructure for other offshore wind projects could have a cumulative impact; however, it is assumed that vessels required for installation would only be present over a portion of the proposed Project's inter-array/inter-link system at any given time. While segments of some OECC routes for these projects would overlap each other geographically (including at least one crossing of the OECCs for the proposed Project and SouthCoast Wind), large areas of open ocean would separate most OECCs, even if simultaneously constructed. Construction of inter-array and inter-link cables would not overlap. While simultaneous cable-laying activities may disrupt vessel traffic over a larger area than if activities occurred sequentially, the total time of disruption would be less than if each project were to conduct cable-laying activities sequentially.

Operations of future offshore wind projects could result in additional risks for anchor strikes; however, utilization of mattress protection and achieving burial depths of inter-array, inter-link, and offshore export cables would reduce the impact of emergency or accidental anchor deployment and not preclude the use of the area by commercial fishing operations, recreation vessels, or transportation vessels. The decommissioning of future projects and removal of underwater infrastructure would decrease the instances and impacts of an emergency or accidental anchor deployment and have the same impacts as construction.

Port utilization: Future offshore wind development would support planned expansions and modifications at ports in the geographic analysis area for navigation and vessel traffic, including the ports of New Bedford, Providence, and Davisville (Quonset Point). Simultaneous construction or decommissioning (and, to a lesser degree, operations) activities for multiple offshore wind projects in the geographic analysis area could stress port capacity and resources and could concentrate vessel traffic in port areas. Such concentrated activity could lead to increased risk of allision, collision, and vessel delay. Based on the vessel traffic generated by the proposed Project, BOEM assumes that construction of each future offshore wind project would generate an average of 22 and a maximum of 56 vessels operating in the geographic analysis area (per phase) for navigation and vessel traffic at any given time, and that each future offshore wind project would generate a daily average of 15 vessel trips during peak construction (COP Volume I; Epsilon 2023). Up to six offshore wind projects (not including the proposed Project) would be under construction at the same time in 2025. During this peak period, Alternative A would result in 132 to 336 vessels operating simultaneously, generating up to 90 vessel trips per project per day to and from ports in the region (assuming overlap of the peak construction periods of all six simultaneous projects). Fewer vessels would be present, and fewer trips would occur during other parts of the overall construction period (2023 to 2030) for offshore wind projects in the RI/MA Lease Areas. The increase in port utilization due to this vessel activity would vary across ports and depend on the specific port or ports supporting each future offshore wind project. It is unlikely that all projects would use the same ports; therefore, the total increase in vessel traffic would be distributed across multiple ports in the region. Other offshore wind projects would likely use a variety of operations ports; therefore, the total increase in vessel traffic would likely be distributed across multiple ports within and outside of the geographic analysis area. Delays for vessels using those ports could occur if two or more projects use the same port for operations activities. The decommissioning and removal of export cables from the SWDA and the OECC would have similar impacts on port utilization as construction.

Presence of structures: Using the assumptions in Appendix E, Alternative A would include approximately 963 WTGs and ESPs (excluding the proposed Project) in the geographic analysis area for navigation and vessel traffic, operating for approximately 30 years. Structures in this area would pose navigational hazards to vessels transiting within and around areas leased for offshore wind projects. Offshore wind projects would increase navigational complexity and ocean space use conflicts, including the presence of WTG and ESP structures in areas where no such structures currently exist, potential compression of vessel traffic both outside and within wind development areas, potential interference with marine vessel radars (MVR) (although other navigation tools are available to ship captains), and potential difficulty seeing other vessels due to a cluttered view field. Under certain atmospheric conditions, wind energy facilities could contribute to fog formation (Hasager et al. 2017).

A study by the University of Texas (Ling et al. 2013) used modeling (but not studies of operational offshore wind facilities) to simulate the electromagnetic scattering and propagation over ocean surfaces to provide a baseline evaluation of simulated electromagnetic and acoustical challenges to sea surface, subsurface, and airborne electronic systems presented by offshore wind energy facilities. This study indicated a potential for MVR interference from offshore wind turbines. Specifically, using modeling, Ling et al. (2013) concluded that:

- Communications systems in the marine environment are unlikely to experience interference as the result of typical offshore wind development configurations, except under extreme proximity or operating conditions;
- MVR and ocean monitoring high frequency sensors may experience interference under certain proximity and operating conditions as the result of typical offshore wind development configurations;
- Sensitive airborne radars may experience serious interference; however, the degree of interference may be system-specific and dependent on whether offshore wind developments are located within the operational area of the radar; and
- Due to the virtual absence of noise exceeding background levels radiated underwater by wind turbines at frequencies above 1 kHz, interference with underwater acoustical systems is deemed to be unlikely at such frequencies. At frequencies below 1 kHz, the tones radiated by wind turbines may cause interference with certain acoustical systems when placed near a wind development.

A 2022 National Academies of Sciences, Engineering, and Medicine (NAS) study found adverse impacts on MVR from offshore WTGs (NAS 2022). Specifically, the study found that offshore WTGs affect MVR in some situations, most commonly through a substantial increase in strong reflected energy cluttering the operator’s display, leading to complications in navigation decision-making (NAS 2022). The sizes of anticipated offshore WTGs and projects would exacerbate these impacts (NAS 2022). This decreased efficacy applies to both traditional, magnetron-based MVRs and as-fielded, solid-state MVRs. Degraded effectiveness of MVR could lead to lost contact with smaller objects, such as recreational vessels and buoys (NAS 2022).

MVR have varying capabilities, and the ability of radar equipment to properly detect objects is dependent on radar type, equipment placement, and operator proficiency. General mitigation and monitoring measures such as properly trained radar operators, properly installed and adjusted vessel equipment, marked wind turbines, and the use of AIS all would enable safe navigation with minimal loss of radar detection (USCG 2020). The NAS study also found that WTG-related MVR interference could be lessened through improved radar signal processing and display logic or signature-enhancing reflectors on small vessels to minimize lost contacts.

As stated in Section E.3.1 in Appendix E, developers of all offshore wind projects in the RI/MA Lease Areas have agreed to install WTGs and ESPs in an aligned 1.0-nautical-mile (1.15-mile) × 1.0-nautical-mile (1.15-mile) grid within fixed east-to-west rows and north-to-south columns. This arrangement would reduce, but not eliminate, navigational complexity and space use conflicts during the operations phases of the projects. Navigational complexity in the area would increase during construction as WTGs and ESPs are installed, would remain constant during simultaneous operations, and would decrease as projects are decommissioned and structures are removed. Decommissioning impacts would be similar to construction impacts.

Potential impacts of these conflicts include increased risk of allisions with stationary structures or vessels and collisions with other vessels; risk of damage to vessels or injury to crews; increased demand for USCG SAR operations due to the increase in allisions (and difficulty completing those operations due to the presence of WTGs); and increased risk of oil or chemical spills from collisions and allisions.

Structures from other offshore wind activities would generate comparable impacts across the entire RI/MA Lease Areas, with the extent of coverage increasing as additional offshore wind projects are constructed. Large vessels headed to or from Boston or New York City that occasionally transit through the SWDA would also need to adjust course to avoid the proposed Project and other planned activities. The presence of neighboring wind energy leases would further increase the navigational complexity in the region, resulting in an increased risk of collisions and allisions, which could result in personal injury or loss of life from a marine casualty, damage to boats or turbines, and oil spills. The presence of neighboring wind energy leases could also affect demand for and resources associated with USCG SAR operations by changing vessel traffic patterns and densities in the larger RI/MA Lease Areas. Additionally, the USCG would need to adjust its SAR planning and search patterns to allow aircraft to fly within the geographic analysis area, leading to a less-optimized search pattern and a lower probability of success.

The fish aggregation and reef effect of offshore wind structures would also provide new opportunities for recreational fishing, although few recreational vessels presently travel as far from shore as the proposed offshore wind structures. The additional recreational vessel activity focused on aggregation and reef effects would incrementally increase vessel congestion and the risk of allision, collision, and spills near WTGs. As stated in Section 3.7, Marine Mammals, some marine mammals may choose to avoid WTGs and ESPs. This could potentially increase the risk of cetacean interaction with vessels, marginally increasing the likelihood of a vessel strike outside the SWDA. Overall, the impacts of this IPF on navigation and vessel traffic would be long term (as long as structures remain), regional (throughout the entire geographic analysis area for navigation and vessel traffic), and continuous.

Traffic: Based on the vessel traffic generated by the proposed Project, it is assumed that construction of each individual offshore wind project (estimated to last 3 years per project) would generate an average of 22 and a maximum of 56 vessels operating in the geographic analysis area for navigation and vessel traffic at any given time. Other vessel traffic in the region (e.g., from commercial fishing, for-hire and individual recreational use, shipping activities, military uses) would overlap with offshore wind-related vessel activity in the open ocean and near ports supporting the offshore wind projects. The impacts of operations-related vessel traffic in and adjacent to the RI/MA Lease Areas could be reduced through a shared operational strategy. As shown in Table E-1 in Appendix E, this increase in vessel traffic and navigation risk would be at its peak in 2025, when up to 841 WTGs and ESPs (out of the up to 963 total in the RI/MA Lease Areas) associated with at least six offshore wind projects (other than the proposed Project) would be under simultaneous construction—i.e., a total of approximately 132 to 336 vessels in the geographic analysis area for navigation and vessel traffic at any given time during peak construction. Because the ports to be used by other offshore wind projects have not been determined, the overlap of vessel activity at any single port cannot be predicted. Traffic from these projects would likely be spread among multiple ports within and outside the geographic analysis area for navigation and vessel traffic, thus potentially reducing the impact of offshore wind-related vessel traffic at any single location. This increased offshore wind-related vessel traffic during construction would have short-term, continuous, localized impacts on overall (wind and non-wind) navigation and vessel traffic. These impacts incorporate the increased engagement of SAR and reduced likelihood of SAR success. Impacts on SAR activities themselves are discussed in Section 3.14.

After offshore wind projects are constructed, related vessel activity would decrease. Vessel activity related to operational offshore wind facilities would consist of scheduled inspection and maintenance activities (COP Volume I, Figures 3.1-3 and 4.1-3; Epsilon 2023), with corrective maintenance as needed. Based on information for the proposed Project (COP Volume I; Epsilon 2023), approximately 250 vessel round trips per offshore wind project—totaling 2,250 vessel trips per year or an average of about 6 vessel trips per day, excluding the proposed Project—are estimated to take place annually during operations of Alternative A. Vessel activity would increase again during decommissioning at the end of the assumed

30-year operating period of each project, with magnitudes and impacts similar to those described for construction.

Conclusions

Impacts of Alternative A. Under Alternative A, conditions for navigation and vessel traffic would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on navigation and vessel traffic would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under Alternative A, ongoing activities would have continuing short- and long-term impacts on existing navigation and vessel traffic, primarily through the presence of structures, port utilization, and additive proposed Project-related vessel traffic. The impacts of ongoing activities, especially presence of structures, port utilization, and vessel traffic, on navigation and vessel traffic would be **moderate**.

Cumulative Impacts of Alternative A. In addition to ongoing activities, planned activities may also contribute to impacts on navigation and vessel traffic. Ongoing and planned activities in the geographic analysis area would result in **moderate** cumulative impacts on navigation and vessel traffic. Future offshore wind projects would increase vessel activity, which could lead to congestion at affected ports, the possible need for port upgrades beyond those currently envisioned, and an increased likelihood of collisions and allisions, with resultant increased risk of accidental releases. Under the assumptions in Appendix E, Alternative A would include up to 963 WTGs and ESPs in the geographic analysis area for navigation and vessel traffic in areas where no such structures currently exist. This would increase the risk for collisions, allisions, and resultant accidental releases and threats to human health and safety.

3.13.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on navigation and vessel traffic:

- The length, route(s), and final width of OECC, inter-array, and inter-link cable routes.
- As described in Section 2.1, Alternatives Analyzed in Detail, the final geographic size of Vineyard Wind 1 would define the northeastern border of Phase 1 of the proposed Project. As a result, the potential footprint of Phase 1 includes a portion of Lease Area OCS-A 0501, as well as portions of Lease Area OCS-1 0534 (Figure 2.1-2). If Vineyard Wind 1 uses its maximum number of spare positions, Phase 1 would be located farther southwest than if Vineyard Wind 1 were to use fewer spare positions.
- Phase 1 could include 50 to 62 WTGs depending on WTGs' electrical capacity (i.e., between 13 to 16 MW). The capacity of WTGs selected for Phase 1 would depend on the feasibility and commercial availability of WTGs to meet the Phase 1 construction schedule. WTGs with higher generating capacities would result in a smaller footprint, while lower generating capacities would result in a larger footprint. To account for the range in the number of WTGs that may be developed for Phase 1, the potential footprint of Phase 1 overlaps with the potential footprint of Phase 2.
- Engineering and environmental constraints could eliminate positions, thereby extending the Phase 1 footprint farther southwest.
- Selection of the Western Muskeget Variant for Phase 2 would affect a different portion of the Muskeget Channel than the proposed (eastern) route.

- Selection of the SCV for Phase 2 would include an additional OECC, cable landing site, OECR, and substation that would carry a portion of Phase 2 electricity to a grid interconnection point in Bristol County, Massachusetts (Figure 2.1-7). If the SCV is necessary, the OECR and OECC through state waters would be evaluated in a supplemental NEPA analysis.
- The timing of proposed Project construction and variability in regional port utilization may result in uncertainty regarding which ports may be available during Phase 1 and Phase 2. It is not expected that all the ports identified would be used; it is more likely that only some ports would be used during construction depending upon final construction logistics planning.
- Decommissioning procedures and co-occurring decommissioning efforts of multiple projects.

3.13.2.3 Impacts of Alternative B – Proposed Action on Navigation and Vessel Traffic

This section identifies potential impacts of Alternative B on navigation and vessel traffic. When analyzing the impacts of Alternative B on navigation and vessel traffic, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for navigation and vessel traffic.

Impacts of Phase 1

Phase 1 would affect navigation and vessel traffic through the following primary IPFs during construction, operations, and decommissioning.

Anchoring and gear utilization: Phase 1 would 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. As a result, anchoring and gear utilization during Phase 1 construction would have negligible impacts on navigation and vessel traffic. Generally, larger vessels accidently dropping anchor on top of an export cable (buried or mattress protected) to prevent drifting in the event of vessel power failure would result in damage to the export cable, risks associated with an anchor contacting an electrified cable, and impacts on the vessel operator's liability and insurance. Larger vessels concerned with the export cable are not expected to pass over the cable area, transiting instead farther west and south. For smaller commercial or recreational vessels, the risks would be the same as for all offshore wind installations, except only over the 108 acres of hard cover and scour protection over foundations and cables.

The operations stage of Phase 1 would not impede vessels anchoring within the SWDA other than near the presence of the WTGs and ESPs (and associated scour protection) and limited placement of cable protection (estimated to occur along no more than 2 percent of the offshore cables within the SWDA). The proposed WTG and ESP spacing allows ample space for emergency anchoring of vessels between the structures, including allowance for an anchor sweep radius. All inter-array, inter-link, and offshore export cables within the proposed Project area and SWDA would be buried beneath the seafloor at a target depth of 5 to 8 feet. The target burial depth is more than twice the burial depth required to protect the cables from fishing activities and provides a maximum of 1 in 100,000-year probability of anchor strike, which is considered a negligible risk (COP Appendix III-I; Epsilon 2023). This abundance of caution would limit the impacts on accidental or emergency anchor deployment and reduce the likelihood of operational disruption or damage. The operational impacts on anchoring and gear utilization are localized, long term, and negligible. The decommissioning and removal of export cables from the SWDA and the OECC would have similar impacts on anchoring and gear utilization as construction. The removal of underwater infrastructure and components would decrease the instances of emergency scenarios requiring larger vessels to deploy anchors and potentially damage WTG/ESP or export cables. The risk of 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 be removed, and smaller commercial or recreational vessels would no longer need to avoid or exercise caution over the areas of hard cover and scour protection over foundations and cables.

Cable emplacement and maintenance: Outside the SWDA, the Phase 1 cables would be installed within a portion of the approximately 3,100- to 5,500-foot-wide shared OECC.[40] The Phase 1 offshore export cables are expected to be located west of the Vineyard Wind 1 offshore export cables. To provide appropriate flexibility for routing and installation and allow room for maintenance or repairs, the Phase 1 cables would typically be separated from each other and the Vineyard Wind 1 cables by 164 and 328 feet, although this distance could be further adjusted pending ongoing routing evaluation (COP Volume I, Section 3.1.3; Epsilon 2023). An average of approximately four vessels may be used for cable-laying activities with up to approximately seven vessels during the peak months of activity (COP Appendix III-I; Epsilon 2023). The offshore export cables would likely be transported directly to the SWDA in a cable-laying vessel, on an ocean-going barge, or on a heavy transport vessel (which may also transport the cable-laying vessel overseas) and installed by the cable-laying vessel upon arrival. Phase 1 construction would restrict vessel movement in the SWDA and OECC and require the presence of large and oversized slow-moving (or stationary) installation or maintenance vessels, which would increase the risk of collisions. Typical cable installation speeds are expected to range from 5.5 to 11 feet per minute, and it is expected that offshore export cable installation activities would occur 24 hours per day. Once offshore export cable installation has begun, to preserve the integrity of the cable, installation would ideally be performed as a continuous action along the entire cable alignment between splices (COP Volume I, Section 3.3.1.3.6; Epsilon 2023). This would lead to incrementally increased congestion and navigational complexity within the SWDA, which could result in crew fatigue, damage to vessels and fishing gear, injury to crews, engagement of USCG SAR, and vessel fuel spills. The space use conflicts for fishing could result in reduced commercial catch within the SWDA. However, by utilizing a shared OECC, Phase 1 would leverage the existing survey work already performed for Vineyard Wind 1, thus reducing survey vessel activity and associated health and safety risks (COP Volume I, Section 2.3; Epsilon 2023). Overall, Phase 1 cable installation would have localized, short-term, intermittent, and minor impacts on navigation and vessel traffic.

The operation of new submarine cables within the SWDA and along the OECC is not anticipated to preclude vessel activities. As stated for the anchoring and gear utilization IPF, the target burial depth for all inter-array, inter-link, and offshore export is more than twice the burial depth that is required to protect the cables from fishing activities and provides a maximum of 1 in 100,000-year probability of anchor strike, which is considered a negligible risk (COP Volume III, Section 9.10; Epsilon 2023). Except for limited areas where sufficient cable burial is not achieved and use of cable protection is required, the inter-array, inter-link, and offshore export cables would not interfere with any typical fishing practices, recreational activities, or transit. These impacts would be localized, long term, and negligible.

During decommissioning and removal of cables, an average of approximately four vessels may be used for cable removal activities with up to approximately seven vessels during the peak months of activity (COP Appendix III-I; Epsilon 2023). Phase 1 would, therefore, result in restricted vessel movement in the SWDA and OECC during decommissioning and cable removal activities. As with the construction stage, this would lead to increased congestion, space conflicts, and navigational complexity within the SWDA and would result in localized, short-term, intermittent, and negligible impacts on navigation and vessel traffic.

[40] Where the OECC travels through Lease Area OCS-A 0501, the width of the corridor may be narrower than 3,100 feet to avoid possible interference with Vineyard Wind 1’s offshore facilities.

Port utilization: Phase 1 construction would produce vessel traffic at multiple ports (Table 3.13-7). The largest number of trips is expected between the SWDA and New Bedford Harbor, with an average of 7 round trips per day and up to 15 round trips per day during the peak of construction activity, although the estimates of vessel traffic are speculative and contingent on construction schedule and supply chain factors. The Port of New Bedford houses over 300 fishing vessels and receives more than 500 large commercial vessel calls each year. Several ferry services operate from the port, including fast ferries to the islands of Martha's Vineyard and Nantucket. The harbor is protected by a large hurricane barrier (breakwater) that has storm surge gates across the entrance channel. The channel has a width of 150 feet at this location, which is the controlling width for entrance of ships. An analysis of AIS data was conducted for New Bedford Bay (COP Appendix III-I, Table 10.1; Epsilon 2023). An average of 8 vessel round trips per day (or an equivalent 16 transits per day) is expected during Phase 1 construction, as compared to an existing average of 45 transits per day for AIS-equipped vessels. Peak traffic typically occurs in July and August, with an existing average of 86 daily transits. The actual total number of existing transits may be significantly higher, possibly by a factor of two or three, due to the numerous smaller vessels that do not utilize AIS (COP Appendix III-I, Section 10.3, and Table 10; Epsilon 2023).

Table 3.13-7: Phase 1 Port Utilization

Port	Average Round Trips Per Day: Peak Construction Activity	Average Round Trips Per Day: Over Construction Period
New Bedford, Massachusetts	15	7
Bridgeport, Connecticut Vineyard Haven, Massachusetts Davisville, Rhode Island South Quay Terminal, Rhode Island	13	6
Providence, Rhode Island Brayton Point Commerce Center, Massachusetts Fall River, Massachusetts New London State Pier, Connecticut Staten Island, New York South Brooklyn Marine Terminal GMD Shipyard, New York Shoreham Terminal, New York	6	3
Salem Harbor, Massachusetts	2	1
Port of Albany, Port of Coeymans, New York Paulsboro Marine Terminal, New Jersey	1	1

Source: COP Appendix III-I, Table 2.7; Epsilon 2023

Phase 1 would generate trips by various methods, including specialized equipment vessels (scour protection installation, survey, jack-up heavy lift, and transport vessels), crew transport vessels (crew change, accommodation vessels), and support vessels (tugboat and barge). Construction of Phase 1 would generate an average of 22 and a maximum of 56 vessels operating in the SWDA or over the OECC route at any given time (COP Volume I, Section 3.3.1.12.1; Epsilon 2023). Many construction vessels would remain at the SWDA or OECC for days or weeks at a time, potentially making infrequent trips to port for bunkering and provisioning as needed. Therefore, although an average of approximately 22 vessels would be present in the SWDA during construction of each phase, fewer vessels would transit to and from port each day.

For the maximum design scenario of Phase 1, approximately 3,000 total vessel round trips are expected during the offshore construction period, which equates to an approximate average of 6 vessel round trips per day under an 18-month offshore construction schedule for Phase 1. During the most active month of construction, it is anticipated that an average of approximately 15 daily vessel round trips could occur (COP Volume I; Epsilon 2023). Overall, it is anticipated that there would be a noticeable increase in the number of large vessels transiting into and out of New Bedford Harbor during construction. This would correspond to less than a 10 percent increase in total transits at the harbor and is within the level of day-to-day variability in number of transits. The increased transits are not expected to result in significant delays or congestion, although movements through the hurricane barrier would need to be carefully managed (COP Appendix III-I, Section 10.3, and Table 10; Epsilon 2023). Near port facilities or adjacent waterways, Phase 1 vessels may require other vessels transiting navigation channels or other areas of confined navigation (e.g., the New Bedford hurricane barrier) to adjust course, where possible, or adjust their departure/arrival times to avoid navigational conflicts (COP Volume III, Table 7.8-3; Epsilon 2023). The presence of large, specialized equipment vessels and support vessels could cause delays for vessels not associated with Phase 1 and produce a change in the port utilization and routes used by fishing or recreational vessel operators.

For Phase 1 operations, the applicant would likely establish a long-term SOV operations base at Barnum Landing in Bridgeport, Connecticut (COP Volume I, Section 3.2.2.6; Epsilon 2023). The SOV operations base would be the primary homeport for the SOV and likely be used for crew exchange, bunkering, spare part storage, and load-out of spares to the SOV and/or other vessels. In addition to the SOV operations base, the applicant may base some Phase 1 operations activities on Martha’s Vineyard. Phase 1 vessels would primarily travel between the operations facilities (likely located in Bridgeport, Vineyard Haven, and/or New Bedford Harbor) and the SWDA. During typical Phase 1 operations, an average of approximately six vessels would operate at the SWDA or along the OECC on any given day. In other maintenance or repair scenarios, up to approximately 14 vessels could operate within the SWDA or along the OECC at one time. Emergencies and corrective maintenance scenarios create a level of unpredictability in the estimated number of vessel trips and the associated level of disruption. Approximately 470 vessel round trips would take place annually during the simultaneous operations of Phase 1 and 2, which equates to an average of less than 2 vessel round trips per day. The SWDA is not heavily trafficked, and vessel activities during operations would not significantly affect the limited vessel traffic occurring within the SWDA (COP Appendix III-I; Epsilon 2023). Additionally, regular maintenance activities would occur in the OECC infrequently, primarily to conduct inspections of the offshore export cables on a scheduled maintenance timetable (COP Volume I, Sections 3.3.2 and 4.3.2; Epsilon 2023). The vessels used for such inspections are similar in size and operational requirements to other vessels frequently operating in the RI/MA Lease Areas and would likely not generate congestion, maneuverability limitations, or reductions in available space while transiting or returning to port. Therefore, few impacts on existing vessel traffic, including passenger vessel traffic, are anticipated from operations activities in the SWDA and along the OECC. Because an average of fewer than two operations vessels would transit to and/or from the operations facility on any given day, vessel activities at the operations facility are not expected to affect other commercial or recreational vessel traffic (COP Volume III, Section 7.8.2.2.1; Epsilon 2023). As a result, Phase 1 operations would have localized, long-term, continuous, and minor impacts on port utilization and availability.

Once the Phase 1 operational terms end, the facilities would be decommissioned by retiring in place or removing cable systems, dismantling and removing WTGs, ESPs, foundations, and scour protection. This process is essentially the reverse of construction and would require similar numbers and sizes of vessels (COP Volume III, Section 7.8.2.3; Epsilon 2023). The decommissioning and removal of export cables from the SWDA and the OECC would, therefore, have similar impacts on port utilization as construction: short term, continuous, and moderate.

Presence of structures: The presence of 50 to 62 WTGs and 1 to 2 ESPs partially or nearly constructed or installed would place obstacles in locations where there are currently none, thus increasing the chance of vessel allision with structures or vessels providing support. Phase 1 would include an increased allision risk and probability for smaller vessels using the area. Allisions with a WTG or an ESP could result in damage to vessels, injury to crews, engagement of USCG SAR, and potentially vessel fuel spills. However, the layout of Phase 1 (WTGs oriented in an east-to-west and north-to-south grid pattern with 1.0- x 1.0-nautical-mile (1.15- x 1.15-mile) spacing and diagonal lines of orientation in the northwest-to-southeast and southwest-northeast directions with a spacing of 0.7 nautical mile [0.8 mile]) would create predictable grid-like organization and likely would not complicate SAR activities (COP Appendix III-I; Epsilon 2023). Per the USCG's (2020) MARIPARS, "SAR capabilities in the WEA [wind energy area] will be impacted by the presence of structures in the ocean where before there were no such structures;" however, the presence of Phase 1 construction vessels and partially constructed foundations and structures are not expected to significantly affect SAR operations in the SWDA and may facilitate operations, as partially constructed structures would be marked and lighted, and construction vessels would continuously be within the SWDA (COP Appendix III-I; Epsilon 2023).

The presence of WTGs (both completed and partially constructed) would affect MVR systems, including the potential for disruptions in radar imagery and clutter on operator screens. In particular, the 2022 NAS study found that offshore WTGs could lead to cluttered MVR images and more complex navigation. Increased vessel traffic due to Phase 1 construction activities would have little to no impact on the successful operation of marine radar systems (COP Volume III, Section 7.8.2.1.3, and Appendix III-I; Epsilon 2023). Provided vessels would not be navigating through the safety zones (granted on a case-by-case basis) around working areas, these potential impacts would only occur in the portion of the turbine field already or partially constructed. Overall, the presence of structures during Phase 1 construction would have localized, long-term, continuous, and moderate impacts on navigation and vessel traffic.

Phase 1 would include up to 64 potential new structures with which vessels could allide. The Navigational and Operational Risk Model (NORM) for operations of both phases of Alternative B quantifies navigational risk for open water and defined waterway conditions and can calculate the occurrence frequency of vessel grounding, head-on collisions, overtaking collisions, crossing collisions, powered allisions, and drifting allisions (COP Appendix III-I; Epsilon 2023). The NORM estimated a small increase in accident frequencies associated with construction of WTGs and ESPs throughout the SWDA (Phase 1 and Phase 2 considered together), with a 0.061 annual frequency pre-construction changing to 0.076 to 0.078 annual frequency during operations. This represents an additional vessel collision once every 59 to 67 years on average and is considered a small change in risk. The increase in overall risk associated with the SWDA is approximately 0.015 additional accidents per year, or one additional accident every 67 years, which is also considered a small change in risk. For reference, Table 3.13-8 shows estimated number of collisions per year and estimated average number of years between collisions under existing (pre-construction) conditions. Much of this risk is associated with the Phase 1 and Phase 2 operations vessels. The risk associated with these operations vessels may be slightly over-estimated in the NORM because these vessels would generally transit during fair weather conditions, whereas the NORM does not distinguish among weather conditions. The overall risk of allision is small with average recurrence intervals for all classes of vessels in the range approximately of 363 to 1,173 years. Of the allisions, much of the risk was associated with drifting allisions. A powered allision is considered of very low probability. The causation probability for collisions and powered allisions (i.e., essentially the probability that human error will occur) was unchanged between the existing and future cases in the model. Table 3.13-9 shows estimated accident frequency during Phase 1 operations, including the change in frequency attributable to Phase 1. Based on the above, the navigational risks and hazards from allision based on the presence of structures would have long-term, continuous, and moderate impacts.

The presence of structures would restrict movement and could potentially compound space use conflicts with WTGs/ESPs and operations vessels, which would require an increase in operator vigilance and awareness. The presence of structures, where there were previously none, would lead to increased congestion and navigational complexity within the SWDA through factors such as turn radius limitations and crew fatigue, which could lead to increased risk of damage to vessels, injury to crews, engagement of

USCG SAR, and vessel fuel spills. The navigational risks and hazards associated with the operations of Phase 1 would have long-term, continuous, and moderate impacts.

Table 3.13-8: Estimated Existing Collision Frequency

Vessel Class	Annual Collision Frequency[a] (collisions per year)	Average Years Between Collisions[b]
All	0.061	16
Cargo	0.0013	759
Tanker	0.00081	1238
Passenger	0.00036	2752
Military	0.00006	17,829
Fishing- trawling	0.029	34
Fishing- transiting	0.024	42
Recreation	0.0053	190
Tug-tow	0.00011	9,415

Source: COP Appendix III-I, Table 9.9, and Table 9.10; Epsilon 2023
[a] These values are also referred to as the pre-construction inter-class collision annual frequencies.
[b] The average number of years between collisions is also referred to as the average recurrence interval.

Due to WTG spacing and minimum blade tip clearance above the ocean surface, USCG marine assets could safely navigate and maneuver within the SWDA; therefore, Phase 1 operations would not affect USCG marine operations (for SAR or other purposes). Disruptions to the operation of emergency transponder systems, used by many ocean-going vessels, would likely not be affected by SAR response or SAR aviation presence in the area. USCG aviation assets would not be affected by Phase 1, except for missions directly within the SWDA, where aviation assets would need to maneuver around WTGs and ESPs. USCG SAR pilots recommend a minimum spacing of 1.0 nautical mile (1.15 miles) between WTGs for search paths to enable aviation assets to safely navigate (USCG 2020). Helicopter operations for USCG SAR missions typically travel at speeds of 70 to 90 knots and can turn with a diameter from 0.9 to 1.2 miles at these speeds. The 1.0- x 1.0-nautical-mile (1.15- x 1.15-mile) spacing of the WTGs is considered adequate for the maneuverability of USCG aviation assets within the SWDA (USCG 2020). Notwithstanding the above, the gridded layout of Phase 1 could complicate SAR activities during operations and lead to abandoned SAR missions and resultant increased fatalities. This would have regional, long-term, continuous, and moderate impacts on navigation and vessel traffic.

The presence of WTGs would affect marine radar systems, including potential disruptions in radar imagery and clutter on operator screens. The MARIPARS noted that the potential for interference with marine radar is site-specific and dependent on many factors, such as turbine size, array layouts, number of turbines, construction material(s), and vessel types. The 2022 NAS study found that offshore WTGs could lead to cluttered MVR images and more complex navigation, though other navigational aids are available. Impacts on marine radar systems and SAR capabilities would, therefore, be long term, regional, and minor on navigation and vessel traffic.

Table 3.13-9: Estimated Accident Frequency during Phase 1 Operations

Vessel Class	Structure	Annual Incident Frequency, Phase 1[a]			Existing Accident	Change in Accident	Average Years Between Incidents, Phase 1[c]			Average Years	Change in Years
		Collisions	Allisions	All Incidents	Frequency[b]	Frequency (%)	Collisions	Allisions	All Incidents	Between Incidents, Existing[b]	Between Accidents (%)
All	Monopile	0.075	0.00085	0.076	0.061	20%	13.3	1,173	13.2	16.3	-23%
	Jacket	0.075	0.0028	0.078	ND	ND	13.3	363	12.9	ND	ND
Cargo	Monopile	0.0014	ND	0.0014	0.0013	7%	738	ND	738	759	-3%
	Jacket	0.0014	ND	0.0014	ND	ND	738	ND	738	ND	ND
Tanker	Monopile	0.00082	ND	0.00082	0.00081	1%	1,215	ND	1,215	1238	-2%
	Jacket	0.00082	ND	0.00082	ND	ND	1,215	ND	1,215	ND	ND
Passenger	Monopile	0.00037	ND	0.00037	0.00036	3%	2,674	ND	2,674	2,752	-3%
	Jacket	0.00037	ND	0.00037	ND	ND	2,674	ND	2,674	ND	ND
Military	Monopile	0.000057	ND	0.000057	0.00006	-5%	17,395	ND	17,395	17,829	-2%
	Jacket	0.000057	ND	0.000057	ND	ND	17,395	ND	17,395	ND	ND
Fishing-trawling	Monopile	0.035	0.00011	0.035	0.029	17%	28.7	9,516	28.6	33.9	-19%
	Jacket	0.035	0.00034	0.035	ND	ND	28.7	2,944	28.4	ND	ND
Fishing-transiting	Monopile	0.027	0.00054	0.028	0.024	14%	36.5	1,853	35.8	42.1	-18%
	Jacket	0.027	0.0017	0.029	ND	ND	36.5	573	34.4	ND	ND
Recreation	Monopile	0.0061	0.00010	0.0062	0.0053	15%	164	10,013	161	190	-18%
	Jacket	0.0061	0.00032	0.0064	ND	ND	164	3,096	156	ND	ND
Tug-tow	Monopile	0.00011	ND	0.00011	0.00011	0%	9,115	ND	9,115	9415	-3%
	Jacket	0.00011	ND	0.00011	ND	ND	9,115	ND	9,115	ND	ND

Source: COP Appendix III-I, Tables 9.11 and 9.12; Epsilon 2023

ND = No data
[a]: Accident frequencies are defined as occurrence frequency of vessel grounding, head-on collisions, overtaking collisions, crossing collisions, powered allisions, and drifting allisions. See COP Appendix III-I, Section 9.3.2; Epsilon 2023.
[b] See Table 3.13-8 for estimated existing collision frequency.
[c] The average number of years between collisions is also referred to as the average recurrence interval.

In response to the potential location of two ESP foundations at a single position within the SWDA (Table 2.1-1 in Chapter 2, Alternatives), the USCG raised the following concerns (Stephen West, Pers. Comm., November 30, 2022):

- Each of the co-located ESPs in one of these pairs could protrude up to 0.07 nautical mile (0.08 mile) into adjoining of the orthogonal (north-to-south or east-to-west) or diagonal corridors between WTG and ESP positions in the SWDA. This “double incursion” would not reduce the width of horizontal and diagonal corridors below the minimum width (0.06 nautical mile [0.07 mile]) recommended in the MARIPARS (USCG 2020).
- Co-located ESP foundations could be as close as 500 feet to each other, resulting in ESP platforms that are as close as 172 feet from each other, creating a potential navigation hazard for vessels that travel between these structures.

The USCG also stated that co-located ESPs would need to be properly labeled on navigation charts and would need appropriate lighting, auditory signals (if appropriate), and AIS designation (Stephen West, Pers. Comm., November 30, 2022).

Co-located ESPs would incrementally increase navigational risks and hazards from allision and collision and complicate SAR activities, compared to the impacts discussed above, and would continue to result in moderate impacts on navigation and vessel traffic. BOEM has included the following mitigation and monitoring measure to address the impacts of ESPs on navigation and vessel traffic, as described in detail in Table H-2 of Appendix H, Mitigation and Monitoring, and would be required as a condition of COP approval:

- The applicant must not adjust approved structure locations in a way that narrows any northwest-to-southeast or northeast-to-southwest transit corridors to less than 0.6 nautical mile (0.07 mile). The applicant must not co-locate ESPs at approved structure locations by adding more than one foundation at an approved location.

Decommissioning impacts from the presence of structures would be similar to those for construction, with increased risk of allision, collision, spills, and interruptions in radar imagery. In addition, the presence of partially removed structures would complicate SAR responses due to the removal of previously present structures, beacons, and lights on structures. These impacts would be short term, localized, and minor.

The risks associated with decommissioning traffic and vessel activity would be similar to risks associated with construction activity. Phase 1 decommissioning would, therefore, result in short-term, temporary, and minor impacts on navigation and vessel traffic during the decommissioning stage.

During decommissioning, Phase 1 would have little to no impact on a mariner’s ability to see and use ATONs, although PATONs would be removed from the SWDA (COP Volume III; Epsilon 2023). Some disruption of established navigation patterns or ATONs in the RI/MA Lease Areas is anticipated due to the presence of decommissioning and removal vessels. Impacts on navigation and vessel traffic during decommissioning would be short term, temporary, and minor.

Traffic: Construction of Phase 1 would generate additional domestic and international vessels operating in the SWDA or over the OECC route at any given time (COP Volume III, Section 7.8.2.1.1, and Table 7.8-3; Epsilon 2023). Up to two vessels trips per day during peak construction would transit to the Phase 1 area from Europe and remain on site from 2 to 12 months. On average, vessels transporting components from Europe directly to the SWDA would make approximately 16 round trips per month over a 2-year offshore construction schedule (COP Volume I, Section 3.3.1.7; Epsilon 2023). On average, four cable-laying, support, and crew vessels may be deployed along sections of the OECC during the construction stage, however, as many as approximately seven vessels may be used for cable-laying activities in any 1 month. Since many of the cable installation activities are sequential, these vessels would not all operate along the OECC simultaneously (COP Volume III, Section 3.3.1.12.1; Epsilon 2023). Vessel traffic associated with Phase 1 construction would not represent a significant increase over the current levels of vessel traffic throughout the RI/MA Lease Areas. The highest density of vessel traffic in the offshore development region occurs outside the RI/MA Lease Areas and primarily within the traffic separation scheme, fairways, precautionary areas, and recommended routes. AIS data suggest that existing vessel traffic levels within the SWDA are relatively low (COP Volume III, Section 7.8.1.1, and Appendix III-I; Epsilon 2023). Because the SWDA is not heavily trafficked, construction activities would not significantly affect the limited vessel traffic within the SWDA. During Phase 1 construction, the applicant would continue to work with ferry operators, harbor pilots, and other vessel operators to ensure any impacts on commercial vessel traffic are minimized to the greatest extent practicable (COP Volume III, Section 7.8.2.1.5; Epsilon 2023). The presence of these vessels would increase the risk of allisions, collisions, and spills; however, vessels not associated with the proposed Project would be able to avoid Phase 1 vessels, components, and access restrictions (i.e., safety zones or restrictions established by the USCG around installation vessels, granted on a case-by-case basis basis) though routine adjustments in navigation. For the OECC, non-Project vessels required to travel a more restricted (narrow) lane near the OECC could potentially experience greater delays waiting for cable-laying vessels to pass. During construction, Phase 1 vessel traffic in ports such as ProvPort, Fall River, New Bedford, and Davisville would result in vessel traffic congestion, limited maneuvering space in navigation channels, and delays in ports and could also increase the risk of collision, allision, and resultant spills in or near ports. Vessel traffic generated by Phase 1 construction would constitute less than 10 percent of typical daily vessel transits into and out of the Port of New Bedford (COP Appendix III-I; Epsilon 2023) but could nonetheless restrict maneuvering room and cause delays accessing the port. This would have localized, long-term, continuous, and moderate impacts on navigation and vessel traffic.

SAR activities may be facilitated to some degree due to the presence of several vessels within the SWDA. This would likely include more restricted vessel movement to boaters and low-flying aircraft in the SWDA and an increased likelihood of vessel allision, which may result in more incidents and fewer successful rescues. This would have localized, long-term, continuous, and minor impacts on navigation and vessel traffic.

For routine Phase 1 operations, an average of approximately four vessels are anticipated to operate at the SWDA or along the OECC at any given time; additional vessels may be required in other maintenance or repair scenarios. Approximately 250 vessel round trips are estimated to take place annually for Phase 1 operations. As discussed under the port utilization IPF, an average of approximately 6 and up to 15 vessels could operate in the SWDA or along the OECC on any given day during operations, depending on the type of maintenance required, with up to 470 annual vessel round trips (approximately 2 per day) during operations of the proposed Project. Because the SWDA is not heavily trafficked, and because the typical operations vessels would be similar in size and operational requirements to other vessels frequently operating in the RI/MA Lease Areas, Phase 1 operations activities would have few impacts on existing vessel traffic, including passenger vessel traffic.

Therefore, Phase 1 operations would have long-term, localized, and minor impacts on navigation and vessel traffic.

Increased vessel activity in the SWDA could impact SAR activities by restricting vessel movement and increasing the likelihood of vessel allision and collisions, which may result in more incidents and fewer successful rescues. This would have localized, long-term, continuous, and minor impacts on navigation and vessel traffic.

During decommissioning, like construction, the presence support and specialized equipment vessels would increase the risk of allisions, collisions, and spills; however, vessels not associated with the proposed Project would be able to avoid Phase 1 vessels, components, and access restrictions though routine adjustments in navigation. For the OECC, non-Project vessels required to travel a more restricted (narrow) lane near the OECC could potentially experience greater delays waiting for cable-removing vessels to pass or idling while work is completed. During decommissioning, Phase 1 vessel traffic in ports such as ProvPort, Fall River, New Bedford, and Davisville would result in vessel traffic congestion, limited maneuvering space in navigation channels, and delays in ports and could also increase the risk of collision, allision, and resultant spills in or near ports. Vessel traffic generated during decommissioning of Phase 1 would constitute less than 10 percent of typical daily vessel transits into and out of the Port of New Bedford (COP Appendix III-I; Epsilon 2023) but could nonetheless restrict maneuvering room and cause delays accessing the port. This would have localized, long-term, continuous, and moderate impacts on navigation and vessel traffic.

Decommissioning impacts on SAR activities and the utilization of aircraft would be similar to those experienced during the construction and operations stages. SAR activities may be facilitated to some degree due to the presence of several vessels within the SWDA. This would likely include more restricted vessel movement to boaters and low-flying aircraft in the SWDA and an increased likelihood of vessel allision, which may result in more incidents and fewer successful rescues. This would have localized, long-term, continuous, and minor impacts on navigation and vessel traffic.

Impacts of Phase 2

Phase 2 would affect navigation and vessel traffic through the following primary IPFs during construction, operations, and decommissioning. If the applicant selects the SCV as part of the final proposed Project design, some or all of the impacts on navigation and vessel traffic from the Phase 2 OECC through Muskeget Channel may not occur, while impacts along the SCV route would occur. BOEM will provide a more detailed analysis of the SCV impacts on navigation and vessel traffic in a supplemental NEPA analysis, if the SCV is selected.

Anchoring and gear utilization: The impacts of Phase 2 construction on anchoring would be the same as those for Phase 1. In addition to vessel damage and trip interruption, interruption of Phase 2 construction is also likely in the event of an anchoring incident, although this would be most likely only in areas of hard cover and scour protection over foundations and cables. These impacts would be localized, temporary to short term, and minor.

The impacts of Phase 2 construction on anchoring and gear utilization for the SCV would be similar to those impacts described for Phase 1, in additional locations (i.e., along the SCV route). These impacts would be localized, temporary to short term, and minor.

Smaller vessels anchoring in the SWDA may have issues with anchors failing to hold near foundations and any associated scour protection, or, alternately, where the anchors may become snagged and potentially lost. Potential impacts from anchoring include deep draft vessels anchoring in an emergency scenario, resulting in damage to the export cable, risks associated with an anchor contacting an electrified cable, and impacts on the vessel operator’s liability and insurance.

Impacts of anchoring and gear utilization during Phase 2 (including the SCV) would be the same as those impacts described for Phase 1. In addition to vessel damage and trip interruption, interruption of Phase 2 construction is also likely in the event of an anchoring incident, although this would be most likely only in areas of hard cover and scour protection over foundations and cables. The operational impacts on anchoring and gear utilization would be localized, long term, and negligible. The decommissioning and removal of export cables from the SWDA and the OECC for Phase 2 would have the same impacts on anchoring and gear utilization as construction for both phases and decommissioning as those of Phase 1. These impacts would be localized, temporary to short term, and negligible.

Cable emplacement and maintenance: Phase 2 impacts for cable emplacement would be similar to those identified for Phase 1. Cable emplacement during Phase 2 could include two routes. The applicant's preferred route for the Phase 2 OECC would parallel the Phase 1 OECC. If necessary, due to technical, logistical, grid interconnection, or other unforeseen issues, the Phase 2 OECC could use the Western Muskeget Variant and/or the SCV. Cable installation along the OECC and within the SWDA could also lead to increased congestion and navigational complexity, which could result in crew fatigue, damage to vessels and fishing gear, injury to crews, engagement of USCG SAR, and vessel fuel spills. Vessels not involved in cable emplacement or maintenance would need to take additional care when crossing cable routes or avoid installation or maintenance areas entirely during installation and maintenance activities. Areas disturbed by OECC construction for Phase 2 would produce localized, temporary changes in fishing, fishing transit, and other commercial or recreational navigation routes or events due to cable emplacement and maintenance, which would constitute a minor impact.

An analysis of 2016 to 2019 AIS data for the federal waters portion of the SCV evaluated the location and frequency of vessel crossings. This analysis showed that vessel traffic density along the SCV is relatively low overall, with the highest traffic concentration closer to shore. Approximately 69 AIS-equipped vessels crossed the SCV daily, most of which were fishing, recreational, or tug-towing (Epsilon 2023). SCV construction would generate localized, temporary changes in fishing, fishing transit, and other commercial or recreational navigation routes or events due to cable emplacement and maintenance, which would constitute a minor impact.

Impacts of cable emplacement and maintenance for Phase 2 operations (including operations related to the SCV) would be the same as those for Phase 1. Phase 2 would include more restricted vessel movement in the SWDA and OECC during cable maintenance activities. This would lead to increased congestion and navigational complexity within the SWDA, which could result in crew fatigue, damage to vessels and fishing gear, injury to crews, engagement of USCG SAR, and vessel fuel spills. The space use conflicts for fishing could result in reduced commercial catch within the SWDA. This would have localized, short-term, intermittent, and negligible impacts on navigation and vessel traffic. The decommissioning and removal of export cables from the SWDA and the OECC for Phase 2 would have the same impacts on cable emplacement and maintenance as construction for both phases and decommissioning as those of Phase 1. These impacts on navigation and vessel traffic would be localized, short term, intermittent, and negligible.

Port utilization: The impacts of Phase 2 construction on port utilization (with or without the SCV) would be similar to those of Phase 1 and could include increased port traffic and space use conflicts. The magnitude of these impacts would vary across ports and depend on the specific Phase 2 construction use of each port. As a result, construction of Phase 2 would have short-term, continuous, and moderate impacts on navigation and vessel traffic.

Impacts on port utilization during Phase 2 operations (including operations related to the SCV) would be similar to those of Phase 1. The proposed Project would likely share some vessels between Phases 1 and 2, thus consolidating trips while both phases are operating. Approximately 470 vessel round trips are estimated to take place annually during the simultaneous operations of both phases, which equates to an average of less than 2 vessel round trips per day. This number would reduce if trips were consolidated. Because an average of fewer than two operations vessels would transit to and/or from the operations facility on any given day, vessel activities at the operations facility are not expected to affect other commercial or recreational vessel traffic (COP Volume III, Section 7.8.2.2.1; Epsilon 2023). Therefore, Phase 2 operations would have localized, long-term, continuous, and minor impacts on port utilization and availability.

The decommissioning and removal of structures and export cables from the SWDA and the OECC (including the SCV OECC) for Phase 2 would have the same impacts on port utilization as decommissioning of Phase 1. Impacts on port utilization during decommissioning would be short term, continuous, and moderate.

Presence of structures: Phase 2 would add up to 82 new stationary structures to the SWDA during construction. This would contribute 218 acres of impact for foundation and scour protection installation and 29 acres of impact for hard protection for offshore and inter-array cables (COP Appendix III-T, Table 1; Epsilon 2023). The SCV could require up to 42 acres of hard protection (Epsilon 2023). Impacts from the presence of structures during Phase 2 would be the same as for Phase 1: short term, continuous, and moderate.

Phase 2 would add up to a total maximum of 82 new stationary structures to the SWDA during operations, where there was previously open unobstructed ocean. Impacts of Phase 2 operations from the presence of these structures would be similar to those for Phase 1, reflecting increased risk of allision/collision (Table 3.13-7), delayed or degraded SAR response, and space use conflicts. This would result in long-term, continuous, and moderate impacts on navigation and vessel traffic.

The decommissioning and removal of structures and of export cables from the SWDA and the OECC for Phase 2 (including the SCV OECC) would have the same impacts of the presence of structures as construction for both phases and decommissioning as those of Phase 1, including the removal of all obstructions and PATONS. Impacts from the presence of structures at decommissioning, like construction, would be short term, localized, and moderate.

Traffic: Impacts on vessel traffic during construction of Phase 2 (including the SCV) would be the same as for Phase 1. Construction of Phase 2 would generate additional domestic and international vessels operating in the SWDA or over the OECC route at any given time (COP Volume III, Section 7.8.2.1.1, and Table 7.8-3; Epsilon 2023). Selection of the SCV as part of the proposed Project would have similar impacts along the SCV OECC route. The presence of these vessels would increase the risk of allisions, collisions, and spills; however, vessels not associated with the proposed Project would be able to avoid Phase 2 vessels, components, and access restrictions though routine adjustments in navigation. For the OECC, non-Project vessels required to travel a more restricted (narrow) lane near the OECC could potentially experience greater delays waiting for cable-laying vessels to pass. During construction, Phase 2 vessel traffic in ports such as ProvPort, Fall River, New Bedford, and Davisville would result in vessel traffic congestion, limited maneuvering space in navigation channels, and delays in ports and could also increase the risk of collision, allision, and resultant spills in or near ports. Construction of Phase 2 would have localized, long-term, continuous, and moderate impacts on navigation and vessel traffic.

SAR activities may be facilitated to some degree due to the presence of vessels, WTGs and ESPs could provide refuge for incident victims, and marking of individual WTGs could facilitate location and rescue by the USCG. This would likely include more restricted vessel movement to boaters and low-flying aircraft in the SWDA and an increased likelihood of vessel allusion, which may result in more incidents and fewer successful rescues. This would have localized, long-term, continuous, and minor impacts on navigation and vessel traffic.

Impacts on traffic as result of Phase 2 operations (including operations associated with the SCV) would be the same as those under Phase 1. The proposed Project would likely share some vessels between Phases 1 and 2 while both phases are operating. A shared operational strategy would enhance operational efficiencies and likely minimize impacts during operations by reducing overall vessel usage within the SWDA. For routine operations of the proposed Project, it is anticipated that an average of approximately six vessels would operate at the SWDA or along the OECC on any given day. In other maintenance or repair scenarios, additional vessels may be required, which are estimated to result in a maximum of approximately 15 vessels operating within the SWDA or along the OECC at one time. These increases in vessel traffic from Phase 2 operations would be minimal compared to existing vessel traffic, including passenger vessel traffic.

Therefore, operations of Phase 2 would have long-term, localized, and minor impacts on navigation and vessel traffic.

The decommissioning and removal of structures and of export cables from the SWDA and the OECC for Phase 2 would have the same impacts on traffic as construction for both phases and decommissioning as those of Phase 1. This would have localized, long-term, continuous, and moderate impacts on navigation and vessel traffic.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-10 in Appendix G would contribute to impacts on navigation and vessel traffic through the primary IPFs of presence of structures, which increases the risk of collision/allision and navigational complexity. The cumulative impacts on navigation and vessel traffic would be **moderate**.

Conclusions

Impacts of Alternative B. Construction, operations, and decommissioning of Alternative B would have **moderate** impacts on navigation and vessel traffic. Impacts on vessels not associated with Alternative B would include changes in navigation routes, delays in ports, degraded communication and radar signals, and increased difficulty of offshore SAR or surveillance missions within the SWDA, all of which would increase navigational safety risks. Some commercial fishing, recreational, and other vessels would choose to avoid the SWDA altogether, leading to some potential funneling of vessel traffic along the SWDA borders. Generally, fewer turbines (i.e., implementation of the larger 16 or 19 MW turbines) in the SWDA would reduce potential impacts on navigation and vessel traffic.

The impact analysis is based on a maximum-case scenario, and if the applicant would implement a less impactful scenario within the PDE, smaller amounts of construction or infrastructure development would result in lower impacts but would not likely result in different impact ratings than those described above.

Cumulative Impacts of Alternative B. The cumulative impacts on navigation and vessel traffic in the geographic analysis area would be **moderate**. The main IPF is the presence of structures, which increases the risk of collision/allision and navigational complexity. Overall impacts on navigation and vessel traffic from ongoing and planned activities, including Alternative B, would be **moderate**, due primarily to the increased possibility for loss of life due to maritime incidents, which would produce significant local and possibly regional disruption for ocean users in the RI/MA Lease Areas.

3.13.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Navigation and Vessel Traffic

When analyzing the impacts of Alternative C on navigation and vessel traffic, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for navigation and vessel traffic. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. These differences would not result in meaningfully different impacts compared to Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on navigation and vessel traffic would be **moderate**. The cumulative impacts of Alternative C would also be **moderate**.

3.13.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Navigation and Vessel Traffic with the Western Muskeget Variant Contingency Option

Impacts on navigation and vessel traffic from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from cable placement that would align with those described under Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B.
- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce the potential impacts on navigation and vessel traffic by a negligible increment for both Phase 1 and Phase 2, as there could be two fewer structures (WTGs or ESPs) potentially installed in the SWDA.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on navigation and vessel traffic relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B; the Preferred Alternative would have **moderate** impacts on navigation and vessel traffic within the geographic analysis area. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **moderate**.

3.14 Other Uses (National Security and Military Use, Aviation and Air Traffic, Offshore Cables and Pipelines, Radar Systems, Scientific Research and Surveys, and Marine Minerals)

3.14.1 Description of the Affected Environment

3.14.1.1 Geographic Analysis Area

This section discusses existing conditions in the geographic analysis area for uses of the OCS not addressed in other portions of the EIS—national security and military use, aviation and air traffic, offshore cables and pipelines, radar systems, scientific research and surveys, and marine minerals—hereafter "other uses," as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.14-1. The geographic analysis area for other uses includes Nantucket Sound, areas south of Martha's Vineyard and Nantucket, the RI/MA Lease Areas, and waters surrounding potential vessel routes to the ports identified for use by the applicant, as well as the cities and towns surrounding the areas where proposed Project-related activities would occur. The geographic analysis area for scientific research and surveys is the same as the geographic analysis area for finfish, invertebrates, and EFH (Section 3.6) and includes U.S. waters from the southern edge of the Scotian Shelf (in the Gulf of Maine) to Cape Hatteras, North Carolina.

3.14.1.2 Existing National Security and Military Uses

Branches of the military currently use and will continue to use the airspace and waters in this area for operations and training. The U.S. Navy, the USCG, and other military and national security entities have numerous facilities in the region (Figure 3.14-2). Major onshore regional military and national security facilities include Naval Station Newport, Naval Submarine Base New London, the Northeast Range Complex/Narragansett Bay Operation Area, Joint Base Cape Cod, and numerous USCG stations (COP Volume III, Section 7.9.1; Epsilon 2023). Onshore and offshore military and national security use areas may have designated surface and subsurface boundaries and special use airspace. Military activities are anticipated to continue into the future and may include routine activities (including SAR[41]) as well as non-routine activities. Military air traffic uses the area, and other government (or government-hired private) aircraft may occasionally fly over the SWDA for data collection and SAR operations.

The SWDA is not located within territorial airspace (i.e., up to 12 nautical miles [14 miles] from shore). However, portions of the OECC, portions of the vessel routes between port facilities and the SWDA, and the port facilities themselves are within territorial airspace. The U.S. Navy and other Department of Defense (DoD) branches use the airspace over and adjacent to the SWDA. The SWDA, along with much of the RI/MA Lease Areas, is within Warning Area W-105A, a block of airspace ranging from 0 to 50,000 feet above mean sea level (AMSL), part of the U.S. Navy-managed Narragansett Bay Complex (COP Volume III, Appendix J; Epsilon 2023; GlobalSecurity.org 2018). Warning Area W-105A is primarily used by the U.S. Air Force (USAF), specifically the 104th Fighter Wing, a unit of the Massachusetts Air National Guard, for operations above 1,000 feet AMSL, but may also be used by other military entities.

[41] While SAR occurs on an as-needed basis and, thus, could be considered non-routine, USCG and other entities conduct regular SAR training and perform active SAR missions frequently enough in or near the geographic analysis area that SAR is evaluated here as a routine activity.

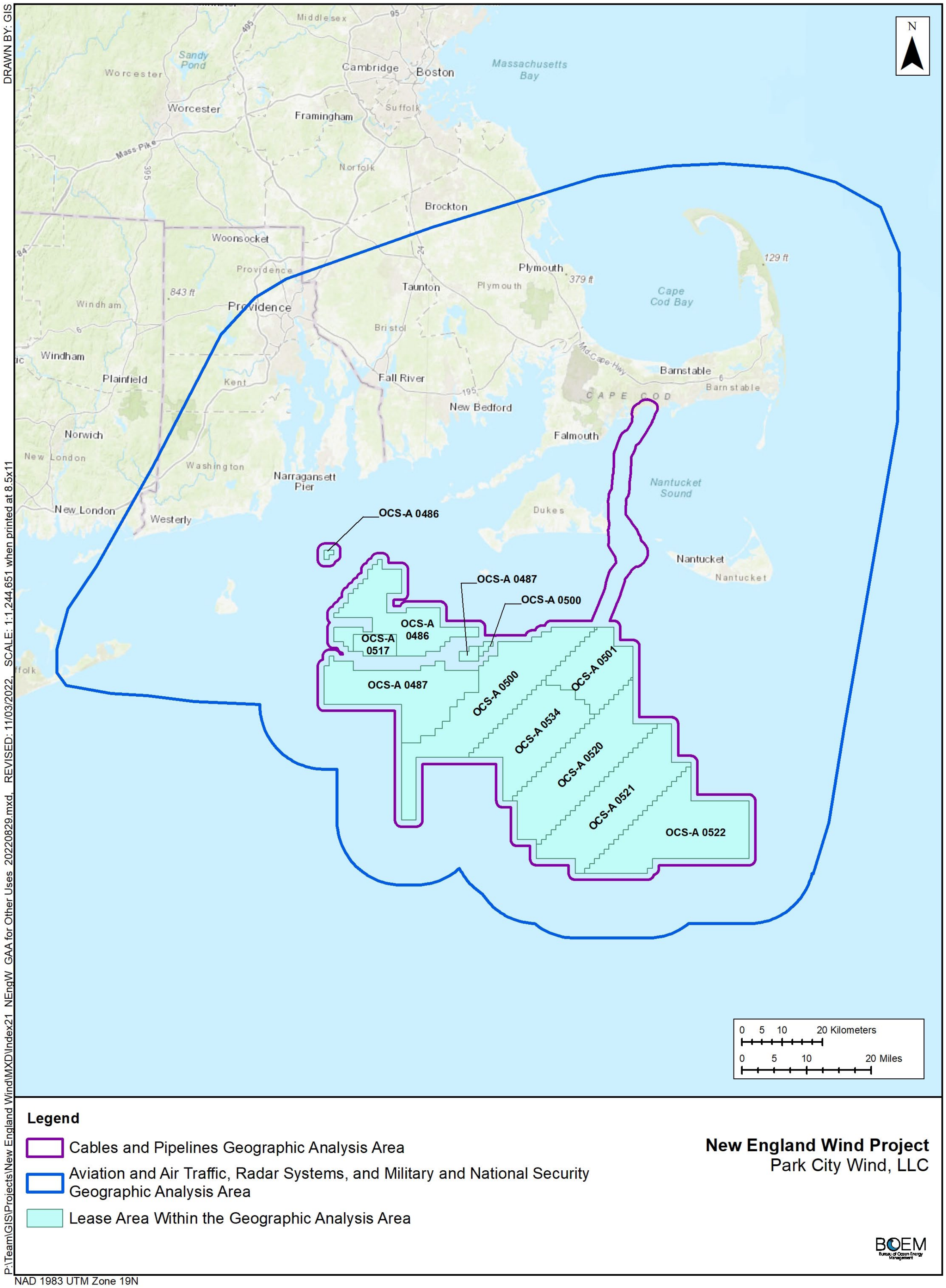
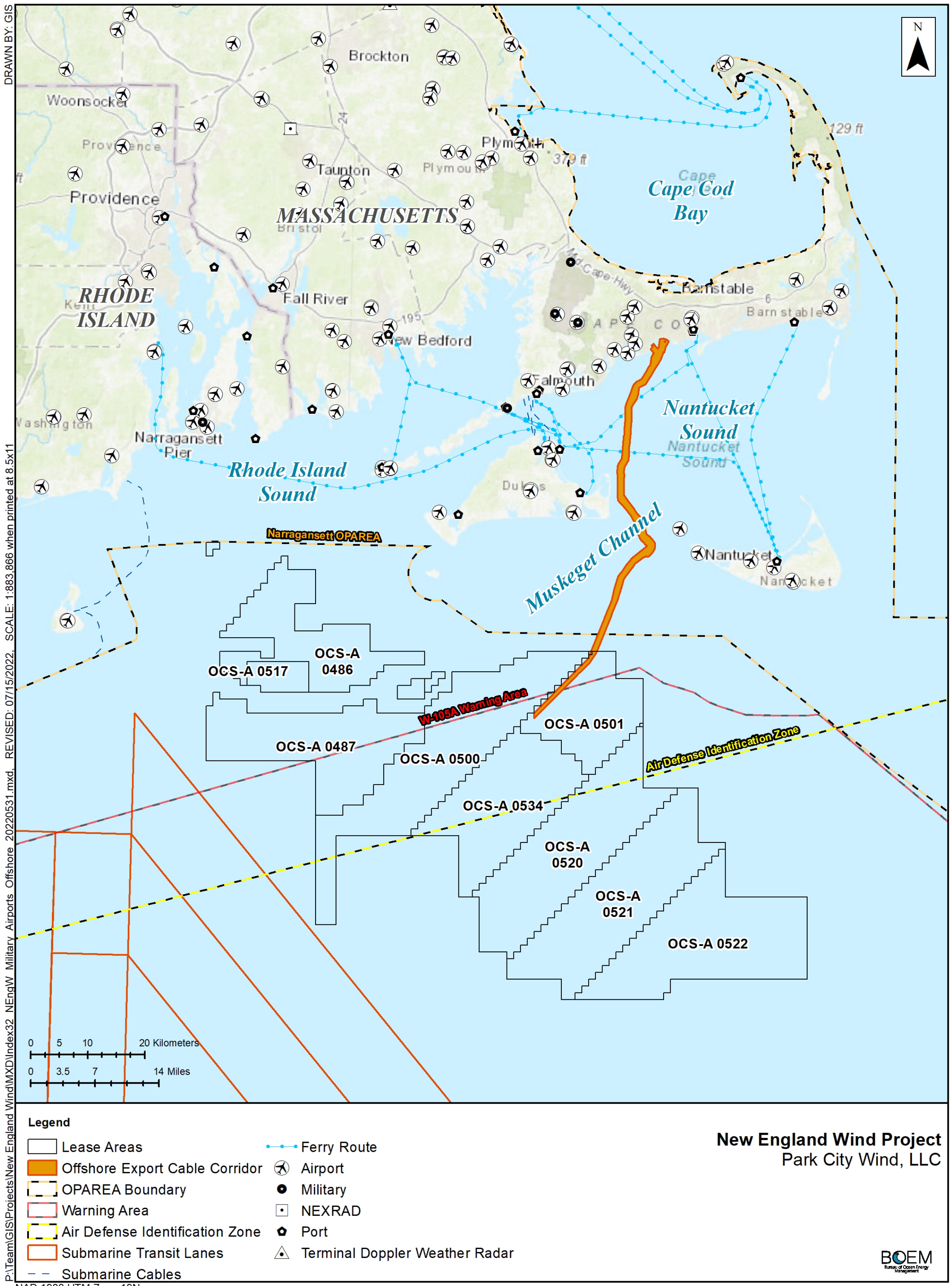


Figure 3.14-1: Geographic Analysis Area for Other Uses



NEXRAD = Next Generation Weather Radar; OPAREA = operating area

Figure 3.14-2: Military and National Security Facilities

USAF activities within W-105A include, but are not limited to, supersonic operations (above 10,000 feet AMSL) and release of flares and chaff down to 2,000 feet (BOEM 2021b). A portion of the SWDA is located within the limits of the Air Defense Identification Zone. All international flights entering this zone must provide the appropriate documentation, but the SWDA's presence in this zone is not likely to have a physical impact on aviation operations. National defense radar systems operating within the region include the Precision Acquisition Vehicle Entry/Phased Array Warning System installation at Joint Base Cape Cod and other military radars (COP Volume III, Section 7.9; Epsilon 2023). Military training exercises typically occur in deeper offshore waters southeast of the SWDA, although military vessels transit through the SWDA (COP Volume III, Section 7.8, Epsilon 2023).

3.14.1.3 Existing Aviation and Air Traffic

There are numerous public and private-use airports in the region. Major airports in the region include Boston Logan International Airport approximately 90 miles north of the SWDA, and T.F. Green Airport in Providence, Rhode Island, approximately 65 miles northwest of the SWDA. The closest public airports to the SWDA are Nantucket Memorial Airport on Nantucket and Katama Airfield and Martha's Vineyard Airport, both located on Martha's Vineyard. Private airports or airstrips near the SWDA are located on Tuckernuck Island and Martha's Vineyard (Trade Wind Airport). Other public and private airports and heliports are located on the mainland.

General aviation traffic in and near the SWDA is highest during the summer tourism season. Over a 1-year period between April 2020 and April 2021, Martha's Vineyard Airport hosted 32,588 aircraft operations, while Nantucket Memorial Airport hosted 52,542 operations (FAA 2022). Commercial and long-distance flights typically occur at or above 18,000 feet AMSL. High-performance jet and turboprop aircraft generally follow instrument flight rules (IFR) routes between 3,000 and 7,000 feet AMSL. Other aircraft operate using Visual Flight Rules (VFR), which do not require designated routes or altitudes. VFR pilots are required to maintain a minimum 500 feet AMSL clearance from any structure or vessel (14 CFR § 91.119). There are no minimum altitude restrictions over water in the absence of any structures or vessels (BOEM 2014b). The Aviation Impact Assessment for Vineyard Wind 1 found that more than 90 percent of existing air traffic over the wind development area for that project (just northeast of the SWDA) occurred at altitudes that would not be impacted by the WTG placements (Epsilon 2020). The FAA has authority to review proposed structures greater than 200 feet AMSL and within 12 nautical miles (13.8 miles) of the shoreline to determine whether the activity would impact safe and efficient use of navigable airspace or air navigation and communication facilities. Construction cranes, construction of turbines in port, and transport of constructed turbines to the leased areas could also necessitate FAA aeronautical studies and compliance with FAA requirements and guidelines for marking and lighting.

3.14.1.4 Existing Offshore Cables and Pipelines

The coastal region of Massachusetts is served by an onshore electrical grid and a network of onshore pipelines. Islands in the region, including Martha's Vineyard and Nantucket, are served by submarine electrical transmission cables. Currently, a total of five submarine transmission cable systems are located in Nantucket Sound, which are identified on NOAA navigational charts for Nantucket and Martha's Vineyard (Figure 3.14-3). Three of the five cables service Martha's Vineyard by connecting the Town of Falmouth on Cape Cod with Vineyard Haven and Tisbury through eastern Vineyard Sound. The two remaining cables service Nantucket with cables from Dennis Port and Hyannis Port (departing from Kalmus Beach in Outer Lewis Bay) interconnecting through Nantucket Sound to a landfall at Jetties Beach.

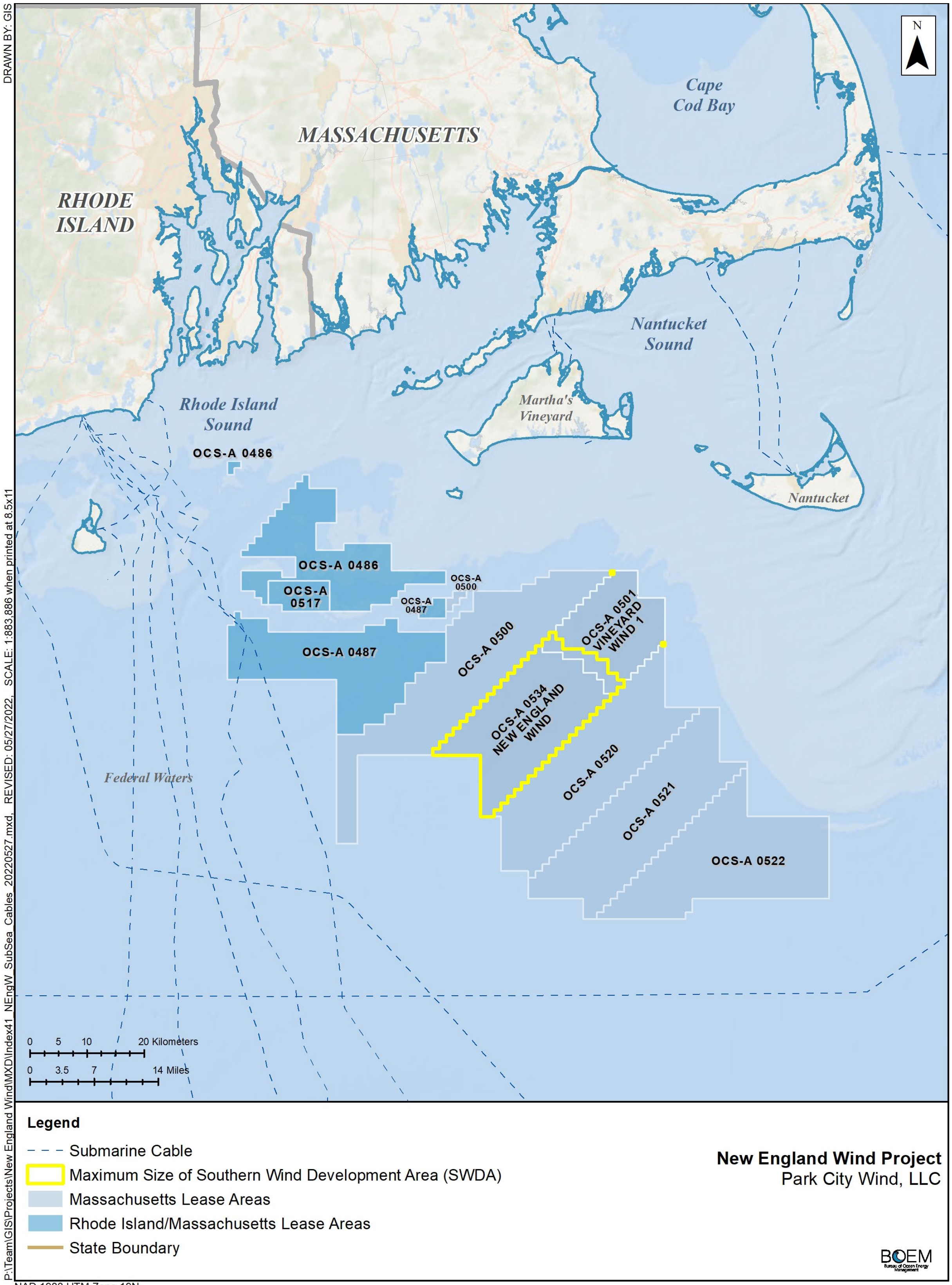


Figure 3.14-3: Submarine Transmission Cables

No offshore pipelines are located within or in the region immediately surrounding the SWDA. Two cables are within the geographic analysis area and cross the far western side of Lease Area OCS-A 0487, approximately 20 miles west-to-northwest of the SWDA. The proposed Project would not intersect and is not expected to impact or be impacted by these submarine transmission cable systems; therefore, the transmission cables in Lease Area OCS-A 0487 are not discussed further.

3.14.1.5 Existing Radar Systems

Radar systems for marine navigation are discussed in Section 3.13, Navigation and Vessel Traffic. Commercial air traffic control radar systems, national defense radar systems, and weather radar systems currently operate in the region to serve national defense, weather, and air traffic control purposes. The closest FAA Terminal Doppler Weather Radar (TDWR) facilities are located near Boston Logan International Airport (Boston TDWR), more than 90 miles from the SWDA. Next Generation Weather Radar (NEXRAD) is a network of 159 high-resolution Doppler weather radars, operated by the National Weather Service (NWS), used for weather forecasting purposes. NEXRAD installations around the SWDA include the NWS Taunton, Massachusetts facility (KBOX), and the NWS Brookhaven, New York facility (KOKX).

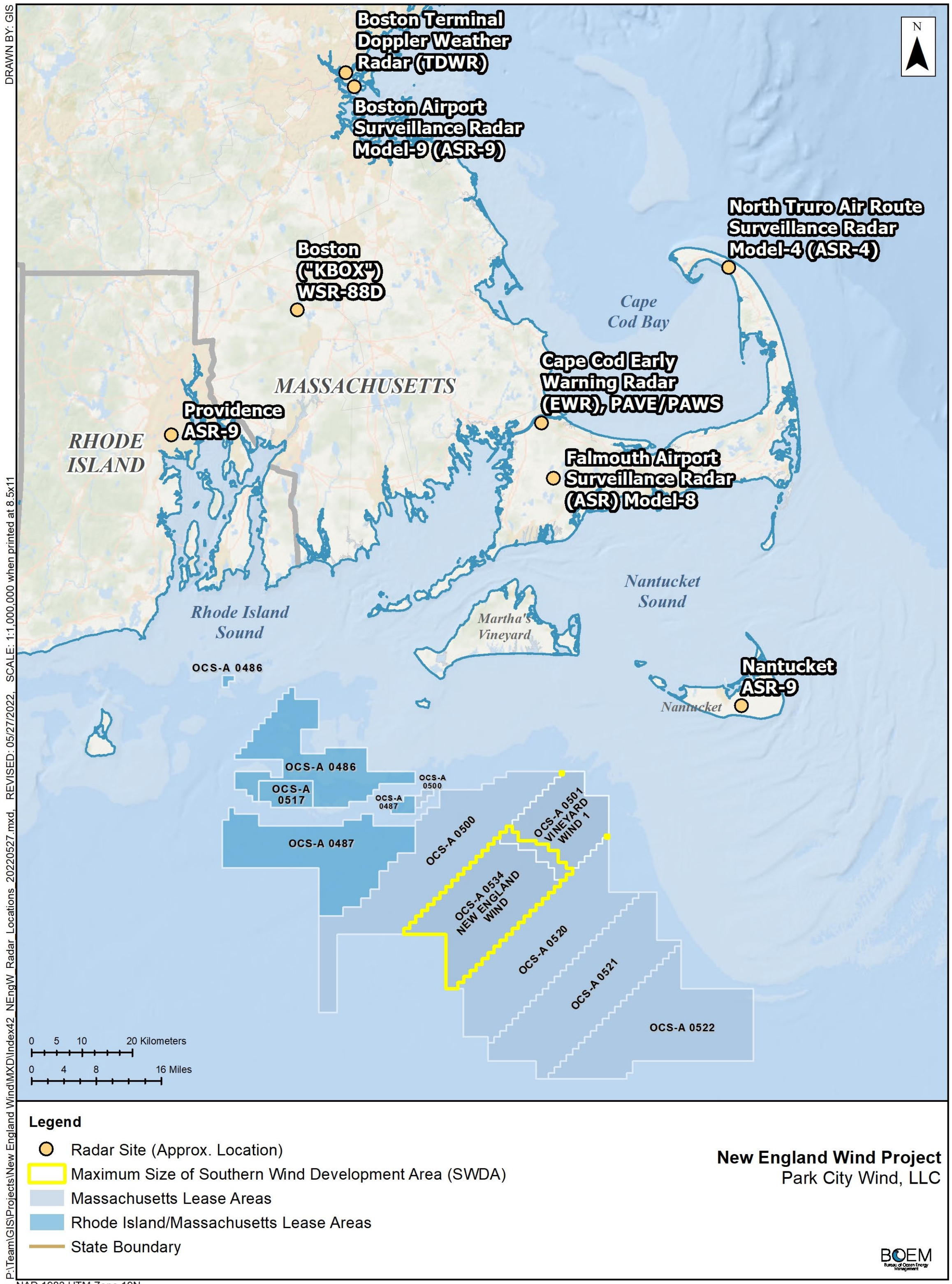
Rutgers University and the Woods Hole Oceanographic Institution maintain a series of coastal high-frequency (HF) radars that study ocean currents as part of NOAA's Integrated Ocean Observing System (IOOS) National Network, including installations on Nantucket, Martha's Vineyard, and Block Island (Roarty 2020). Military radar systems within the geographic analysis area include the Precision Acquisition Vehicle Entry/Phased Array Warning System installation at Joint Base Cape Cod (also known as Cape Cod Air Force Station Early Warning Radar [AFS EWR]). Other radar sites within the geographic analysis area include Boston Airport Surveillance Radar (ASR)-9, Cape Cod Air Force Station Early Warning Radar, Falmouth ASR-8, Nantucket ASR-9, North Truro Air Route Surveillance Radar (ARSR)-4, Coventry (Providence) ASR-9, Riverhead ARSR-4, Boston (KBOX) Weather Surveillance Radar (WSR)-88D, and Brookhaven WSR-88D (COP Volume III, Section 7.9.1.6; Epsilon 2023). The DoD uses the Cape Cod AFS EWR for ballistic missile defense and space surveillance. The North American Aerospace Defense Command's (NORAD) radar operations and defense of national critical infrastructure are located in the same geographic areas (BOEM 2021b). Existing radar systems would continue to provide weather, navigational, and national security support to the region.

Ten primary surveillance radar sites are within approximately 100 nautical miles (115 miles) of the SWDA (Figure 3.14-4). These radar sites provide radar data to multiple DoD, Department of Homeland Security (DHS), FAA, and NOAA facilities for conducting air traffic control, air defense, ballistic missile defense, homeland security, space surveillance, and weather operations. Two navigational aid sites are near the proposed wind turbines, Martha's Vineyard very high frequency omnidirectional range and co-located distance measuring equipment. Additionally, 12 of the IOOS HF radar sites were identified in the vicinity of the SWDA, as were 2 navigational aid sites in Martha's Vineyard and Nantucket.

3.14.1.6 Existing Scientific Research and Surveys

Research in the geographic analysis area includes oceanographic, biological, geophysical, and archaeological surveys focused on the OCS and nearshore environments, and/or resources that may be impacted by offshore wind development. Federal agencies, state agencies, educational institutions, and environmental non-governmental organizations participate in ongoing research offshore in the RI/MA Lease Areas and surrounding waters. Aerial and ship-based research include oceanographic, biological, geophysical, and archaeological surveys, and data collected support fisheries assessments and management actions, protected species assessments and management actions, ecosystem-based fisheries management, and regional and national climate assessments, as well as a number of regional, national, and international science activities.

BOEM is committed to working with NOAA toward a long-term regional solution to account for changes in survey methodologies because of offshore wind farms. On December 4, 2022, NOAA and BOEM published a Federal Survey Mitigation Strategy for the Northeast U.S. region that identifies and addresses anticipated impacts of offshore wind energy development on NOAA's scientific surveys (Hare et al. 2022). This implementation strategy also defines stakeholders, partners, and other ocean users that will be engaged throughout the process and identifies potential resources for successful implementation. Activities described in the implementation strategy are designed to mitigate the impact of offshore wind energy development on NOAA surveys and are referred to as the Federal Survey Mitigation Program. The mitigation program will include survey-specific mitigation plans for each affected survey including vessel and aerial surveys. While the program has been finalized, additional development of survey-specific mitigation plans is ongoing. The implementation strategy is intended to guide the implementation of the mitigation program through the duration of wind energy development in the Northeast U.S. region. More information on scientific survey mitigation is available in Appendix H, Mitigation and Monitoring (Table H-2).



PAVE/PAWS = precision avionics vectoring equipment/phased array warning system

Figure 3.14-4: Surveillance Radar Sites

The NEFSC, NMFS, NOAA, and MA DMF operate or support surveys related to ecological monitoring and fisheries stock assessments in the RI/MA Lease Areas. These surveys are used in part to develop data that inform stock assessments and fisheries management and influence fisheries management planning. Fisheries stock assessment surveys and ecological monitoring surveys that occur in the region include, but are not limited to:

- NEFSC northeast bottom trawl survey;
- NARW Sighting Advisory System;
- NEFSC sea scallop survey;
- NEFSC seal abundance survey;
- NEFSC surf clam/ocean quahog survey;
- NEFSC Ecosystem Monitoring Program;
- MA DMF spring and fall trawl surveys;
- New England Aquarium aerial surveys;
- Virginia Institute of Marine Science scallop dredge survey;
- Atlantic Marine Assessment Program for Protected Species surveys; and
- Surveys conducted by the applicant and other offshore wind leaseholders, which would only occur in their respective lease areas.

Specific biological surveys conducted in leased areas offshore Massachusetts include vessel-based surveys to monitor marine mammals, sea turtles, and seabirds, and NARW aerial surveys. Other activities anticipated to continue or occur within the geographic analysis area include offshore wind site assessment activities, construction of planned offshore wind facilities and associated cable systems, and vessel activity related to offshore wind development. Additional scientific surveys to ascertain impacts of offshore wind development are also likely to occur.

3.14.1.7 Existing Marine Minerals

The demand for sand resources suitable for beach replenishment efforts along the Atlantic Coast has increased due to shoreline erosion, damage from coastal storms, and climate change-induced sea level rise. BOEM funded offshore surveys from 2015 to 2017 as part of the Atlantic Sand Assessment Project to identify sources of sand in federal waters to help coastal communities recover from storms and coastal erosion (BOEM Undated). BOEM’s Marine Minerals Information System indicates no sand resource areas or federal OCS sand and mineral lease areas located within the geographic analysis area (BOEM-MMIS Undated). Additionally, no significant sand resource blocks were identified in the geographic analysis area (COP Volume III, Section 7.9; Epsilon 2023).

3.14.2 Environmental Consequences

Definitions of impact levels for other uses are described in Table 3.14-1. There are no beneficial impacts on other uses.

Table 3.14-1: Impact Level Definitions for Other Uses

Impact Level	Definition
Negligible	Impacts would be so small as to be unmeasurable.
Minor	Impacts on the affected activity would be avoided, and impacts would not disrupt the normal or routine functions of the affected activity. Once the proposed Project is decommissioned, the affected activity would return to a condition with no measurable impacts.
Moderate	Impacts on the affected activity would be unavoidable. The affected activity would have to adjust to account for disruptions due to impacts of the proposed Project, or once the proposed Project is decommissioned, the affected activity could return to a condition with no measurable impacts if proper remedial action is taken.
Major	The affected activity would experience unavoidable disruptions to a degree beyond what is normally acceptable, and once the proposed Project is decommissioned, the affected activity could retain measurable impacts indefinitely, even if remedial action is taken.

3.14.2.1 Impacts of Alternative A – No Action Alternative on Other Uses

When analyzing the impacts of Alternative A on other uses, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for other uses (Table G.1-11 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for other uses described in Section 3.14.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on other uses would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under Alternative A, ongoing activities, future non-offshore wind activities, and future offshore wind activities would have continuing short- and long-term impacts on other uses. This section discusses the environmental consequences of Alternative A on other uses.

National security and military use: National security and military interests would continue to use the onshore and offshore areas in the geographic analysis area. Ongoing activities could potentially affect military and national security activities if facilities or associated vessel traffic limits maneuverability of military aircraft or vessels or affects the scope of military or national security operations. Existing stationary facilities that present allision risks act as fish aggregating devices (FAD) or pose navigational hazards include the five offshore wind turbines associated with Block Island Wind Farm, dock facilities, meteorological buoys associated with offshore wind lease areas, and other offshore or shoreline-based structures. No additional non-offshore wind stationary structures were identified within the offshore portion of the geographic analysis area, but private or commercial docks may be added close to the shoreline. Onshore facilities that may pose navigational hazards include onshore wind turbines, communication towers, and other onshore commercial, industrial, and residential structures.

No future non-offshore wind stationary structures that could affect national security and military activity were identified within the offshore analysis area. Onshore, development activities are anticipated to continue with additional proposed communications towers and onshore commercial, industrial, and residential developments. Current and future vessel traffic in the region is described in Section 3.13.

Current activities associated with offshore wind in the geographic analysis area are limited to vessels conducting site assessment surveys.

Aviation and air traffic: Air traffic is expected to continue at current levels in and around the SWDA. Ongoing activities could potentially affect aviation and air traffic by introducing obstructions to airspace and altering navigational routes. Existing aboveground stationary facilities within the geographic analysis area that present navigational hazards or may potentially cause space use conflicts include the five WTGs in the Block Island Wind Farm, onshore wind turbines, communication towers, dock facilities, and other onshore and offshore structures exceeding 200 feet AMSL. No future non-offshore wind stationary structures were identified within the offshore analysis area. Onshore development activities are anticipated to continue with additional proposed communications towers and onshore commercial, industrial, and residential developments.

Offshore cables and pipelines: Five existing submarine cables extend between the mainland and Nantucket and Martha's Vineyard. These submarine cables would remain in current locations with infrequent maintenance continuing along those cable routes for the foreseeable future. Ongoing activities could potentially affect existing cables by damaging or causing service outages to existing offshore power cables, or by affecting the siting of future cables. Structures within and near the geographic analysis area that pose potential allision hazards to cable maintenance vessels include the five Block Island Wind Farm WTGs, meteorological buoys associated with offshore wind lease areas, and shoreline developments such as docks, ports, and other structures.

Radar systems: Ongoing activities could potentially affect radar systems if construction or operational activities cause interference with radar signals. WTGs in the direct line-of-sight with or extremely close to radar systems can cause clutter and interference, which can result in false targets, reduced radar sensitivity, decreased probability of detection, and radar tracking anomalies. Existing wind energy developments in the area include scattered onshore wind turbines and five WTGs in the Block Island Wind Farm. Planned non-offshore wind structures proposed for construction in the lease areas that could affect radar systems have not been identified.

Scientific research and surveys: Scientific research activities would continue into the foreseeable future, although at potentially different levels in the geographic analysis area due to ongoing research and new opportunities. Other offshore wind projects would affect scientific research and surveys by decreasing opportunities for research or through navigation obstructions that impede research, which in turn would affect survey methodologies and data collection practices, and may increase scientific uncertainty in fish stock assessments, endangered species monitoring, and other research efforts. Stationary structures are limited in the open ocean environment of the geographic analysis area, and include meteorological buoys associated with site assessment activities, the five Block Island Wind Farm WTGs, and the two Coastal Virginia Offshore Wind Project WTGs offshore Virginia. Although not yet constructed, Vineyard Wind 1 and the South Fork Wind Projects, both within the geographic analysis area, have been approved by BOEM and are currently under construction. Other lease areas within the geographic analysis area are not yet developed and are in various stages of permitting.

Marine minerals: Ongoing activities are unlikely to impact marine minerals because there are no sand resource areas or federal OCS sand and mineral lease areas or significant sand resource blocks located within the geographic analysis area (BOEM-MMIS Undated).

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on other uses include continued operations of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Ongoing operations of the Block Island Wind Farm and ongoing construction of the Vineyard Wind 1 and South Fork Wind

Projects, along with planned offshore wind activities, would affect other uses through the primary IPFs described below.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind development activities would affect other uses through the following primary IPFs.

National Security and Military Use

The boundaries of the RI/MA Lease Areas were developed through coordination with stakeholders to address concerns of overlapping military and security uses. BOEM continues to coordinate with stakeholders to minimize these concerns as needed.

Cable emplacement and maintenance: Ongoing activities and future non-offshore wind activities are limited to infrequent maintenance events along existing submarine cables within the geographic analysis area. Construction from future offshore wind activities would cause military and national security vessels to change route or navigate around temporarily active construction sites above cables. Military and national security vessels would also need to avoid anchoring in any hard protection areas. Construction from future offshore wind activities would occur between 2023 and 2030, with up to seven offshore wind projects under construction simultaneously in 2025. BOEM assumes all offshore wind project developers would coordinate with the DoD and the U.S. Navy on any proposed uses of distributed acoustic sensing (DAS) to address impacts on U.S. Navy operations, as required by conditions in the COPs for those projects.

Presence of structures: Existing stationary facilities that present allision risks are limited in the open waters of the geographic analysis area and include the five offshore wind turbines associated with Block Island Wind Farm and meteorological buoys operated for offshore wind farm site assessment. Dock facilities and other structures are concentrated along the coastline. Installation of up to 963 WTGs and ESPs, plus the presence of lift vessels during construction within the lease areas, would increase the risk of allision for military and national security vessels, including USCG SAR vessels. In general, deep-draft military vessels are not anticipated to transit outside of navigation channels unless necessary for SAR operations or other non-typical activities. Therefore, vessels more likely to allide with WTGs or ESPs would be smaller-draft vessels moving within and near wind installation. Deep-draft military and national security vessels near traffic separations schemes or port entrances could potentially lose power and allide with a nearby WTG. Risks would increase over time as additional wind energy facilities are built within the RI/MA Lease Areas starting in 2023 through 2030, with up to six offshore wind projects under construction simultaneously in 2025 (Table E-1 in Appendix E). Wind energy facility structures would be lighted according to USCG and BOEM requirements at sea level to decrease allision risk.

Allision risk would be further mitigated by the agreement among all RI/MA Lease Areas applicants to locate WTGs and ESPs in a 1-nautical-mile (1.9-kilometer, 1.15-mile) × 1-nautical-mile (1.9-kilometer, 1.15-mile) grid, pursuant to USCG's MARIPARS (USCG 2020). This arrangement is intended to facilitate safe navigation through the RI/MA Lease Areas (Brostrom et al. 2019). The Final MARIPARS did not recommend implementation of any formal routing measures (USCG 2020).

The installation of up to 963 foundations within the geographic analysis area could create an artificial reef effect, attracting species of interest for recreational fishing or sightseeing, resulting in vessels that may travel farther offshore than typically occurs. Recreational fishing vessel traffic would be additive to vessel traffic that already transits the leased areas and could increase demand for USCG SAR operations near the

WTGs. Increased risk of conflict or collision risks for military and national security vessels would be *de minimis* because military vessels are not anticipated to transit outside of navigation channels unless necessary for SAR operations or non-typical activities. Risk would gradually increase between 2023 and 2030 as offshore wind structures are installed across the RI/MA Lease Areas, and recreational fishing vessels begin to access the development area and would decrease incrementally as projects are decommissioned and structures removed.

The addition of up to 963 foundations within the geographic analysis area between 2023 and 2030 would incrementally change navigational patterns and increase navigational complexity for vessels and aircraft operating in the region around wind energy projects. During construction periods between 2023 and 2030, use of stationary lift vessels in the lease areas, cranes at port locations, and vessels transporting WTGs components in transit between the two locations would further increase navigational complexity in areas immediately around these tall structures. Increased navigational complexity would increase the risk of allisions for military and national security vessels as discussed above, and for military and national security aircraft. It is assumed that other offshore wind operators would implement a strict operational protocol with the USCG that requires operators to maintain control over the WTGs to selectively stop rotation and orient blades and nacelles within a specified time to mitigate impacts on SAR aircraft operating in the leased areas. Additionally, USCG would need to adjust their SAR planning and search patterns to allow aircraft to fly within the geographic analysis area, leading to a less optimized search pattern and a lower probability of success. Prior to construction, applicants must file Form 7460-1 (Notice of Proposed Construction) with the FAA for each individual structure exceeding 200 feet AMSL within U.S. territorial waters, which triggers a review to identify and resolve potential aviation conflicts. The DoD and the DHS, (which typically includes the USCG) would be invited to review and comment on the filing (per Section 5-2-2[a] of FAA Order JO 7400.2M, Procedures for Handling Airspace Matters) (FAA 2019a), and BOEM assumes that this process would be used, in addition to any pre-permitting coordination performed by the proposed Project applicants, to identify and resolve potential conflicts with military air traffic. For example, the Bay State Wind Project, which is proposed to be located in OCS-A 0500 and overlaps W-105A, received Determinations of No Hazard for WTG blade tips up to 1,049 feet AMSL (FAA 2019b). Implementation of navigational lighting and marking per FAA (2020), USCG (2019), and BOEM (2021a) requirements and guidelines would further reduce the risk of aircraft collisions. Wind energy structures (including WTGs and ESPs) would be visible on military and national security vessel and aircraft radar. It is assumed that all project operators would coordinate with relevant agencies during the COP development process to identify and minimize conflicts with military and national security operations. Navigational hazards would gradually be eliminated when structures are removed during decommissioning.

Access to active construction areas would be temporarily restricted within the RI/MA Lease Areas between 2023 and 2030. Presence of the proposed 963 foundations during the various project operational timeframes would change long-term navigation patterns in and around the RI/MA Lease Areas. As multiple projects are built, changing navigation patterns could concentrate vessels around the edges of the leased areas, potentially causing space use conflicts and increasing the risk of collisions between military/national security and civilian vessels. Warning area W-105A overlies the SWDA (COP Volume III, Appendix J; Epsilon 2023). Wind development in the lease areas could have an increasing impact on the USAF 104th Fighter Wing's ability to train within W-105A as construction occurs in these areas between 2023 and 2030, and a consistent impact during project operations.

All the offshore wind projects in the RI/MA Lease Areas would construct OECCs within the geographic analysis area for other uses, generally from the northern portion of each lease area to a landing site in Massachusetts, Rhode Island, or another state. Precise cable corridors are not known for any specific project, but construction timeframes would likely be staggered between 2023 and 2030. Military and national security vessels may need to navigate around temporarily active construction sites above these cable routes. While projects are operational, transmission cables would be passive structures located on the seafloor and would only potentially impact military and national security operations during very infrequent cable maintenance events. The U.S. Navy raised concerns about impacts on naval operations from deployment of DAS technology through fiber optic cables in the submarine cable system (BOEM 2021b). Similar to the proposed Project, it is assumed that other future offshore wind project operators would coordinate with the DoD and the U.S. Navy on any proposal to use DAS.

Traffic: Vessel traffic associated with construction and decommissioning of future offshore wind facilities could cause military and national security vessels to change routes and experience congestion and delays in port and within vessel transit routes. Wind energy facility operators use vessels for construction, maintenance, and decommissioning activities, with the highest vessel traffic during construction (approximately 2023 through 2030) and decommissioning. Construction periods would likely be staggered, but some overlap is possible. During construction, large vessels with limited maneuverability would deliver components of WTGs, ESPs, and associated equipment to one or more port facilities and to the SWDA. These vessels would operate within restricted navigation channels or be on station during construction activities. Operational traffic would occur at lower, consistent levels over the 33-year operational timeframes for each project. Current levels of vessel traffic are discussed in Section 3.13. Vessel traffic and overall future offshore wind vessel activity would be most pronounced during construction and decommissioning time periods, when as many as six offshore wind projects could be under construction simultaneously. Operational traffic associated with each of the other offshore wind projects would be similar to existing civilian vessel traffic in the region. Risks of collisions between military vessels and offshore wind vessels would be highest during construction and decommissioning.

Aviation and Air Traffic

Presence of structures: Construction of future offshore wind facilities could add up to 949 WTGs with maximum blade tip heights of up to 1,171 feet AMSL to the RI/MA Lease Areas between 2023 and 2030. In addition, stationary and vessel-mounted construction cranes would be used in ports during construction, and WTGs are anticipated to have a temporary height of up to 328 feet during assembly at construction staging areas. Addition of these structures would incrementally increase navigational complexity and change aircraft navigation patterns in the region around the leased areas offshore Massachusetts and Rhode Island, along transit routes between ports and construction sites, and locally around ports. These changes could compress lower-altitude aviation activity into more limited airspace in these areas, leading to airspace conflicts or congestion, and increasing collision risks for low-flying aircraft. However, open airspace around the RI/MA Lease Areas would still be available over the open ocean, and ports used for offshore WTG construction would be planned and developed to accommodate tall structures. The addition of WTGs throughout the RI/MA Lease Areas would alter navigation patterns associated with nearby airports, including, but not limited to, Nantucket Memorial Airport. Port improvements and construction activities in or near ports may require alteration of navigation patterns at nearby airports, including, but not limited to, Sikorski Memorial Airport (Bridgeport, Connecticut) and New Bedford Regional Airport. Navigational hazards and collision risks at ports and in transit routes would be reduced as construction is completed, and all navigation hazards and collision risks would be gradually eliminated during decommissioning as offshore WTGs are removed.

All existing stationary structures would have navigation marking and lighting in accordance with FAA (2020) and BOEM (2021a) requirements and guidelines, and structures exceeding 200 feet AMSL and located within U.S. territorial waters would have been analyzed for potential impacts on air traffic at the time of construction through the review process triggered by filing Form 7460-1 (COP Volume III, Section 7.9; Epsilon 2023), as described under National Security and Military Use. Because the WTGs would be taller than 699 feet, low intensity aviation obstruction lights would be required at mid-tower, in addition to lights on the nacelle (COP Volume III, Section 3.3; Epsilon 2023). With a maximum vertical extension of 1,171 feet AMSL, the WTG blade tips within territorial waters would be identified as obstructions through the FAA obstruction evaluation process defined in 14 CFR § 77.17(a)(1). Aeronautical studies could be conducted to evaluate potential physical or electromagnetic radiation impacts from these WTGs on the operation of air navigation facilities, including impacts on existing or proposed air navigation, communications, radar, and control systems, VFR or IFR operations, airport traffic control cab views, and airport capacities (including impacts resulting from the structure when combined with the impact of other existing or proposed structures) (FAA 2019a). FAA obstacle clearance surfaces, which are level or sloping "imaginary" surfaces associated with airspace that identify the minimum required obstacle clearance (FAA 2018), are also investigated. As specified above, prior to construction, applicants for all individual structures exceeding 200 feet AMSL within U.S. territorial waters must file Form 7460-1 (Notice of Proposed Construction) with the FAA, which triggers a review to identify and resolve aviation risks through an aeronautical study.

For example, the Bay State Wind Project, proposed to be located in OCS-A 0500, received Determinations of No Hazard for WTG blade tips with heights up to 1,049 feet AMSL within U.S. territorial waters (FAA 2019b). The WTGs associated with the Bay State Wind Project were found to exceed obstruction standards of 14 CFR Part 77 in part due to necessary changes in minimum instrument flight altitudes or minimum obstacle clearance altitudes; however, the aeronautical study determined that the project would not have a substantial impact on any existing or proposed arrival, departure, or en-route IFR operations or procedures (FAA 2019b). Similar to the proposed Project, it is assumed that project applicants would conduct aeronautical studies as part of a project's due diligence regardless of their position within or outside U.S. territorial waters boundaries. In addition, BOEM assumes that offshore wind project operators would coordinate with aviation interests throughout the planning, construction, operations, and decommissioning process to avoid or minimize impacts on aviation activities and air traffic. This coordination would include notification to the FAA of construction activities, and the FAA would issue Notices to Airmen for each vessel movement above a specified height along with Temporary Flight Restrictions associated with WTGs under construction in the SWDA or in transit between ports and the SWDA (COP Volume III, Section 7.9; Epsilon 2023).

Offshore Cables and Pipelines

Cable emplacement and maintenance: Several other offshore wind projects are currently planned for the RI/MA Lease Areas. SouthCoast Wind is the only other project with officially announced plans to install offshore cables within the vicinity of the OECC for the proposed Project. SouthCoast Wind currently plans to install its offshore export cables north from Lease Area OCS-A 0521 through Muskeget Channel and Nantucket Sound to a landfall site on Cape Cod's southern shore (AECOM et al. 2021). The applicant for the proposed Project and the applicant for SouthCoast Wind would coordinate on any required cable crossings.

Future offshore wind cables would also consider the location of existing cables during routing, including the South Fork Wind, SouthCoast Wind, and the Bay Wind State offshore export cables. However, these export cables can be crossed using standard protection techniques during construction, operations, and decommissioning. During proposed Project operational timeframes, impacts on submarine cables crossed by offshore wind cables would be limited to rare occasions when maintenance work at the cable crossings would be required. Impacts on submarine cables would be reduced during decommissioning of offshore wind farms, as export cables associated with those projects are de-energized and decommissioned and would be eliminated if cables are removed.

Presence of structures: No pipelines were identified within the geographic analysis area. Five existing submarine cables are outside of the SWDA but near the OECC between Martha's Vineyard and Nantucket and Cape Cod. Construction of future wind energy facilities (excluding the proposed Project) would add up to 963 WTGs and ESPs, along with approximately 1,448 miles of OECC and 2,186 miles of inter-array cables and to the RI/MA Lease Areas between 2023 and 2030. Presence of these structures could preclude additional submarine cable development, including cables for future offshore wind facilities, from the wind development areas and require future cables to route around the leased areas.

Ongoing maintenance of existing submarine cables would continue into the future, and future offshore wind activities would restrict future cable placement within developed areas of the RI/MA Lease Areas. Future cables may be precluded from all developed areas within the RI/MA Lease Areas after installation of WTGs, ESPs, and inter-array cabling systems due to the density of cables within the SWDA, but future cables could cross the OECCs for these projects using standard protection techniques.

Radar Systems

Presence of structures: Operational onshore and offshore WTGs in the direct line-of-sight with or extremely close to radar systems can cause clutter and interference. Construction of future wind energy facilities would add up to 949 WTGs with maximum blade tip heights of up to 1,171 feet AMSL to the RI/MA Lease Areas between 2023 and 2030. NOAA NEXRAD weather radar systems are located a sufficient distance from the RI/MA Lease Areas such that radar interference and mitigation would not be anticipated (COP Volume III, Section 7.9, Figure 7.9-1; Epsilon 2023). The operational WTGs could affect HF radar signals from the IOOS network (Roarty 2020). Development of offshore wind projects in the RI/MA Lease Areas could incrementally decrease the effectiveness of individual military radar systems if the field of WTGs expands within the radar system's coverage area. In addition, large areas of installed WTGs within the RI/MA Lease Areas could create a large geographic area of degraded radar coverage that could impact multiple radars. Therefore, it is reasonable to assume that future offshore wind facilities could adversely affect NORAD's radar operations and defense of national critical infrastructure located in the same geographic areas (Clearinghouse 2022).

BOEM, in conjunction with the IOOS Surface Currents Program, would develop plans to mitigate WTG interference with oceanographic HF radars. The FAA would evaluate potential impacts on radar systems that fall within its purview, as well as mitigation and monitoring measures for those impacts through their review of Form 7460-1 for individual WTGs within U.S. territorial waters (as explained in the National Security and Military Use discussion) (FAA 2019a). Developers of other offshore wind projects would be required to coordinate with military and national security agencies to identify potential impacts and any mitigation and monitoring measures specific to radar systems, in accordance with FAA Order JO 7400.2M (FAA 2019a). For example, the Bay State Wind Project received Determinations of No Hazard for WTGs with heights of up to 1,049 feet AMSL. Although WTGs associated with the Bay State Wind Project were found to be within the direct line-of-sight for the Falmouth ASR-8, Nantucket ASR-9, and Coventry (Rhode Island) ASR-9 radar systems, the aeronautical study determined that the Bay State Wind Project's WTGs would not have a substantial impact on radar operations at the time of study (FAA 2019b). BOEM assumes that each project applicant would conduct an independent radar analysis, particularly for WTGs outside of U.S. territorial waters, to identify potential impacts and any mitigation and monitoring measures specific to aeronautical, military, and weather radar systems for each WTG analyzed, per BOEM-identified BMPs (Table E-5in Appendix E).[42] BOEM would continue to coordinate with the Clearinghouse and IOOS to review each proposed offshore wind project on a project-by-project basis and would attempt to de-conflict project concerns identified through such consultation related to oceanographic (via IOOS) and military and national security (via the Clearinghouse) radar systems with

[42] BOEM recommends the following be included in a COP to "demonstrate that the project is being conducted in a manner that confirms to responsible offshore development, to include the use of BMPs, in accordance with 30 CFR 585.621" (BOEM 2020): "Lessees and grantees should conduct all necessary studies of potential interference of proposed wind turbine generators with commercial air traffic control radar systems, national defense radar systems, and weather radar systems; they also should identify possible solutions" (BOEM 2020).

COP approval conditions, including concerns related to installation of multiple projects. Impacts on radar systems would gradually decrease during decommissioning as WTGs are decommissioned and removed.

Scientific Research and Surveys

Presence of structures: Construction of other wind energy projects in the RI/MA Lease Areas would add up to 949 WTGs (with blade tip heights of up to 1,171 feet MLLW) and ESPs, associated cable systems, and vessel activity that would present additional navigational obstructions for sea- and air-based scientific surveys. Collectively, these developments would prevent NOAA from continuing scientific research surveys or protected species surveys under current vessel capacities, would affect monitoring protocols in the geographic analysis area, could conflict with state and nearshore surveys, and may reduce opportunities for other NOAA scientific research studies in the area.

This EIS incorporates by reference the detailed summary of and potential impacts on NOAA's scientific research provided in the Vineyard Wind 1 Final EIS (BOEM 2021b) in Section B.3 of Appendix B, Supplemental Information and Additional Figures and Tables. In summary, offshore wind facilities actuate impacts on scientific surveys and advice by preclusion of NOAA survey vessels and aircraft from sampling in survey strata and impacts on the random-stratified statistical design that is the basis for assessments, advice, and analyses. NOAA determined that survey activities within offshore wind facilities are outside of safety and operational limits. Alteration of benthic and pelagic habitats and airspace in and around the wind energy development would require new designs and methods to sample new habitats and reduce sampling productivity through navigation impacts on aerial and vessel surveys. Survey vessels would be required to navigate around offshore wind projects to access survey locations, leading to a decrease in survey precision and operational efficiency. The height of turbines would affect aerial survey design and protocols, requiring flight altitudes and transects to change. Therefore, scientific survey and protected species survey operations would be reduced or eliminated as offshore wind facilities are constructed. If stock or population changes, biomass estimates, or other environmental parameters differ within the offshore wind lease areas but cannot be observed as part of surveys, resulting survey indices could be biased and unsuitable for monitoring stock status. Offshore wind facilities would disrupt survey sampling statistical designs, such as random-stratified sampling. Impacts on the statistical design of region-wide surveys violate the assumptions of probabilistic sampling methods. Development of new survey technologies, changes in survey methodologies, and required calibrations could help to mitigate losses in accuracy and precision of current practices caused by the impacts of wind development on survey strata.

Other offshore wind projects could also require implementation of mitigation and monitoring measures identified in RODs. Identification and analysis of specific measures are speculative at this time; however, these measures could further affect NOAA's ongoing scientific research surveys or protected species surveys because of increased vessel activity or in-water structures from these projects. BOEM is committed to working with NOAA toward a long-term regional solution to account for changes in survey methodologies as a result of offshore wind farms. The *NOAA Fisheries and BOEM Federal Survey Mitigation Implementation Strategy - Northeast U.S. Region* (Hare et al. 2022) outlines a federal survey mitigation program that will include survey-specific mitigation plans for each affected survey, including both vessel and aerial surveys. Measures from the final, published implementation strategy are analyzed in this Final EIS.

Overall, planned offshore wind energy projects in the area would significantly affect NOAA's scientific research and protected species surveys, potentially leading to impacts on fishery participants and communities, as well as potential major impacts on monitoring and assessment activities associated with recovery and conservation programs for protected species.

Marine Minerals

As stated in Section 3.14.1.7, there are no sand resource areas, federal OCS sand and mineral lease areas, or significant sand resource blocks in the geographic analysis area (BOEM-MMIS Undated). Therefore, future marine minerals leasing in this area is unlikely, and conflicts with future offshore wind developments are not expected.

Conclusions

Impacts of Alternative A. Under Alternative A, other uses would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built as proposed under Alternative A, ongoing activities would have continuing impacts on other uses, primarily through presence of structures that introduce navigational complexities and vessel traffic.

BOEM anticipates the other uses impacts as a result of ongoing non-offshore and offshore wind activities associated with Alternative A would be **negligible** for national security and military use, aviation and air traffic, offshore cables and pipelines, radar systems, and marine mineral extraction. National security and military use, aviation and air traffic, vessel traffic, commercial fishing, and scientific research and surveys are expected to continue in the geographic analysis area. Impacts from ongoing non-offshore and offshore wind activities on scientific research and surveys are anticipated to be **major** due to the impacts of ongoing offshore wind activities.

Cumulative Impacts of Alternative A. In addition to ongoing activities, the impacts of planned activities other than offshore wind would also contribute to impacts on other uses. Planned activities expected to occur in the geographic study area other than offshore wind include increasing vessel traffic, continued residential, commercial, and industrial development onshore and along the shoreline, and continued development of FAA-regulated structures such as communication towers and onshore WTGs.

No planned non-offshore wind stationary structures were identified within the offshore portion of the geographic analysis area, and there would be no planned structures to act as navigation hazards or FADs. Planned offshore wind cable activities in the offshore portion of the geographic analysis area include those associated with the South Fork Wind (Lease Area OCS-A 0517) and Vineyard Wind 1 (Lease Area OCS-A 0501). Any structures exceeding 200 feet AMSL within FAA jurisdiction or otherwise triggering FAA review would be required to submit Form 7460-1 for FAA review, with the DoD and DHS invited to provide input, and BOEM assumes any issues with aviation routes or radar systems would be resolved through this process.

BOEM anticipates that the cumulative impact of Alternative A would be **negligible** for aviation and air traffic and marine mineral extraction; **minor** for cables and pipelines due to planned routing around foundations; **moderate** for radar systems due to WTG interference; and **major** for national security and military use and scientific research and surveys. Impacts for military and national security uses are primarily driven by impacts on USCG SAR operations, which would be **major**. The presence of stationary structures associated with ongoing and planned offshore wind energy projects could prevent or impede continued NOAA scientific research surveys using current vessel capacities and monitoring protocols or reduce opportunities for other NOAA scientific research studies in the area. Coordinators of large vessel survey operations or operations deploying mobile survey gear have determined that activities within offshore wind facilities would not be within current safety and operational limits. In addition, changes in required flight altitudes due to the proposed WTG height would affect aerial surveys design and protocols. BOEM acknowledges that NOAA's Office of Marine and Aviation Operations endorses the restriction of large-vessel operation to greater than 1 nautical mile (1.15 miles) from wind installations due to safety and operational challenges.

3.14.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of impacts on other uses:

- As described in Section 2.1, Alternatives Analyzed in Detail, the final geographic size of Vineyard Wind 1 would define the northeastern border of Phase 1. As a result, the potential footprint of Phase 1 includes a portion of Lease Area OCS-A 0501, as well as portions of Lease Area OCS-A 0534 (Figure 1.1-2). If Vineyard Wind 1 uses its maximum number of spare positions, Phase 1 would be located farther southwest than if Vineyard Wind 1 were to use fewer spare positions.
- Phases 1 and 2 combined would include up to 132 WTGs and ESPs. The number of WTGs in each phase would depend on the generating capacity of the selected WTGs for each phase, which, in turn, depends on the feasibility and commercial availability of WTGs to meet the Phase 1 and Phase 2 construction schedules. WTGs with higher generating capacities would result in a smaller footprint (i.e., fewer positions used), while lower generating capacities would result in a larger footprint. To account for the range in the number of WTGs that may be developed for Phase 1, the potential footprint of Phase 1 overlaps with the potential footprint of Phase 2 (Figure 1.1-2).
- Engineering and environmental constraints could eliminate positions, thereby extending the Phase 1 footprint farther southwest.
- Length, route(s), and final width of cable route.
- The timing of construction and variability in regional port utilization may result in uncertainty regarding which ports may be available during Phase 1 and Phase 2. It is not expected that all the ports identified (Section G.2.7, Land Use and Coastal Infrastructure) would be used; it is more likely that only some ports would be used during construction depending upon final construction logistics planning.
- Decommissioning procedures and co-occurring decommissioning efforts of multiple projects.

The analysis of national security and military use, offshore cables and pipelines, scientific research and surveys, marine minerals, and offshore energy in this section is based on a maximum-case scenario of 130 WTGs. The maximum vertical extension of WTG blade tips is 1,171 feet for both phases of the proposed Project.

3.14.2.3 Impacts of Alternative B – Proposed Action on Other Uses

This section identifies the potential impacts of Alternative B on other uses. When analyzing the impacts of Alternative B on other uses, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for other uses.

Impacts of Phase 1

Phase 1 would affect other uses through the following primary IPFs during construction, operations, and decommissioning.

National Security and Military Use

Cable emplacement and maintenance: Cable construction vessels associated with Phase 1 could cause military and national security vessels to change route or navigate around temporarily active construction sites above cables. Military and national security vessels would also need to avoid anchoring in hard protection areas for Phase 1 cables. These concerns notwithstanding, impacts on military and national security uses at any one site along the cable route during construction of Phase 1 would be localized, temporary, and negligible. To address U.S. Navy concerns about impacts on naval operations, BOEM could require as a condition of COP approval that the proposed Project include distributed fiber optic sensing technology.

Presence of structures: Phase 1 would use stationary lift vessels in the SWDA and cranes in ports during construction. These structures and vessels would add navigational complexity and increase the risk of allision or collision for national security and military vessels, particularly in bad weather or low visibility. The impacts of Phase 1 WTGs on national security and military use (including WTGs under construction or in place prior to operation) are discussed under the Operations and Maintenance and Conceptual Decommissioning subsection. As described in Section 3.13, vessel traffic for Phase 1 would be limited. The applicant and the USCG would provide Offshore Wind Mariner Updates and Notice to Mariners that describe proposed Project-related activities (including the presence of these structures) that may be of interest to military and national security interests. As a result, the impacts of Phase 1 on national security and military use due to the presence of structures would be localized, temporary, and minor.

Phase 1 would consist of up to 64 structures (including up to 62 WTGs and 1 or 2 ESPs) in the SWDA in a uniform 1-nautical-mile (1.15-mile) × 1-nautical-mile (1.15-mile) grid. These structures would increase the risk of allision for national security and military vessels that travel through the SWDA, particularly in bad weather or low visibility. In addition, Phase 1 structures could create an artificial reef effect that could attract species of interest to recreational fishing or sightseeing, thereby attracting additional recreational fishing and sightseeing vessels that would be additive to existing vessel traffic in the area. The presence of additional recreational vessels would add to conflict or collision risks for military and national security vessels and could increase demand for SAR operations.

Military traffic within the SWDA is relatively low (17 vessels recorded from 2016 to 2019), and deep-draft military vessels are not anticipated to navigate outside navigation channels unless necessary for SAR operations. Generally, the vessels more likely to allide with WTGs or ESPs would be smaller and moving within and near wind installations. Deep draft military and national security vessels near traffic separations schemes or port entrances could potentially lose power and allide with a nearby WTG. Allision risks would be mitigated by the uniform 1-nautical-mile (1.15-mile) × 1-nautical-mile (1.15-mile) WTG spacing. WTGs and ESPs would be marked as a navigational hazard per FAA (2020), USCG (2019), and BOEM (2021a) requirements, and risk would be consistent within the 33-year operational period. The WTGs would be visible on radar systems of low-flying military and national security aircraft and would appear similar to other large-scale sea surface activity on radar systems. The USCG would need to adjust its SAR planning and search patterns to allow aircraft to fly within the geographic analysis area, leading to a less optimized search pattern and a lower probability of success. This could lead to increased loss of life due to maritime incidents. As part of Phase 1, the applicant would voluntarily implement an operational protocol with the USCG that requires the WTGs to stop rotating within a specified time to mitigate impacts on search and rescue aircraft operating in the SWDA (COP Volume III, Section 7.8; Epsilon 2023). The applicant would file FAA Form 7460-1 for WTGs located in territorial waters to initiate consultation regarding an FAA hazard determination for Phase 1 (Section 3.14.1.2).

BOEM coordinated with the DoD throughout the leasing area identification process and environmental review process for the RI/MA Lease Areas (BOEM 2014a). During the EIS process for Vineyard Wind 1, USAF identified a concern that WTGs within warning area W-105A, which overlies the majority of the SWDA, could impact the 104th Fighter Wing's ability to train in W-105A. The USAF indicated that these concerns could be allayed because Vineyard Wind 1 structures would be able to withstand daily sonic overpressures (sonic booms) from supersonic operations, and potentially falling debris from chaff and flare, and assuming the USAF would not be held liable for damage to property or personnel (BOEM 2021b). BOEM assumes that similar conditions would apply to Phase 1 and would continue to work with the USAF, the DoD and national security interests to identify strategies to de-conflict these concerns through conditions of COP approval. The applicant would ensure that a Marine Coordinator remains on duty for the life of Phase 1 to liaise with the military and national security interests to reduce potential conflicts. The DoD found minor but acceptable impacts with Vineyard Wind 1 (BOEM 2021b). As stated above, BOEM will continue to consult with DoD but assumes at this time that DoD's conclusion for Phase 1 would be similar to Vineyard Wind 1. These reviews did not include USCG's activities such as SAR. These impacts are addressed in Section 3.13. Overall, the operations of Phase 1 structures would cause localized, long-term, and minor to moderate impacts on national security and military use. Specifically, increased navigational complexity and allision and collision risk would have minor impacts, while USCG-SAR activities would experience moderate impacts due to the reduced probability of successful SAR missions.

The impacts of Phase 1 decommissioning would be similar to those described for construction, and the navigational hazards created by WTGs, ESPs, and stationary vessels would be gradually eliminated during decommissioning as structures are removed.

Traffic: Vessel traffic associated with Phase 1 construction could cause military and national security vessels to change routes and could cause congestion and delays in port and within transit routes. The applicant would coordinate with the U.S. Navy and USCG during construction of Phase 1 to minimize conflicts within the SWDA, along transit routes, and within ports. The offshore components of Phase 1 would be monitored and controlled remotely from the proposed operations facilities. As stated above, the DoD found minor but acceptable impacts with Vineyard Wind 1. BOEM will continue to consult with DoD; however, for analytical purposes in this Final EIS, BOEM assumes that DoD's conclusion for Phase 1 would be similar to Vineyard Wind 1. The applicant would voluntarily employ a Marine Coordinator for the life of Alternative B to liaise with the military and national security interests to reduce potential conflicts. The applicant and the USCG would provide Offshore Wind Mariner Updates and Notice to Mariners that describe proposed Project-related activities that may be of interest to military and national security interests, including U.S. Navy aircraft and vessels operating within the region. Collectively, these actions would improve safety but would not remove the navigational hazard associated with installing WTGs in the open ocean of the SWDA. As a result, Phase 1 construction would have localized, temporary, and minor impacts on military and national security vessel traffic, except for moderate impacts on USCG-SAR vessel activity.

As described in Section 3.13, Phase 1 operations vessel traffic would be minimal. These activities would be similar to existing civilian vessel activity in and near the SWDA, and the applicant would comply with coordination requirements. In accordance with the stipulations in Lease OCS-A 0534, the applicant would temporarily suspend operations and evacuate the SWDA if required for national security or defense purposes. Due to limited existing national security and military traffic within the SWDA, operational conflicts are not anticipated within the SWDA. Therefore, impacts on military and national security from Phase 1 would be negligible during operations.

Impacts from decommissioning would be the same as the impacts associated with construction, described above: minor, except for moderate impacts on USCG-SAR vessel activity.

Aviation and Air Traffic

Presence of structures: The impacts of Phase 1 WTGs on aviation and air traffic (including WTGs under construction or in place prior to operation) are discussed under the Operations and Maintenance and Conceptual Decommissioning subsections. Construction of Phase 1 would involve the movement of tall WTG components between ports and the SWDA, as well as construction cranes and other stationary tall equipment within the SWDA. The applicant would file FAA Form 7460-1 for Phase 1 WTGs, as well as for individual structures in territorial waters exceeding 200 feet AMSL, including construction cranes and vessels transiting tall structures between port and the SWDA during construction. The filing would trigger a review to identify and resolve aviation risks through updated aeronautical studies, with consideration of existing obstacles in FAA records. If necessary, the FAA would issue Notices to Airmen for each vessel movement along with Temporary Flight Restrictions associated with WTGs under construction in the SWDA or in transit between ports and the SWDA (COP Volume III, Section 7.9; Epsilon 2023). Pilots who choose to fly at lower altitudes over open ocean near the SWDA would have to alter routes to avoid potential collisions with these structures. As a result, Phase 1 construction would result in localized, short-term, and minor impacts on aviation and air traffic.

Construction of Phase 1 would add up to 62 WTGs with maximum blade tip heights of up to 1,171 feet AMSL to the SWDA. While the SWDA would be outside of public use and military airport study areas, the Phase 1 WTGs would be “obstructions” pursuant to 14 CFR § 77.17(a)(2) (Obstruction Standard) and 14 CFR § 77.19/21/23 (Imaginary Surfaces), based on their height. As a result, a full aeronautical study must be conducted for Phase 1 (COP Volume III, Appendix III-J; Epsilon 2023).

The FAA establishes and enforces the following airspace and flight rules and procedures potentially applicable to Phase 1 (COP Volume III, Appendix III-J; Epsilon 2023):

- VFR traffic pattern airspace or designated VFR routes pursuant to 14 CFR § 77.17(a)(1) that follow recognizable landmarks.
- Instrument departure and approach procedures for routing and climb gradients to and from airports to ensure pilots have sufficient clearance from terrain and obstacles.
- En-route airways are established by the FAA to ensure at least a 1,000-foot obstacle clearance along routes between airports in non-mountainous areas.
- Protection areas for navigational aids.

The Phase 1 WTGs would not interfere with the airspace or procedures described above (COP Volume III, Appendix III-J; Epsilon 2023).

The FAA establishes minimum vectoring altitudes (MVA) and minimum IFR altitude charts that define the lowest altitude for which air traffic controllers can issue radar vectors due to obstacle clearance. The FAA mandates that sectors have a minimum obstacle clearance of 1,000 feet in non-mountainous areas. Boston Consolidated (A90) Terminal Radar Approach Control (TRACON) MVA sectors, Providence (PVD) TRACON MVA sectors, and Boston (ZBW) Air Route Traffic Control Center minimum IFR altitude sectors overlie the SWDA, with obstacle clearance surfaces ranging from 549 to 4,849 feet AMSL. At 1,171 feet AMSL, the Phase 1 WTGs would exceed some surface heights and would require an increase to a Boston Consolidated (A90) TRACON MVA (COP Volume III, Appendix III-J; Epsilon 2023).

Pilots who choose to fly at lower altitudes over open ocean near the SWDA would have to alter routes to avoid potential collisions with WTGs. The WTGs would use ADLS; would have navigational markings and lighting pursuant to FAA (2020), USCG (2019), and BOEM (2021a) requirements and guidelines (including the use of ADLS); and would be visible on the radar systems of low-flying aircrafts, similar to other large-scale sea surface activity.

Impacts on military airspace, specifically W-105A, are discussed in the sub-IPF for national security and military use. Impacts on radars involved in managing air traffic are discussed in the sub-IPF for radar systems.

The applicant would file FAA Form 7460-1 for Phase 1 WTGs, as well as for individual structures in territorial waters exceeding 200 feet AMSL, including construction cranes and vessels transiting tall structures between port and the SWDA during construction. The filing would trigger a review to identify and resolve aviation risks through updated aeronautical studies, with consideration of existing obstacles in FAA records.

While Phase 1 WTGs in combination with other existing or proposed tall structures onshore and offshore would increase navigational complexity for aircraft in the area and potentially necessitate changes to air navigation patterns, the FAA has established methods for marking potential obstructions, mitigating potential impacts, and notifying aviation interests about any changes to airspace management. Implementation of these standard procedures would reduce risks associated with impacts from structures on aviation and air traffic. As appropriate, BOEM would condition COP approval on satisfaction of conditions that FAA imposes for Phase 1 WTGs. Because the SWDA coincides with W-105A, impacts from Phase 1 could be major if the Clearinghouse issues a Notice of Presumed Risk to National Security. Based on previous consultations for Vineyard Wind 1, BOEM does not anticipate such a finding; therefore, impacts on aviation and air traffic from Phase 1 would be localized, long term, and minor.

Offshore Cables and Pipelines

Cable emplacement and maintenance: As stated in Section 3.14.2.1, the OECC for the proposed Project could cross the OECC for SouthCoast Wind. BOEM assumes that the applicant (or the developer of SouthCoast Wind, depending on the timing of cable installation for the two projects) would use standard protection techniques during construction to achieve this cable crossing. As a result, the impacts of Phase 1 on cables and pipelines under this IPF would be localized, temporary, and negligible.

Presence of structures: Onshore construction of Phase 1 would not impact offshore cables and pipelines due to lack of spatial overlap with these facilities. Construction of Phase 1 is not likely to pose an allision risk to vessels conducting maintenance activities at existing submarine cables near the SWDA. Such vessels could route around or through the SWDA, but impacts such as allision would be rare due to infrequency of submarine cable maintenance, the limited number of stationary Phase 1 construction vessels, and adherence to required maritime safety procedures. As a result, the impacts of Phase 1 on cables and pipelines under this IPF would be localized, long term, and negligible.

While the OECC for Phase 1 does not cross any existing offshore cables or pipelines, the presence of Phase 1's WTGs, ESPs, and inter-array cabling system within the SWDA could preclude future submarine cable development through the SWDA. Future submarine cables, including future offshore wind export cables, would need to be routed around the SWDA during the operational timeframe. Space use conflicts could be eliminated during decommissioning if structures are removed. Any future crossings of the OECC and new submarine cables could be protected by standard techniques during operations and decommissioning; therefore, overall impacts on cables from Phase 1 operations and decommissioning would be localized, long term, and negligible.

Radar Systems

Presence of structures: Construction of onshore facilities associated with Phase 1 is not anticipated to impact radar systems. Phase 1 WTGs could cause interference for ground-based radar. While WTGs in the direct line-of-sight with or extremely close to radar systems can cause clutter and interference, most ground-based radar systems are located a sufficient distance from the SWDA that radar interference is not anticipated, and mitigation would not be required. Phase 1 is outside of the instrumented range for the FAA's TDWR located at Boston Logan International Airport (COP Volume III, Section 7.9.2; Epsilon 2023).

The PST long range radar (LRR) analysis accounts for ARSR sites and a few select ASR sites used for air defense and homeland security. The PST LRR analysis does not account for all DoD, DHS, and/or FAA radar sites, including EWR sites. Further, the PST NEXRAD analysis accounts for WSR-88D radar sites but does not account for FAA TDWR radar sites. The PST LRR results show four air traffic control, air defense, and homeland security radar sites—Falmouth ASR-8, Nantucket ASR-9, North ARSR-4, and Providence ASR-9—in proximity to the SWDA. A basic radar line of sight analysis was conducted for seven radar sites, and analyses identified that the Phase 1 WTGs would be visible to the Falmouth ASR-8 and Nantucket ASR-9 radar sites, would impact the Falmouth ASR-8 (Clearinghouse 2022) and could potentially affect the Providence ASR-9. The analysis indicated that the Phase 1 WTGs would not affect the secondary surveillance radar collocated with the Nantucket ASR-9. Because there are multiple radar sites within approximately 100 nautical miles (115 miles) of the proposed Project area, overlapping coverage in addition to existing efforts by the operator(s) to optimize radar systems would mitigate any potential impacts of Phase 1. The radar line of sight analyses also identified that the Phase 1 WTGs would be visible to and could impact the Cape Cod AFS EWR. As a result, the applicant is consulting with the DoD Siting Clearinghouse on this issue (COP Volume III, Section 7.9.2.1.2; Epsilon 2023). The applicant expects to enter into an agreement with DoD to mitigate conflicts with or impacts on NORAD radar systems. Anticipated mitigation and monitoring measures are discussed in Appendix H.

For weather radars, a U.S. Department of Energy screening tool for WTG siting did not identify any potential conflicts between Phase 1 and ground-based NOAA NEXRAD weather radars (COP Volume III, Section 7.9.2; Epsilon 2023). WTGs located in other NEXRAD lines of sight can affect radar reflectivity, velocity, internal algorithms that generate alerts and derive weather products, and other attributes and functions. In general, the severity of impacts is related to the separation distance between the WTGs and the NEXRAD facility, with impacts increasing as distance decreases, especially for WTGs located within 11 miles of the NEXRAD facility (COP Volume III, Section 7.9.2.2; Epsilon 2023), although NEXRAD radars can be affected up to 60 miles away, depending on terrain. The Clearinghouse review of Vineyard Wind 1 conducted in 2020 stated interference from Vineyard Wind 1 WTGs could adversely affect NORAD radar operations and defense of national critical infrastructure (BOEM 2021b). The SWDA is outside the radar line-of-sight for 3 of the 12 HF radar systems reviewed in this section: the Amagansett HF radar, Moriches HF radar, and the Nauset HF radar, although radar impacts are still possible beyond line-of-sight due to the propagation of HF electromagnetic waves over the ocean surface. Some or all of the WTGs within the SWDA are within the radar line-of-sight for the remaining nine HF radar systems: Block Island Long Range HF radar, Martha's Vineyard HF radar, Nantucket Island HF radar, Camp Varnum HF radar, Horseneck Beach State Reservation HF radar, Long Point Wildlife Refuge HF radar, Martha's Vineyard Coastal Observatory Meteorological Mast HF radar, Nantucket HF radar, and the Squibnocket Farms HF radar. For coastal HF radar systems, the applicant would consult with the radar operators and IOOS to evaluate whether the proposed WTGs are expected to cause radar interference to the extent that radar performance is affected and implement, where feasible, mitigations identified by the IOOS Surface Currents Program. Additionally, the applicant's Marine Coordinator would remain on duty for the life of Phase 1 to liaise with military, national security, civilian, and private interests to reduce potential radar conflicts.

The FAA would evaluate potential impacts on radar systems, as well as mitigation and monitoring measures when the applicant files Form 7460-1 for Phase 1 WTGs. To address concerns about impacts on radar systems, BOEM could include FAA-recommended mitigation and monitoring measures resulting from the filing of Form 7460-1 (if any) as COP approval conditions. The applicant's Marine Coordinator would remain on duty for the life of Phase 1 to liaise with military, national security, civilian, and private interests to reduce potential radar conflicts. Pending consultation with the FAA and the Clearinghouse, Phase 1 operations would have localized, long-term, and moderate impacts on radar systems.

Scientific Research and Surveys

Presence of structures: Construction of Phase 1 would add up to 62 WTGs (with blade tip heights of up to 1,171 feet MLLW) and ESPs, associated cable systems, and vessel activity that would present additional navigational obstructions for sea- and air-based scientific surveys. This would affect the statistical design of surveys, reduce survey efficiency, and prevent monitoring of habitat alteration within the SWDA. Research activities may continue within the proposed SWDA during construction, as permissible by survey operators and boat captains; however, research and survey vessels may need to alter transit routes to avoid construction vessels and other activities. Phase 1 would also impact survey operations by excluding certain areas within the SWDA occupied by proposed Project components (e.g., WTG foundations, cable routes) from potential sampling, and by impacting survey gear performance, efficiency, and availability. Aerial survey track lines for cetacean and sea turtle abundance surveys could not continue at the current altitude (600 feet AMSL) within the proposed Project area because the planned maximum-case scenario for WTG blade tip height would exceed the survey altitude. The increased altitude necessary for safe survey operations could result in lower chances of detecting marine mammals and sea turtles, especially smaller species. Agencies would likely need to expend resources to update scientific survey methodologies due to construction of Phase 1, as well as to evaluate these changes on stock assessments and fisheries management. The applicant would update all relevant parties throughout construction of Phase 1 and would issue Offshore Wind Mariner Update Bulletins and Notices to Mariners regarding Phase 1 related activities. Therefore, the impacts of Phase 1 construction on scientific research and surveys would be minor to moderate.

Phase 1 would impact scientific research and surveys in the SWDA and greater geographic analysis area. Both BOEM and NOAA have acknowledged that survey methodologies may require updates or changes. BOEM and NOAA are collaborating to design surveys and/or changes in current survey methodology to generate comparable information to the historic dataset. The Other Uses section of the Final EIS for Vineyard Wind 1 provides a detailed summary of NOAA and other research and surveys potentially affected by that project. Those descriptions and impact conclusions are broadly applicable to Alternative B (including Phase 1) and are reprinted in Section B.3 of Appendix B. BOEM and NMFS are working cooperatively on a mitigation strategy to reduce potential impacts on the bottom trawl survey and other surveys from offshore wind facilities (Appendix H). The 1-nautical-mile (1.15-mile) × 1-nautical-mile (1.15-mile) spacing and fixed east-to-west rows and north-to-south columns between WTGs and ESPs in the SWDA would accommodate smaller vessels for surveys through the proposed Project area.

In recognition of the regional importance and nature of fisheries science, the applicant expects to continue working with BOEM and other state and federal agencies, academic institutions, and other stakeholders to continue developing appropriate fisheries studies. The applicant is working with other offshore wind developers, fishing industry representatives and federal and state agencies through its participation with the Responsible Offshore Science Alliance and a Regional Wildlife Science Entity. Additionally, Phase 1 may provide increased opportunities for scientific research and surveys within the geographic analysis area, due to the unprecedented nature of offshore wind projects in the geographic analysis area. These efforts notwithstanding, Phase 1 would have major impacts on existing NMFS scientific research and surveys conducted in and around the SWDA because long-standing surveys would not be able to continue as currently designed, and extensive costs and efforts would be required to adjust survey approaches. Phase 1 would also have potential major impacts on monitoring and assessment activities associated with recovery and conservation programs for protected species. The loss of precision and accuracy would be a significant hurdle, as new data collection methods are tested and become usable and robust over time. Implementing mitigation and monitoring measures, including the development of survey adaptation plans, standardization and calibration of sampling methods, and annual data collections following new designs and methods would help reduce uncertainty in survey data and associated assessment results and increase the utility of additional data collected as part of any required project-specific monitoring plan.

Impacts on scientific research and surveys from decommissioning would be the same as the impacts associated with construction and would dissipate once WTGs and ESPs are removed. Phase 1 would have minor to moderate impacts.

Marine Minerals

Construction of Phase 1 would have no impacts on marine minerals, due to the absence of any such resources in the RI/MA Lease Areas, including the SWDA or OECC. Therefore, the impacts of Phase 1 on marine minerals would be negligible.

Operations and decommissioning of Phase 1 would not affect future sand and mineral extraction due to the absence of those resources. Therefore, Phase 1 would have negligible impacts on marine minerals.

Impacts of Phase 2

The impacts of Phase 2 construction, operations, and decommissioning on other uses would be similar to or the same as described for Phase 1 for IPFs related to cable emplacement and maintenance, the presence of structures, and traffic. Phase 2 would involve the construction, operation, and decommissioning of more WTGs (88 versus 62) and ESPs (up to 3 versus up to 2). The impacts of Phase 2 on national security and military use, aviation and air traffic, offshore cables and pipelines, and scientific research and surveys would be more widespread than described in Phase 1, due to the increased number of WTGs and the increased extent of inter-array cables. The impacts of Phase 2 on radar systems would be reduced compared to Phase 1, due to the increased distance of Phase 2 WTGs from land-based radars. The impacts of Phase 2 on marine minerals would be the same as those of Phase 1.

While the impacts of Phase 2 on other uses would differ from Phase 1 impacts, the incremental differences between Phase 2 and Phase 1 would not change any of the impact magnitudes described for Phase 1 construction, operations, or decommissioning. As a result, the magnitudes of impacts on other uses from Phase 2 would be the same as those described for Phase 1. If the applicant includes the SCV as part of the final proposed Project design, some or all of the impacts on other uses from the Phase 2 OECC through Muskeget Channel would not occur. BOEM will provide a more detailed analysis of the impacts of the SCV on other uses in a supplemental NEPA analysis, if the SCV is selected.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-11 in Appendix G would contribute to impacts on other uses through the primary IPFs of cable maintenance and emplacement and the presence of structures. The installation of up to 1,033 WTGs within the RI/MA Lease Areas would primarily introduce long-term navigational complexity in the region and pose navigational hazards. This would increase allision risks for vessels and collision risks for aircraft and hinder USCG SAR operations across a larger area, potentially leading to decreased likelihood of success, earlier abandonment of search, and resultant increased loss of life.

The cumulative impacts on other uses would result in **negligible** impacts for marine minerals; **minor** impacts for aviation and air traffic and offshore cables and pipelines; **moderate** impacts on radar systems; and **major** impacts for national security and military use and scientific research and surveys.

Conclusions: Impacts of Alternative B

In summary, Alternative B would impact other uses to varying degrees as described in this section.

National Security and Military Use

Alternative B would have **moderate** impacts on national security and military use. The WTG and ESPs of Alternative B would cause localized, long-term, and minor to moderate impacts from allision risk; localized, long-term, and minor impacts from allision risks and elevated need for SAR operations due to increased interest to recreational fishing or sightseeing within the SWDA; localized, long-term, and minor impacts on most military and national security uses from increased navigational complexity and associated risks, except for moderate impacts on SAR operations due to reduced likelihood of success; localized, long-term, and minor impacts on military vessels and aircraft from increased space use conflicts; and negligible impacts from potential conflict with vessels conducting export cable emplacement and maintenance.

Impacts on military and national security from vessel traffic related to Alternative B would be localized, temporary, and minor during construction and decommissioning, and negligible during operations. As part of Alternative B, the applicant would voluntarily implement an operational protocol that requires the WTGs to stop rotating within a specified time to mitigate impacts on search and rescue aircraft operating in the SWDA (COP Volume III, Section 7.8; Epsilon 2023). The applicant would employ a Marine Coordinator to liaise with military and national security interests as needed. These actions would improve safety but would not remove the navigational hazard associated with installing WTGs in the open ocean.

Alternative B would result in minor impacts on most military and national security uses in the geographic analysis area but moderate impacts on USCG SAR operations because a notable and measurable impact is anticipated, but the resource would likely recover completely when the impacting agents were gone and/or remedial or mitigating actions were taken. The main drivers for these impact ratings are the installation of structures, primarily WTGs, within the RI/MA Lease Areas that would hinder USCG SAR operations, leading to increased loss of life. FAA review, coordination with military and national security interests, and other mitigation actions may improve safety of SAR operations, but these mitigation measures would not remove the navigational hazard associated with installing WTGs over a larger area in the open ocean.

Aviation and Air Traffic

Construction, operations, and decommissioning of Alternative B would have **minor** impacts on aviation and air traffic (impacts on military aviation activities are included in the impacts for national defense and military use). Potential impacts on aviation and air traffic would primarily be caused by tall mobile and stationary structures during Alternative B construction and decommissioning, and operation of WTGs in the SWDA, all of which could trigger the need for FAA review and study. This FAA review may identify changes to navigational patterns for local airports. The applicant’s Marine Coordinator would liaise with aviation interests to reduce potential conflicts over the life of the proposed Project.

Alternative B would result in **minor** impacts on aviation and air traffic because air traffic would be able to continue over and around the RI/MA Lease Areas after any required changes to air traffic navigation patterns are made through established processes.

Offshore Cables and Pipelines

Construction, operations, and decommissioning of Alternative B would have **negligible** impacts on offshore cables and pipelines, due to the absence of existing submarine cables and pipelines in the SWDA and crossing OECC routes. Although future submarine cables, including future offshore wind export cables, would need to be routed around the SWDA, the OECC cables could be crossed using standard techniques to avoid impacts.

Radar Systems

Construction, operations, and decommissioning of Alternative B would have **moderate** impacts on radar systems. Although presence of WTGs has the potential to cause interference with radar systems, ground-based radar systems are located a sufficient distance from the SWDA that radar interference is not anticipated and mitigation would not be required, resulting in minor impacts. The FAA would evaluate potential impacts on radar systems, as well as mitigation and monitoring measures when the applicant files Form 7460-1 for individual WTGs. The applicant's Marine Coordinator would remain on duty for the life of Alternative B to liaise with military, national security, civilian, and private interests to reduce potential radar conflicts. BOEM would continue to work with military and national security agencies to identify and de-conflict concerns about radar impacts.

Impacts would gradually increase during construction, remain at a stable level during operations, and decrease as multiple project WTGs are decommissioned; therefore, Alternative B would have long-term **moderate** impacts on radar systems; potential conflicts would be addressed through established processes.

Scientific Research and Surveys

Construction, operations, and decommissioning of Alternative B would have **major** impacts on scientific research and surveys. During operation of Alternative B, the presence of WTGs, ESPs, and cables would prevent long-standing surveys from continuing as currently designed, and extensive costs and efforts would be required to adjust survey approaches. The inability to continue surveys as currently designed would have a significant impact on monitoring and assessment activities associated with recovery and conservation programs for protected species, as well as surveys supporting commercial fisheries management activities. Mitigation and monitoring measures such as survey adaptation plans, standardization and calibration of sampling methods, and annual data collections following new designs and methods would help to address some of these concerns, but may not fully address impacts, and such measures would require considerable time and testing to fully implement.

Marine Minerals

Construction, operations, and decommissioning of Alternative B would have a **negligible** impact on marine minerals because no federal OCS sand and mineral lease areas or significant sand resource blocks are located within the SWDA. Similarly, there are no such resources within the RI/MA Lease Areas.

Conclusions: Cumulative Impacts of Alternative B

In summary, Alternative B, when combined with ongoing and planned activities in the geographic analysis area, would affect other uses to varying degrees as described in this section, as follows.

- **National security and military use:** Cumulative impacts of Alternative B would be minor on most military and national security uses but **major** on USCG SAR operations. The main drivers for these impact ratings are the installation of structures, primarily WTGs, within the RI/MA Lease Areas that would hinder USCG SAR operations, leading to increased loss of life.
- **Aviation and air traffic:** Cumulative impacts of Alternative B would be **minor**, primarily due to tall mobile and stationary structures during construction and decommissioning, as well as operations of WTGs in the RI/MA Lease Areas.
- **Offshore cables and pipelines:** Cumulative impacts of Alternative B would be **minor**, due to the limited number of cable crossings and the availability of standard protection techniques to achieve these crossings.

- **Radar systems:** Cumulative impacts of Alternative B would be **moderate**. Offshore WTGs in the RI/MA Lease Areas could incrementally decrease the effectiveness of individual radar systems and create a large geographic area of incrementally degraded radar coverage.
- **Scientific research and surveys:** Cumulative impacts of Alternative B would be **major**. The presence of WTGs, ESPs, and cables would prevent long-standing surveys from continuing as currently designed and involve extensive costs and effort to adjust survey approaches. The inability to continue surveys as currently designed would have a significant impact on monitoring and assessment activities for protected species and commercial fisheries management.
- **Marine minerals:** Cumulative impacts of Alternative B would be **negligible** because no federal OCS sand and mineral lease areas or significant sand resource blocks are located within the RI/MA Lease Areas.

While the significance level of impacts would remain the same, as discussed above, BOEM may include mitigation and monitoring measures to address impacts on other uses in the geographic analysis area, as described in detail in Table H-2 of Appendix H. Any implemented mitigation measures for ongoing surveys in the geographic analysis area will be consistent with the BOEM and NMFS Final Survey Mitigation Strategy for the Northeast U.S. Region (Hare et al. 2022).

3.14.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Other Uses

When analyzing the impacts of Alternative C on other uses, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for other uses. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. These differences would not result in meaningfully different impacts compared to those of Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on other uses would be the same as those impacts for Alternative B: **negligible** impacts on offshore cables and pipelines and marine minerals; **minor** impacts on aviation and air traffic; **moderate** impacts on national security and military use and radar systems; and **major** impacts on scientific research and surveys. The cumulative impacts of Alternative C would align with those of Alternative B: **negligible** impacts on marine minerals; **minor** impacts on aviation and air traffic and offshore cables and pipelines; **moderate** impacts on radar systems, and **major** impacts on national security and military use and scientific research and surveys.

3.14.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Other Uses with the Western Muskeget Variant Contingency Option

Impacts on other uses from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B.

- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H) as described under Alternative B. This would reduce the potential impacts on other uses by a negligible increment for both Phase 1 and Phase 2 as there could be two fewer structures (WTGs or ESPs) potentially installed in the SWDA.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on other uses relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **negligible** impacts on offshore cables and pipelines and marine minerals; **minor** impacts on aviation and air traffic; **moderate** impacts on national security and military use and radar systems, and **major** impacts on scientific research and surveys. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **negligible** impacts on marine minerals; **minor** impacts on aviation and air traffic and offshore cables and pipelines; **moderate** impacts on radar systems; and **major** impacts on military and national security uses and scientific research and surveys.

3.15 Recreation and Tourism

3.15.1 Description of the Affected Environment

3.15.1.1 Geographic Analysis Area

This section discusses existing recreation and tourism resources and activities within the geographic analysis area, as described in Table D-1 in Appendix D, Geographical Analysis Areas, and shown on Figure 3.15-1. The geographic analysis area includes:

- Massachusetts counties containing onshore export cable infrastructure (Barnstable County for Phases 1 and 2, as well as Bristol County for the Phase 2 SCV);
- The City of Bridgeport, Connecticut, where the operations base would be located; and,
- The geographic analysis area for scenic and visual resources (Section 3.16, Scenic and Visual Resources).

This geographic analysis area allows for review of impacts on offshore recreational activities, recreational resources near the onshore infrastructure and operations base, and visual resources as they relate to recreation and tourism.

Table G.1-18 contains a summary of ongoing and future offshore activities other than offshore wind, which is discussed below.

The geographic analysis area supports ocean-based recreation and tourism: boating, fishing, shellfishing, sightseeing, wildlife viewing, swimming, beach visiting, hiking, and other activities. Recreational boating in the geographic analysis area ranges from ocean-going vessels to small boats used in sheltered coastal waters and includes sailboats, motorboats, kayaks, canoes, and paddleboats. Marine-oriented recreational businesses offer boat rentals, charter fishing, and sightseeing excursions, including trips for viewing whales and other wildlife. Coastal businesses offer hiking, canoe, or kayak tours. Many coastal and ocean amenities that are free for public access function as key drivers for coastal businesses within the recreation and tourism sectors. As discussed in Section 3.11, Demographics, Employment, and Economics, recreation and hospitality are major sectors of the economy in the geographic analysis area, supported by the ocean-based recreation uses.

The scenic quality of the coastal environment is important to the identity, attraction, and economic health of many of the coastal communities. The visual qualities of historic coastal towns, which include marine activities within small-scale harbors and the ability to view birds and marine life, are important community characteristics.

3.15.1.2 Offshore Recreational Activities

A 2012 survey of marine recreational boat owners in northeast states found the highest density of recreational vessel routes within the geographic analysis area occurred within Nantucket Sound, Vineyard Sound, and Buzzards Bay (Starbuck and Lipsky 2013). In nearby marine areas, highly traveled areas for recreational vessel traffic also occurred within Block Island Sound, Long Island Sound, the Providence River, Boston Harbor, and Salem Harbor. Recreational boating density lessened as the distance from the coast increased.

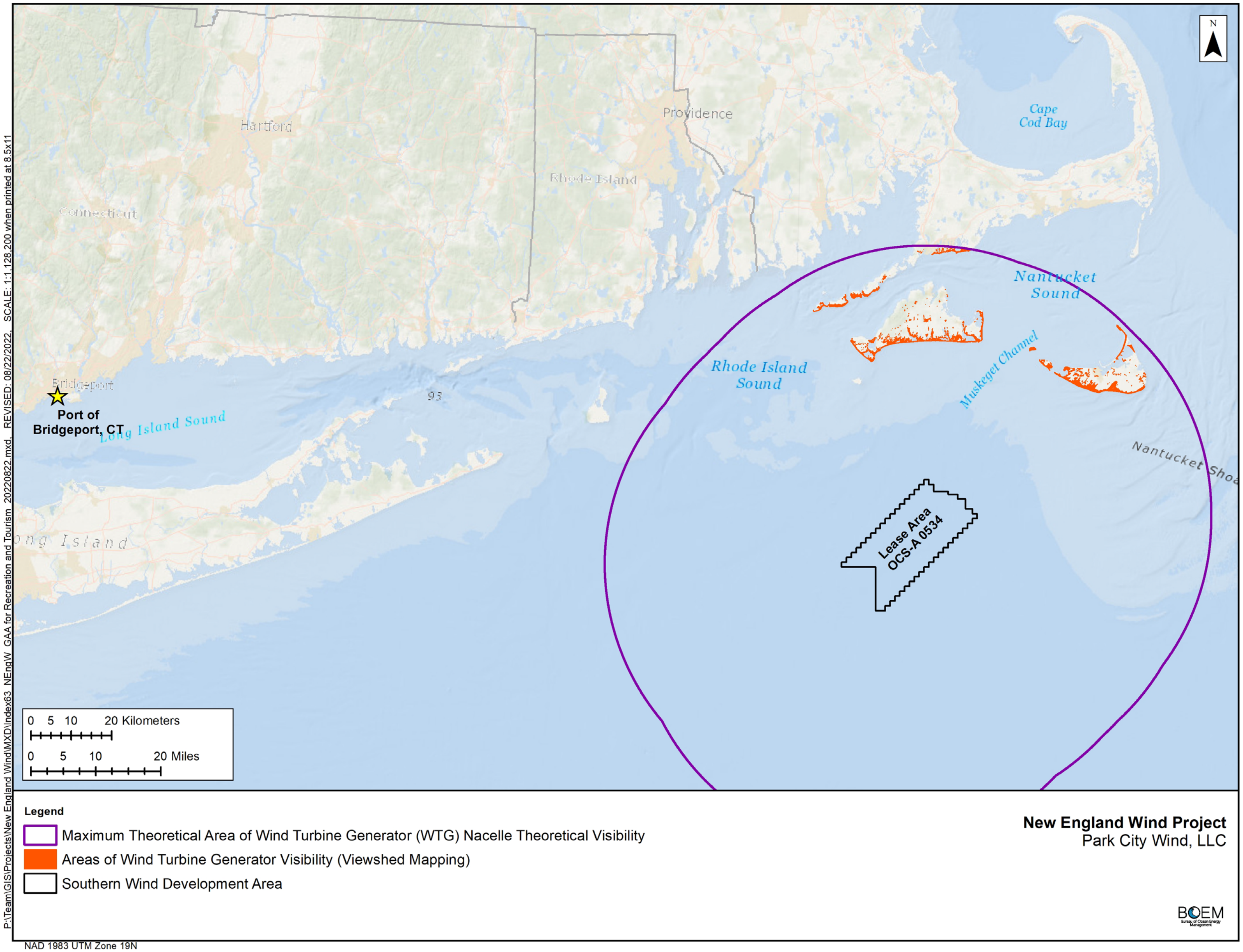


Figure 3.15-1: Geographic Analysis Area for Recreation and Tourism

Generally, along the northeastern coast, more than half (52.4 percent) of recreational boating occurred within 1.2 miles of the coastline (Starbuck and Lipsky 2013). A smaller but still significant proportion of recreational boating occurs farther offshore. A 2020 USCG survey found that 139,000 recreational boats registered or stored in Massachusetts were taken out on the water at least once in 2018, including trips on both inland and marine waters, and 11 percent of these boats, including 26 percent of motorized boats, traveled at least 3 nautical miles (3.5 miles) from the coastline at least once (RTI International 2020).

Recreational boating varies seasonally, with peak boating season occurring between May and September, and includes several types of activities:

- The 2012 survey found that fishing accounted for 43 percent of recreational boating activity off the Massachusetts coast, followed by other (e.g., sightseeing, shellfishing, buying food and supplies; 29 percent), relaxing (19 percent), wildlife viewing (7 percent), and scuba diving or swimming (1 percent each).
- Striped bass was the most commonly targeted fish species within Massachusetts state waters. Outside of state waters, Atlantic cod, Atlantic bluefin tuna, and haddock were the most commonly targeted species.
- Respondents engaging in wildlife viewing most commonly cited birds as the target for viewing (60 percent). Other respondents listed seals (24 percent), whales (7 percent), dolphins and porpoises (6 percent), or sea turtles (1 percent).
- Boating excursions commonly included expenditures at other recreation and tourism-related businesses, including marinas, restaurants, lodging, and entertainment (Starbuck and Lipsky 2013).

In response to questions about recreational boating near other activities, most boaters (58 percent) responded that they could continue to enjoy recreational boating near offshore wind farm turbines, and 53 percent had the same response for recreational boating near ship/tanker/ferry traffic. Boaters ranked port operations and industrial waterfront as the least compatible with recreational boating, with only 44 percent indicating that they could enjoy recreational boating near these uses (Starbuck and Lipsky 2013).

An annual average of almost 2 million private and for-hire angler trips originated in Massachusetts between 2007 and 2012 (Kirkpatrick et al. 2017). An estimated 1.9 percent of the total trips originating in Massachusetts traveled within 1 mile of the RI/MA Lease Areas. Data specific to harbors in the geographic analysis area indicate that 10 percent of private angler trips originating from several locations traveled within 1 mile of the RI/MA Lease Areas, including trips from harbors in Dukes County (Chilmark, Edgartown, Oak Bluffs, and Tisbury), Barnstable County (Falmouth), and Bristol County (New Bedford, Fall River, Fairhaven, and Westport). Regionally, less than 0.5 percent of angler trips originating in Connecticut or New York and 3.6 percent of trips originating in Rhode Island traveled within 1 mile of the RI/MA Lease Areas. Popular HMS fishing locations overlapping with the SWDA include Gordon’s Gully, Fathom Hole, and The Dump (Figure 3.9-2 in Section 3.9, Commercial and For-Hire Recreational Fishing).

Nationally, the Atlantic coast accounted for the majority of marine recreational fishing trips (more than 69 percent) and catch (nearly 63 percent) in 2019 (NOAA 2021c). More than 130 million marine recreational fishing trips originated in Atlantic coast states. About 6 percent of these trips (approximately 7.4 million) originated in Massachusetts, and an estimated 16 percent (about 20.9 million) of fishing trips originated in the nearby states of New York, Connecticut, and Rhode Island. The most commonly caught non-bait species (in numbers of fish) were black sea bass, bluefish, striped bass, summer flounder, and scup. The largest harvests by weight were striped bass, bluefish, scup, mahi-mahi, and black sea bass (NOAA 2021c).

Fishing for Atlantic HMS, defined as federally regulated sharks, blue and white marlin, sailfish, roundscale spearfish, swordfish, and federally regulated tunas, occurs farther offshore than most other recreational fishing and is, therefore, more likely to overlap with areas where future offshore wind development would occur. Except where specifically noted, the discussion of existing HMS fishing includes private and for-hire fishing. Section 3.9 provides additional information on for-hire recreational fishing. Federal Atlantic HMS angling permits are issued to a vessel and authorize anyone traveling in that vessel to fish for, retain, or possess federally regulated HMS. In 2016, there were 20,020 permit holders. Fourteen percent of HMS angling trips began in Massachusetts; only Florida (16 percent of trips) had a higher percentage of trip originations. Three percent of trips began in Rhode Island (Hutt and Silva 2019).

A 2020 BOEM study provides a baseline assessment of HMS fishing in southern New England, using an online survey (from August 2019 through May 2020), data from the NMFS Large Pelagics Intercept Survey, and tagging data. The 171 online survey respondents included 136 private anglers, 34 charter/headboat captains, and 1 unknown respondent. All respondents reported using mobile fishing tactics (trolling, drifting, casting/run), and some also reported using stationary tactics (anchoring) to target HMS. Large fleets of 50 to 100 recreational vessels sometimes congregate in small geographic areas when targeting popular HMS (Kneebone and Capizzano 2020).

From 2002 through 2018, approximately 12 percent of HMS trips and 18 percent of tagging events in southern New England occurred within the RI/MA Lease Areas (Kneebone and Capizzano 2020). HMS trips in the lease areas that include the Vineyard Wind 1 and New England Wind Projects[43] represented 1 to 5 percent of total HMS trips in southern New England and 6 to 28 percent of trips in the RI/MA Lease Areas, depending on the year (Kneebone and Capizzano 2020). Trips within the SWDA primarily originated in Massachusetts and Rhode Island. The same was true for the RI/MA Lease Areas overall, although a notable number of trips also originated in Connecticut and New York (Kneebone and Capizzano 2020). The greatest amount of HMS fishing effort occurred west of the RI/MA Lease Areas in the waters south and east of Montauk Point and Block Island.

Numerous sailboat races occur within the geographic analysis area, originating from Nantucket, Martha's Vineyard, Hyannis on Cape Cod, and other harbors, and generally do not use routes as far offshore as the RI/MA Lease Areas. Long-distance sailboat races with routes as far offshore as the RI/MA Lease Areas may pass through the geographic analysis area depending upon the route selected for a particular year. These races include the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race (COP Volume III, Section 7.5.1.2; Epsilon 2023).

3.15.1.3 Coastal Communities

The NMFS Social Indicator Map identifies the levels of recreational fishing engagement and reliance in coastal communities. Recreational fishing engagement measures the presence of recreational fishing through fishing activity estimates. Recreational fishing reliance measures the presence of recreational fishing in relation to the population size of a community (NMFS 2021h).

Within the geographic analysis area, the towns of Barnstable and Nantucket rank "High" for recreational fishing engagement, while several towns adjacent to Barnstable rank "Medium High." Coastal towns within Bristol County (New Bedford, Fairhaven, and Westport) are ranked "Medium" to "Medium High." For recreational fishing reliance, most of these areas rank "Low," except for a few towns, including

[43] At the time of the study, this was identified as Lease Area OCS-A 0501; it is now identified as OCS-A 0501 and OCS-A 0534.

Nantucket, Woods Hole, Falmouth, and West Dennis, which are ranked “Medium.” Bridgeport, Connecticut, is ranked “Low” for recreational fishing engagement and reliance.

The towns on Martha’s Vineyard rank “Low” in recreational fishing engagement and reliance.

3.15.1.4 Onshore Recreation

The geographic analysis area incorporates Barnstable, Dukes, Nantucket, Plymouth and Bristol counties in Massachusetts and the City of Bridgeport, Connecticut. These jurisdictions are either in the area where proposed Project structures would be visible or proposed Project onshore facilities would be located.

Barnstable County, comprised of the entirety of Cape Cod, has 550 miles of coastline, mostly sandy beaches, with more than 150 public beaches, several private beaches, and limited access coastal areas. There are approximately 30 harbors, 40 marinas and boatyards, and approximately two dozen private boating and yacht clubs in the county (COP Volume III, Section 7.5.1.1; Epsilon 2023). Several wildlife sanctuaries in the county, along with the Cape Cod National Seashore, serve as important destinations for onshore wildlife viewing. Cape Cod is a popular tourist destination and depends economically on the recreation and tourism industries (Section 3.11).

The proposed Project’s onshore facilities would be within the Town of Barnstable, the largest of Barnstable County’s 15 municipalities. The Town of Barnstable has 170 miles of coastline, mostly privately owned. Only 9.4 miles of coastline are publicly controlled and available for recreation, and only 2.4 miles are both publicly controlled and easily accessible (Ridley and Associates 2018). The town’s 14 public beaches (11 along the coast and 3 near ponds) account for 133 acres, while public boat landings occupy 12 acres. During the summer, the public beaches are crowded, and beach parking lots frequently reach capacity by mid-morning. Freshwater and marine boating and fishing are popular recreational activities. Shellfishing is a commercially and recreationally significant activity in Barnstable, and the town issued 2,760 recreational shellfishing permits in 2017 (Ridley and Associates 2018). The Phase 2 landfall site is most likely to be at Dowses Beach, a resident-only beach for which parking permits are limited to Town of Barnstable residents and landlords (Town of Barnstable Code Chapter 401A Attachment 1). Dowses Beach has beach access, a 220-space parking lot, a bathhouse with showers, and an accessible pier with a viewing/fishing platform (Town of Barnstable 2021). The pier is accessed from the north end of the parking lot, at the point furthest from the access road to Dowses Beach, and contains benches with lowered railings to create accessible fishing points.

Inland recreation facilities in the Town of Barnstable include Wequaquet Lake, covering 596 acres. A small town-owned beach and boat ramp are located along the lake’s western edge, adjacent to a portion of Shootflying Road proposed for use for the Onshore Cable Export Route. The town facilities occupy a land area 50 to 150 feet wide between the lake and Shootflying Road, with the public parking area adjacent to the road. A private yacht club is also located adjacent to the lake, about 2,000 feet west of Shootflying Road. Other inland public lands include the Barnstable State Forest, an unimproved, forested, 53-acre tract located about 400 feet east of the West Barnstable Substation (which would be used for proposed Project interconnection to the electric grid) and adjacent to the northern edge of the transmission line ROW that would be a possible route for the proposed Project’s interconnection cable.

Dukes County, which consists of Martha’s Vineyard and other islands south of mainland Massachusetts, has approximately 150 miles of coastline, 15 public beaches, and 6 public boat launch facilities for coastal waters. Dukes County’s only federally protected land is Noman’s Land Island National Wildlife Refuge (COP Volume III, Section 7.5.1.1; Epsilon 2023). On Martha’s Vineyard, the largest island in the county, approximately 36 percent of the island (20,720 acres) is protected open space, and 38 percent of coastline is open to the general public (Martha’s Vineyard Commission 2010). Recreational boating is supported by five harbors, two marinas, and three yacht clubs (COP Volume III, Section 7.5.1.1; Epsilon 2023).

Nantucket County has approximately 110 miles of shoreline, of which 80 miles (129 kilometers) are sandy beach open to the public. The Nantucket Wildlife Refuge, a 25-acre tract, is the only federally protected land. Nantucket's two main harbors, Nantucket and Madaket, are popular seasonal destinations for recreational and commercial vessels. The island also has two yacht clubs, multiple marinas, and two public access boat ramps (COP Volume III, Section 7.5.1.1; Epsilon 2023).

For both Martha's Vineyard and Nantucket, the coastal landscapes, small towns, fishing fleets, and numerous historical resources provide a character and setting that attract residents, businesses, seasonal residents, and visitors. Numerous lodging facilities, restaurants, short-term housing rentals, and marine recreational services (i.e., charters, tours, and rentals) support tourism.

Bristol County may be selected for Phase 2 landfall sites, onshore export cable routes, and substation sites (Figure 2.1-7). Bristol County has numerous state and local parks along its coastline, including Horseneck Beach State Reservation, Demarest Lloyd State Park, Frank Knowles/Little River Reserve, West Island State Reservation, Fort Phoenix State Reservation, South Shore Marshes Wildlife Management Area, and Nasketucket Bay State Reservation. The Freetown/Fall River State Forest, Southeastern Massachusetts Bioreserve, and Acushnet Cedar Swamp State Reservation occupy substantial inland land area.

The City of Bridgeport, Connecticut, has 24 miles of waterfront on Long Island Sound that includes two harbors: Black Rock Harbor and Bridgeport Harbor. The waterfront has historically been dominated by industrial uses but also includes residential areas and recreational uses, such as parks, private marinas, yacht clubs, and recreational marine services. The historic Seaside Park, with 2.5 miles of coastline, provides beaches and other recreational space. The city's plans seek to increase public access and recreational use of the waterfront, including new pathways, parkland, and recreational facilities, complemented by mixed-use commercial and residential development (City of Bridgeport 2017, 2019).

3.15.2 Environmental Consequences

Definitions of impact levels for recreation and tourism are described in Table 3.15-1.

Table 3.15-1: Impact Level Definitions for Recreation and Tourism

Impact Level	Impact Type	Definition
Negligible	Adverse	Impacts on the recreation setting, recreation opportunities, or recreation experiences would be so small as to be unmeasurable.
	Beneficial	No impact or measurable impact.
Minor	Adverse	Impacts would not disrupt the normal functions of the affected activities and communities.
	Beneficial	A small and measurable improvement to infrastructure/facilities and community services or benefit for tourism.
Moderate	Adverse	The affected activity or community would have to adjust somewhat to account for disruptions due to the proposed Project.
	Beneficial	A notable and measurable improvement to infrastructure/facilities and community services or benefit for tourism.
Major	Adverse	The affected activity or community would have to adjust to significant disruptions due to large local or notable regional adverse impacts of the proposed Project.
	Beneficial	A large local, or notable regional improvement to infrastructure/facilities and community services or benefit for tourism.

3.15.2.1 Impacts of Alternative A – No Action Alternative on Recreation and Tourism

When analyzing the impacts of Alternative A on recreation and tourism, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for recreation and tourism (Table G.1-12 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for recreation and tourism described in Section 3.15.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on recreation and tourism include other offshore wind projects that would be built to meet the state demand for additional electricity. Therefore, impacts from ongoing, future offshore wind activities, as well as future non-offshore wind activities, would still occur (Table G.1-18). The impacts on recreation and tourism would be similar, but the exact impacts would not be the same due to temporal and geographical differences. Visitors would continue to pursue activities that rely on the area's coastal and ocean environment, scenic qualities, natural resources, and establishments that provide services for recreation and tourism. While the geographic analysis area has a strong tourism industry and abundant coastal and offshore recreational facilities, many of which are associated with scenic views, local jurisdictions face challenges maintaining the recreational resources. The primary concern for the ocean-based resources is protection of water quality. The following analysis addresses planned offshore wind projects that fall within the geographic analysis area and considers the assumptions included in Appendix E.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on recreation and tourism include continued operations of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Ongoing operations of the Block Island Wind Farm and ongoing construction of Vineyard Wind 1 and South Fork Wind Project, along with planned offshore wind activities, would affect recreation and tourism through the primary IPFs described below.

Cumulative Impacts

The cumulative impact analysis for Alternative A considers the impacts of Alternative A in combination with other planned non-offshore wind activities and planned offshore wind activities (other than Alternative B). Future offshore wind activities would affect recreation and tourism through the following primary IPFs. The maximum-case scenario for recreation and tourism differs depending on the specific topic:

- Impacts on recreational fishing and boating (as discussed for the noise and presence of structures IPFs) are based on state demand within the RI/MA Lease Areas being met using the greatest number of foundations and WTGs, resulting in construction and operation of up to 963 WTGs and ESPs (Appendix E).
- Impacts on recreation and tourism due to the impacts of visible offshore wind structures, specifically WTGs, are based on state demand within the RI/MA Lease Areas being met using the smallest number of foundations and WTGs (and, therefore, the tallest WTGs), resulting in construction and operations of up to 903 WTGs visible from locations onshore (Appendix E).

Anchoring and gear utilization: This IPF would potentially impact recreational boating both through the presence of an increased number of anchored vessels within the geographic analysis area and the creation of offshore areas with cable hardcover or scour protection where recreational vessels may experience limitations or difficulty in anchoring.

Increased vessel anchoring during development of future offshore wind would affect recreational boaters. The greatest volume of anchored vessels would occur in offshore work areas during construction. The applicant conservatively estimates that an average of 30 and a maximum of 60 vessels would be present at the SWDA at any given time during construction, including an average of 7 and maximum of 15 vessels used for cable-laying activities along the OECC in any 1 month (COP Volume III, Section 7.8.2.1; Epsilon 2023). Future offshore wind projects may generate similar numbers of active and/or anchored vessels, depending on project size and construction schedule. Anchored construction-related vessels within 12 nautical miles (13.8 miles) of the shore may be within temporary safety zones established in coordination with the USCG for active construction areas (COP Appendix III-I, Section 11.1; Epsilon 2023). Future offshore wind development in the geographic analysis area is anticipated to result in increased survey activity and overlapping construction periods beginning in 2022, with as many as six projects (not including the proposed Project) under construction at one time in 2025, with others in surveying, permitting, or operational stages.

Vessel anchoring would also occur during operations. Following construction of future offshore projects (if approved), the presence of ten operating offshore wind projects in the geographic analysis area would result in a long-term increase in the number of vessels anchored during periodic maintenance and monitoring.

Anchored construction, survey, or service vessels would have localized, temporary impacts on recreational boating. Recreational vessels would be able to navigate around anchored vessels with only brief inconvenience. The temporary turbidity from anchoring would briefly alter the behavior of species important to recreational fishing (Section 3.6, Finfish, Invertebrates, and Essential Fish Habitat) and sightseeing (whales, dolphins, and seals). Inconvenience and navigational complexity for recreational vessels would be localized, variable, and long term with increased frequency of anchored vessels during surveying and construction and reduced frequency of anchored vessels during operations.

Cable emplacement and maintenance: Under Alternative A, future offshore wind export cables from offshore wind projects in the RI/MA Lease Areas could cross 1,488 miles, while inter-array cables could total 2,186 miles (Appendix E). Cable emplacement for other future offshore wind projects would likely occur between 2023 and 2030. Based on the assumptions in Appendix E, offshore export cables, inter-array cables, and inter-link cables for the offshore wind projects in the RI/MA Lease Areas could affect up to 11,032 acres.

Offshore cable emplacement for future offshore wind development projects would have temporary, localized, impacts on recreational boating while cables are being installed. Vessels would need to navigate around work areas, and recreational boaters would likely prefer to avoid the noise and disruption caused by installation. Cable installation could also have temporary impacts on fish and invertebrates of interest for recreational fishing, due to the required dredging, turbulence, and disturbance; however, species would recover upon completion (Section 3.6). Active work and restricted areas would only occur over the cable segment being emplaced at a given time. Once onshore cables are installed, periodic maintenance could also generate temporary work areas, noise, and disruption. Cables from other offshore wind projects would result in an increased number of maintenance needs.

Impacts of cable emplacement on recreational boating and tourism would be short term in a given area, but continuous, and localized. Impacts of cable maintenance would be short term, infrequent, and localized. Cable removal during decommissioning would have impacts similar to cable installation: localized and temporary.

Lighting: Construction of future offshore wind projects could result in additional vessel lighting within multiple work areas in the RI/MA Lease Areas, with as many as seven offshore wind energy projects under construction at one time between 2023 and 2030 (Appendix E), but little of this lighting would be visible from coastlines. Construction-related nighttime vessel lighting would be used if future offshore wind development projects include nighttime, dusk, or early morning construction or material transport. In a maximum-case scenario, lights could be active throughout nighttime hours for up to six future offshore wind projects (other than the proposed Project) within the geographic analysis area simultaneously under active construction. Vessel lighting would enable recreational boaters to safely avoid nighttime construction areas. The impact on recreational boaters would be localized, sporadic, short term, and minimized by the limited offshore recreational activities that occur at night.

Aviation warning lighting required on the WTGs would be visible from south-facing beaches and coastlines within the geographic analysis area and could have impacts on recreation and tourism in certain locations if the lighting influences visitor decisions in selecting coastal locations to visit. At night, required aviation lighting on the WTGs would consist of red lights on the nacelle flashing 30 times per minute and mid-tower red lights flashing at the same frequency. Warning lighting from up to 903 WTGs could theoretically be visible within the geographic analysis area, depending on viewer location, intervening vegetation, and topography and atmospheric conditions.

A University of Delaware study evaluating the impacts of visible offshore WTGs on beach use found that WTGs visible more than 15 miles from the viewer would have negligible impacts on businesses dependent on recreation and tourism activity (Parsons and Firestone 2018). The study participants viewed visual simulations of WTGs in clear, hazy, and nighttime conditions (without ADLS). A 2017 visual preference study conducted by North Carolina State University evaluated the impact of offshore wind facilities on vacation rental prices. The study found that nighttime views of aviation hazard lighting (without ADLS) for WTGs close to shore (5 to 8 miles) would adversely impact the rental price of properties with ocean views (Lutzeyer et al. 2017). It did not specifically address the relationship between lighting, nighttime views, and tourism for WTGs 15 or more miles from shore. More than 95 percent of the WTG positions envisioned in the geographic analysis area would be more than 15 miles from coastal locations with views of the WTGs.

In addition to recreational fishing, marine wildlife-viewing is an important recreational activity. A 2013 BOEM study evaluated the impacts of WTG lighting on birds, bats, marine mammals, sea turtles, and fish. The study found that existing guidelines “appear to provide for the marking and lighting of [WTGs] that will pose minimal if any impacts on birds, bats, marine mammals, sea turtles or fish” (Orr et al. 2013). By extension, WTG lighting subject to existing lighting guidelines or ADLS would not affect recreational fishing or wildlife viewing.

As a result, although lighting on WTGs would have a continuous, long-term impact on recreation and tourism, the impact in the geographic analysis area is likely to be limited to individual decisions by visitors to south-facing coastal and elevated areas, with less impact on the recreation and tourism industry as a whole.

The applicant proposes the use of ADLS for the proposed Project (COP Volume III, Section 2.2.1 and 2.3.1; Epsilon 2023). ADLS would only activate WTG lighting when aircraft enter a predefined airspace. For the proposed Project, this was estimated to occur 235 times during the year, for a total of 9 to 13 minutes annually (less than 0.1 percent of annual nighttime hours) (COP Appendix III-K; Epsilon

2023). When implemented for other wind energy projects in the RI/MA Lease Areas, depending on exact location and layout, ADLS would likely result in similar limits on the frequency of WTG aviation warning lighting use for future offshore wind projects. This would significantly reduce the already minimal impacts on recreation and tourism associated with lighting on WTGs.

Noise: Noise from future wind development construction, pile driving, G&G survey activities, trenching, operations, and vessels could result in impacts on recreation and tourism.

Onshore construction noise from cable installation at the landfall sites (near public beaches) and inland (if cable routes are near parkland, recreation areas, or other areas of public interest) would temporarily disturb the quiet enjoyment of the site, especially in locations where such quiet is an expected or typical condition. Similarly, offshore noise from G&G survey activities, pile driving, trenching, and construction-related vessels would intrude upon the natural sounds of the marine environment and cause boaters to avoid areas of noise-generating activity. For construction within 12 nautical miles (13.8 miles) of the coast, the USCG would establish safety zones that would be off-limits to boaters and encompass the areas of the most intense noise from OECC installation.

Noise modeling for the Block Island Wind Farm (an existing, five-turbine facility located about 50 miles west of the proposed Project) predicted that pile driving, the noisiest aspect of WTG installation, would generate noise estimated at 60 A-weighted decibels (dBA) experienced by boaters at a distance of 1 nautical mile (1.15 miles) from the construction zone (Tetra Tech 2012), comparable in volume to the noise level of a normal conversation (OSHA 2011; CDC 2019). Pile-driving noise would be produced intermittently during construction of each project for several hours per foundation for the installation of no more than two foundations per day (COP Volume I, Section 3.3.1.4; Epsilon 2023). One or more projects may install up to two foundations per day, either sequentially or simultaneously from 2023 to 2030 (Table E-1), and pile driving would likely occur during the same months that recreational boating is most popular (May through October). Lower levels of construction-related noise from other construction activities and along the OECC would result in lower levels of noise that recreational boaters are also likely to avoid.

For operations, measurement of sound generation from wind energy systems in Europe that are similar to 8 to 10 MW turbine systems indicated that sound levels in the 100 to 120 dBA range may be experienced at the source (directly at the operating turbine) but attenuate rapidly to a level of less than 50 dBA at a distance of 0.5 nautical mile (0.57 mile) from the source (CHC 2018). Similarly, Block Island Wind Farm modeling predicted noise levels at the turbine exceeding 50 dBA but typically falling to less than 50 dBA at 0.5 nautical mile (0.57 mile) and less than 40 dBA at 1 nautical mile (1.15 miles) (Tetra Tech 2012). Maintenance operations could temporarily produce localized vessel and equipment noise.

Accordingly, the impact of noise on recreation and tourism during construction would be intense and disruptive but short term and localized. Multiple projects under construction at the same time would increase the number of locations within the geographic analysis area that experience noise disruptions. The impact of noise during operations would be localized, continuous, and long term, with brief, more intensive noise during occasional repair activities.

Species important to recreational fishing and sightseeing within the RI/MA Lease Areas and along OECC routes may be affected, as discussed in Section 3.6; Section 3.7, Marine Mammals; and Section G.2.4, Birds. G&G survey noise and pile driving would cause the most impactful noises. Recreational fishing for HMS such as tuna, shark, and marlin are more likely to be affected, as these fisheries are farther offshore than most fisheries and, therefore, more likely to experience temporary impacts resulting from the noise generated by future offshore wind construction. Construction noise could contribute to temporary impacts on marine mammals, with resulting impacts on marine sightseeing that relies on the presence of mammals, primarily whales. However, as noted in Section 3.7, BMPs can minimize exposure of individual mammals to harmful impacts and avoid measurable, population-level impacts.

Noise from operational WTGs would have little impact on finfish, invertebrates, and marine mammals and would, therefore, have little impact on recreational fishing or sightseeing.

Based on the discussion above, future offshore wind construction would result in short-term and localized impacts on recreational fishing and marine sightseeing, due to offshore construction-related noise, as well as temporary impacts on fish and marine mammal populations. Multiple construction projects would increase the spatial and temporal extent of temporary disturbance to marine species within the geographic analysis area. BOEM's assumed construction schedule for future offshore wind projects (Appendix E) indicates the possibility of up to six wind projects (excluding the proposed Project) simultaneously under development in the RI/MA Lease Areas and up to 963 WTGs and ESPs installed from 2023 to 2030 in the RI/MA Lease Areas.

No long-term impacts are anticipated from noise, provided that mitigation and monitoring measures included in the ROD for other activities (including offshore wind) are implemented to prevent population-level harm to fish and marine mammal populations.

Port utilization: The geographic analysis area for recreation and tourism incorporates existing or potential ports at Bridgeport, New Bedford, Brayton Point, Fall River, and Vineyard Haven Harbor, which are anticipated to be used to support future offshore wind construction and operations. Additional ports outside the geographic analysis area for recreation and tourism may be used for staging and construction. Some of these ports also provide facilities for recreational vessels, and most of the ports are on waterways or within harbors shared with recreational docks and marinas. Recreational and industrial marine traffic would continue to share waterways during offshore wind development. Port improvements requiring construction or dredging could result in short-term displacement and disruption to recreational vessels but could also provide long-term benefits to recreational boating if the improvements result in increased berths and amenities for recreational vessels, improved navigational channels, or opportunities to separate recreational boating from commercial shipping.

Presence of structures: The placement of up to 963 WTGs and ESPs within the RI/MA Lease Areas would be the maximum-case scenario for recreational fishing and boating. Future offshore wind structures would be added intermittently in the RI/MA Lease Areas from 2023 to 2030, and these structures would remain until decommissioning of each facility is complete (up to 33 years from installation). The geographic extent of impacts from planned offshore wind development would increase as additional offshore wind projects are constructed. The offshore structures would have long-term impacts on recreational boating and fishing through the risk of allision; risk of gear entanglement, damage, or loss; navigation hazards; space use conflicts; presence of cable infrastructure; and visual impacts. The future offshore wind structures could have beneficial impacts on recreation through fish aggregation and reef effects.

The presence of future offshore wind structures would increase the risk of allision or collision with other vessels and the complexity of navigation within the RI/MA Lease Areas. Generally, the vessels more likely to allide with WTGs or ESPs would be smaller vessels moving within and near wind installations, such as recreational vessels. Navigational risks are described in more detail in Section 3.13, Navigation and Vessel Traffic.

Future offshore wind development could require adjustment of routes for recreational boaters, anglers, sailboat races, and sightseeing boats, but the impact of the future offshore wind structures on recreational boating would be limited by the distance offshore. The closest WTG—a WTG position within Lease Area OCS-A 0486, as viewed from Squibnocket Beach South (Appendix I, Seascape and Landscape Visual

Impact Assessment)—could be about 10.6 miles from shore. The 2012 survey of recreational boaters along the northeastern United States coast, discussed in Section 3.15.1, found that more than half (52 percent) of recreational boating occurred within 1.2 miles of the coastline (Starbuck and Lipsky 2013). The 2020 USCG data found that only 11 percent of recreational vessels traveled more than 3 miles off the coastline in 2018 (RTI International 2020). Most recreational vessels would continue to navigate within 3 miles of shore and would not interact with offshore WTGs or ESPs. The owners of relatively large recreational vessels surveyed by Dalton et al. (2020) confirm the general preference for boating closer to the coast than the RI/MA Lease Areas.

Recreational boating farther from shore would be affected by the presence of future offshore wind structures. Examples include recreational fishing (especially HMS fishing), sightseeing boats, and large sailing vessels, including sailboat races. As noted in Section 3.15.1, data from 2002 through 2018 indicates that recreational HMS fishing activity occurs within the RI/MA Lease Areas, although the greatest volume of HMS fishing activity in southern New England is west of the RI/MA Lease Areas. HMS fishing within the proposed Project lease area and the adjacent Vineyard Wind 1 lease area accounted for up to 5 percent of HMS trips in southern New England and up to 28 percent of HMS trips in the RI/MA Lease Areas (Kneebone and Capizzano 2020). Commonly used mobile methods for HMS angling such as trolling and drifting may be incompatible with the presence of WTGs and ESPs, depending on weather conditions and specific techniques. For example, trolling may involve trailing many feet of lines and hooks behind the vessel and then following large pelagic fish once they are hooked; this could result in navigational and maneuverability challenges around WTGs. These concerns notwithstanding, habitat conversion resulting from the presence of WTG and ESP structures would also benefit recreational fishing (Section 3.9).

Several long-distance sailboat races may pass through the geographic analysis area, depending on the route selected for a particular year, including the Transatlantic Race, Marion to Bermuda Race, and Newport Bermuda Race (COP Volume III, Section 7.5.1.2; Epsilon 2023). Larger sightseeing boats travel to offshore locations where whale sightings are more likely. These recreational vessels would need to navigate around future offshore wind projects or navigate through them while avoiding allisions. In addition, sailing vessels with masts taller than the lowest elevation of WTG blade tips would need to avoid WTGs and would likely choose to avoid future offshore wind projects altogether.

The RI/MA Lease Areas would have an estimated 963 foundations with 2,964 acres of scour protection, along with 23,700 acres of hard protection for offshore export, inter-array, and inter-link cables (some of which may be outside of the geographic analysis area for recreation and tourism), which results in an increased risk of recreational fishing gear loss or damage by entanglement. The cable protection would also present a hazard for anchoring, as anchors could have difficulty holding or become snagged and lost. Accurate marine charts could make operators of recreational vessels aware of the locations of the cable protection and scour protection. If the hazards are not noted on charts, operators may lose anchors, leading to increased risks associated with drifting vessels that are not securely anchored. Buried offshore cables would not pose a risk for most recreational vessels, as anchors from smaller vessels would not penetrate to the target burial depth (6 to 8 feet) for the cables. Because anchoring is uncommon in water depths where WTGs would be installed, anchoring risk is more likely to affect export cables in shallower water closer to coastlines. The risk to recreational boating would be localized, continuous, and long term.

Future offshore wind structures could provide new opportunities for offshore tourism by attracting recreational fishing and sightseeing. The wind structures could produce artificial reef effects, attracting species of interest for recreational fishing and resulting in an increase in recreational boaters traveling farther from shore to fish within the RI/MA Lease Areas. The structures may also create foraging opportunities for seals, small odontocetes, and sea turtles, attracting recreational boaters and sightseeing vessels. In addition, the future offshore wind projects could attract sightseeing boats for tours. Although the likelihood of recreational vessels visiting the offshore WTG foundations would diminish with distance from shore, increasing numbers of offshore structures may encourage a greater volume of recreational vessels to travel to the RI/MA Lease Areas. Additional fishing and tourism activity generated by the presence of structures could also increase the likelihood of allisions and collisions involving recreational fishing or sightseeing vessels (Section 3.13).

A 2020 study examined reactions of recreational boaters to potential offshore wind development in the RI/MA Lease Areas. The study was based on a survey of 2,500 recreational boaters using ports in Rhode Island, evenly split between sailing and motor vessels (including vessels greater than 5 net tons or at least 26 feet in length) (Dalton et al. 2020). Survey respondents tended to prefer boating closer to the coast, south of Newport and near Block Island, as opposed to near the RI/MA Lease Areas. The survey found that boating within 100 feet of an offshore wind facility would detract considerably from a boater's experience. However, boaters who fished expressed less negative impact from boating near a turbine than those who do not fish, and recreational fishing boaters expected to catch more target species. The study concluded that a wind energy facility in the RI/MA Lease Areas would be unlikely to have significant impacts on recreational boaters because many boaters prefer to use waters closer to the coast, most recreational boaters from Rhode Island ports who choose to visit the RI/MA Lease Areas would likely keep their distance from new structures, and increased abundance of targeted fish species near offshore wind facilities would have beneficial impacts on recreational fishing (Dalton et al. 2020).

The visual impacts of WTGs may also affect recreation and tourism (Section 3.16). Sightseeing excursions to observe the WTGs would benefit the recreation/tourism experience. However, if experiencing a vast pristine ocean condition is the purpose of the viewer's sightseeing excursion, then the visual dominance of WTGs and ESPs may detract from the viewer's recreation/tourism experience.

Studies and surveys evaluating the impacts of offshore wind facilities on tourism have found that established offshore wind facilities in Europe did not decrease tourist numbers, experience, or revenue (Smythe et al. 2018). A survey-based study, detailed as follows, found that for prospective offshore wind facilities (based on visual simulations), proximity of WTGs to shore correlated with the share of respondents who would expect a worsened experience visiting the coast (Parsons and Firestone 2018):

- At a distance of 15 miles, the percentage of respondents who reported that their beach experience would be worsened by the visibility of WTGs was about the same as the percentage of those who reported that their experience would be improved (e.g., by knowledge of the benefits of offshore wind);
- About 68 percent of respondents indicated that the visibility of WTGs would neither improve nor worsen their experience;
- Reported trip loss (respondents who stated that they would visit a different beach without offshore wind) averaged 8 percent when wind projects were 12.5 miles offshore, 6 percent when 15 miles offshore, and 5 percent when 20 miles offshore; and
- About 2.6 percent of respondents were more likely to visit a beach with visible offshore wind facilities at any distance.

A 2019 survey of 553 coastal recreation users in New Hampshire included participants in water-based recreation activities such as fishing from shore and boats, motorized and non-motorized boating, beach activities, and surfing at the New Hampshire seacoast (Ferguson et al. 2020). Most (77 percent) supported offshore wind development along the New Hampshire coast, while 12 percent opposed it and 11 percent were neutral. Regarding the impact on their outdoor recreation experience, 43 percent anticipated that offshore wind development would have a beneficial impact, 31 percent that it would have a neutral impact, and 26 percent anticipated that offshore wind development would have an adverse impact.

The southern shores of Martha's Vineyard and Nantucket located within the viewshed of the WTGs are sparsely developed; however, public beaches and tourism attractions in these areas are highly valued for scenic, historic, and recreational qualities and draw large numbers of daytime visitors during the summertime tourism seasons. When visible, WTGs would add a contrasting visual element to ocean views that are currently characterized by open ocean (Section 3.16). Based on the available studies, portions of 949 WTGs associated with Alternative A could be visible from shorelines (depending on vegetation, topography, atmospheric conditions, and the viewers' visual acuity), of which up to 50 (fewer than 5 percent) would be within 15 miles of shore (Appendix E). Based on the research cited above on the relationship between visual impacts and recreational experience impacts, the impact of visible WTGs on recreation and tourism would be long term and continuous for a limited number of locations. Seaside locations on the southern coast of Nantucket and Martha's Vineyard could experience some reduced recreational and tourism activity, but the visible presence of WTGs would be unlikely to affect shore-based or marine recreation and tourism in the geographic analysis area as a whole.

Traffic: Future offshore wind project construction and decommissioning and, to a lesser extent, future offshore wind project operations would generate increased vessel traffic that could inconvenience recreational vessel traffic within the geographic analysis area. The impacts would occur primarily during construction, along routes between ports and the future offshore wind construction areas.

Vessel traffic for each project is unknown; however, as an example, the proposed Project is projected to generate an average of 6 or 7 daily vessel trips between ports and offshore work areas over the entire construction stage and up to 15 vessel trips daily during peak construction activity (COP Volume III, Section 7.8.2.1.1; Epsilon 2023). As shown in Appendix E, as many as six offshore wind projects (not including the proposed Project) could be under construction simultaneously in 2025. During such periods, construction of offshore wind projects would generate an average of 48 to 56 vessel trips daily from Atlantic coast ports to worksites within the geographic analysis area.

Up to ten future offshore wind projects could be constructed in the RI/MA Lease Areas between 2023 and 2030 (Appendix E). Operations for the proposed Project are anticipated to generate an average of one to two vessel round trips per day (two to four one-way trips) between a port and the SWDA for observation, with additional vessel trips occurring as needed for repair and maintenance activities. Based on the estimates for the proposed Project, Alternative A would generate an average of 10 to 20 vessel trips per day during operations.

Increased vessel traffic would require increased alertness on the part of recreational or tourist-related vessels and could result in minor delays or route adjustments. The likelihood of vessel collisions would increase as a result of the higher volumes of vessel traffic during construction. The possibility of delays and risk of collisions would increase if more than one future offshore wind facility is under construction at the same time. Vessel traffic associated with future offshore wind would have long-term and variable impacts on vessel traffic related to recreation and tourism. Higher volumes during construction would result in greater inconvenience, disruption of the natural marine environment, and risk of collision. Vessel traffic during operations would represent only a modest increase in the background volumes of vessel traffic, with minimal impacts on recreational vessels.

Conclusions

Impacts of Alternative A. Under Alternative A, existing conditions for recreation and tourism would continue to follow current regional trends and respond to ongoing non-offshore wind and offshore wind activities. Other offshore wind projects that could affect the same geographic analysis area for recreation and tourism would be built to meet the state demand for additional electricity that the proposed Project would have provided. While the proposed Project would not be built under Alternative A, ongoing activities would have continuing impacts on recreation and tourism, the overall impacts of Alternative A combined with ongoing activities would result in **moderate** impacts and **minor** beneficial impacts.

Cumulative Impacts of Alternative A. Future offshore wind activities are expected to contribute considerably to several IPFs, the most prominent being noise and traffic during construction and the presence of offshore structures during operations. Noise and traffic would have impacts on visitors who may avoid onshore and offshore noise sources and vessels and impacts on recreational fishing and sightseeing as a result of the impacts on fish, invertebrates, and marine mammals. The long-term presence of offshore wind structures would result in increased navigational constraints and risks, potential gear entanglement and loss, and visual impacts from offshore structures. The cumulative impacts of Alternative A would be **moderate**, along with **minor** beneficial impacts due to the presence of offshore structures and cable hard cover, which could provide opportunities for fishing and sightseeing.

3.15.2.2 Relevant Design Parameters and Potential Variances in Impacts

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on recreation and tourism:

- The exact number of WTGs and ESPs and height of WTGs. A larger number of WTGs would result in the greatest impact on recreational vessel navigation. Taller WTGs would have greater impacts on scenic and visual resources (Section 3.16), increasing the impact on visual components of recreation and tourism.
  - Phase 1 and Phase 2 would include up to 132 foundations (including 10 positions reassigned from Vineyard Wind 1, as described in Section 2.1.2). This would up to 62 WTGs for Phase 1 and up to 88 WTGs for Phase 2.
  - WTGs for Phase 1 and Phase 2 would have a maximum nacelle-top height of 725 feet MLLW and a maximum blade tip height of 1,171 feet MLLW (Appendix C).
- The time of year during which onshore and near shore construction occurs. Tourism and recreational activities in the SWDA tend to be higher from May through September, and especially from June through August.
- The location of Phase 2 landfall sites, onshore export cable routes, and substations in relation to recreational resources.

3.15.2.3 Impacts of Alternative B – Proposed Action on Recreation and Tourism

This section identifies potential impacts of Alternative B on recreation and tourism. When analyzing the impacts of Alternative B on recreation and tourism, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for recreation and tourism.

Impacts of Phase 1

Phase 1 would affect recreation and tourism through the following primary IPFs during construction, operations, and decommissioning.

Anchoring and gear utilization: Anchoring by vessels during Phase 1 would contribute to disturbance of marine species and inconvenience to recreational vessels that must navigate around the anchored vessels. Phase 1 would deploy 7 to 15 vessels monthly along sections of the OECC during cable installation activities, although these vessels may not all be deployed at the same time (COP Volume III, Section 7.8.2.1.1; Epsilon 2023). During the construction stage, an average of 30 vessels (up to 60 vessels during the period of maximum activity) would be present in the SWDA or OECC at any one time. Some anchored vessels within 12 nautical miles (13.8 miles) of the coast could be within a temporary safety zone established by the USCG (COP Appendix III-I, Section 11.1; Epsilon 2023). Vessel anchoring for Phase 1 construction would have localized, short-term, and minor impacts on recreation and tourism due to the need to navigate around vessels and work areas and the disturbance of species important to recreational fishing (Section 3.6).

An average of 5 and up to 15 vessels are anticipated to be operating within the SWDA daily for Phase 1 (COP Volume III, Section 7.8.2.2.1; Epsilon 2023). More vessels may be needed for certain maintenance or repair scenarios. The Phase 1 operational vessel anchoring within the SWDA would have localized, long-term, and negligible impacts on recreation and tourism. Anchoring of Phase 1 vessels during decommissioning would have the same impacts as the anchoring needed for Phase 1 construction: localized, short-term, and minor impacts on recreation and tourism from Phase 1.

Cable emplacement and maintenance: Installation of offshore cables would temporarily restrict access to the OECC route. An average of 7 cable-laying, support, and crew vessels and a maximum of 15 vessels may be deployed along sections of the OECC during construction activities (COP Volume III, Section 7.8.2.1.1; Epsilon 2023). Vessels are likely to remain at the same location for several days. Recreational vessels traveling near the route of the OECC would need to navigate around vessels and access-restricted areas associated with OECC installation. In addition, the OCEC route crosses the routes for commercial ferry services operating out of Hyannis, Martha’s Vineyard, and Nantucket, important to tourism and area residents. As noted in Section 3.13, numerous means would be used to communicate with mariners regarding construction-related marine activities. The localized, temporary need for changes in recreational and tourism-related navigation routes due to Phase 1 cable emplacement and maintenance would constitute a minor impact.

Cable installation along the OECC and within the SWDA could also affect fish and mammals of interest for recreational fishing and sightseeing through dredging and turbulence, although species would recover upon completion (Sections 3.6 and 3.7), resulting in localized, short-term, and minor impacts on recreation and tourism.

Onshore construction would affect recreation and tourism at the landfall site. The Phase 1 landfall site at Covell’s Beach or Craigville Beach would experience disturbance during installation of the cable onshore/offshore transition vaults, as well as HDD or trenching in preparation for joining the onshore and offshore cables. Construction would prevent the use of part of the beach parking lot and discourage beach visitation due to noise and activity. These impacts would be unavoidable during construction but temporary. The applicant would not perform activities at the landfall site during the months of June through September, unless authorized by the host town. Onshore construction would have temporary, localized, and moderate impacts on recreation and tourism at the landfall site.

The onshore export cable route would be within the ROW of Shootflying Hill Road, where the road provides access to the Town of Barnstable’s beach and boat ramp for Wequaquet Lake. The noise and pavement disturbance during cable installation would result in temporary noise and disturbance for the recreation facilities, with short-term and negligible impacts on the recreational resource.

During operations, offshore cable maintenance would require infrequent vessel traffic and trenching. Recreational vessels traveling near the route of the OECC would need to navigate around vessels and access restricted areas associated with OECC maintenance. Onshore facilities would be monitored and controlled remotely; if monitors determine that repair work is necessary, the repairs would typically involve accessing the cables through manholes at the beach parking lot used for the landfall site and along the OECR, without affecting surrounding land uses. The operations at the manholes would result in limited disturbance to beach enjoyment and parking (COP Volume III, Section 7.5.2.2.1; Epsilon 2023).

The localized, temporary disturbance to marine recreation and beach use due to cable emplacement and maintenance would have short-term, infrequent, and minor impacts on recreation and tourism.

Cable removal during decommissioning would have impacts similar to cable installation: localized, temporary, and minor impacts on recreation and tourism from Phase 1.

Lighting: When nighttime construction occurs, the vessel lighting for vessels traveling to and working at Phase 1 offshore construction areas may be visible from onshore locations depending on the distance from shore, vessel height, and atmospheric conditions. Visibility would be sporadic and variable. Although most construction would occur during daylight hours, construction vessels would use work lights to improve visibility during nighttime or poor visibility, in accordance with USCG requirements. Work lights are generally directed downward and would not typically be visible from shore (COP Appendix III-H.a; Epsilon 2023). Due to the limited duration, frequency, and intensity of such lighting as viewed from coastlines, visible construction-related vessel lighting for Phase 1would result in a short-term, intermittent, and negligible impact on recreation and tourism.

During operations, Phase 1 would generate nighttime lighting due to required aviation hazard lighting on WTGs. Hazard lighting from Phase 1 WTGs could be visible from south-facing coastlines and elevated locations on Martha's Vineyard, Nantucket, and neighboring islands, depending on vegetation, topography, and atmospheric conditions (COP Appendix III-H.a, Section 5.2.1; Epsilon 2023). The applicant has committed to implement ADLS that would activate the WTG lighting only when aircraft approach Vineyard Wind 1 WTGs, which is expected to occur less than 0.1 percent of annual nighttime hours. Due to the limited duration and frequency of such events and the distance of the Phase 1 WTGs from shore, visible aviation hazard lighting for Phase 1 would result in long-term, intermittent, and negligible impacts on recreation and tourism.

Noise: Noise from vessels and offshore construction activities, especially pile driving and trenching, would result in impacts on recreation and tourism. Temporary impacts on recreation and tourism would occur within the SWDA and along the OECC route on species important to recreational fishing and sightseeing. The noise-related temporary disruptions to or changes in offshore fish, shellfish, and marine mammal populations discussed in Sections 3.6 and 3.7 would have a moderate impact on recreational fishing, shellfishing, or wildlife-watching activities within the SWDA, although whale-watching tours in particular typically travel north of Cape Cod, away from the SWDA.

In addition to the temporary disruption to fish, shellfish, and marine wildlife populations, noise from offshore construction and onshore cable installation near the landfall area would have impacts on the recreational enjoyment of the marine and coastal environments, with minor impacts on recreation and tourism. Covell's Beach or Craigville Beach and nearby areas would experience noise during construction. Offshore construction noise would occur from vessels, trenching, and pile driving along the OECC and within the SWDA. Pile driving, the noisiest aspect of WTG installation, was projected to generate noise estimated at 60 dBA at a distance of 1 nautical mile (1.15 miles) from the construction zone (Tetra Tech 2012), comparable to the noise level of a normal conversation (OSHA 2011; CDC 2019). Pile driving would occur for approximately 2 to 3 hours per foundation or 4 to 6 hours per day for the installation of two foundations per day. In areas within or near the OECC and SWDA that are available for recreational boating during construction, increased noise from construction would discourage recreational boating. Overall, construction noise from Phase 1 would have localized, short-term, and minor to moderate impacts on recreation and tourism.

Onshore substation noise would not affect recreational resources. Offshore operational noise from Phase 1 WTGs would be similar to the noise described for offshore wind projects under Alternative A. Accordingly, operational noise from Phase 1 would have a continuous, long-term, and negligible impact on recreation and tourism. During decommissioning, noise-related impacts from offshore worksites would be similar to construction (except for the absence of pile driving), with localized, short-term, and minor impacts on recreation and tourism from Phase 1.

Port utilization: Several ports within the geographic analysis area for recreation and tourism would be shared by recreational vessel traffic and Phase 1 staging and construction support, including Bridgeport, Vineyard Haven Harbor, and Port of New Bedford. Proposed Project construction is projected to use New Bedford Harbor extensively, with an average of 7 and a peak of 15 vessel round trips daily between New Bedford and offshore construction worksites. Use of Vineyard Haven is uncertain, with an average of six round trips daily anticipated from several ports, including Vineyard Haven, Bridgeport, Davisville, and South Quay Terminal (COP Volume III, Section 7.8.2.1; Epsilon 2023). Recreational vessel operators are accustomed to existing, high levels of commercial and industrial traffic at the Port of New Bedford (Section 3.13). The added vessel traffic would not significantly affect recreational vessel movements or availability of docking facilities. Construction of Phase 1 would have a short-term and negligible to minor impact on recreation and tourism due to port utilization within the geographic analysis area.

The applicant anticipates using Bridgeport Harbor as the operations base and Vineyard Haven Harbor for crew transfer and support vessels during Phase 1 operations (COP Volume III, Section 7.8.2.1; Epsilon 2023). On average, no more than one vessel round trip daily is anticipated, from either of these ports or possibly from other ports for a specific maintenance need. The operational vessel traffic would not significantly affect recreational vessel movements or availability of docking facilities at Vineyard Haven. Accordingly, Phase 1 operations would have long-term, continuous, and negligible impacts on recreation and tourism due to port utilization within the geographic analysis area.

Decommissioning may result in short-term, increased use of port facilities that also serve recreational vessel traffic, with short-term and negligible to minor impacts on recreation and tourism from Phase 1.

Presence of structures: The Phase 1 onshore substation and potential expansion of the West Barnstable Substation would have no impacts on recreational or tourism resources, as these facilities are not adjacent to and unlikely to be visible from recreational lands or facilities. Other onshore facilities (cables and landfall vaults) would be underground, with no impact on aboveground uses except when maintenance or repairs are needed, as addressed in the cable emplacement and maintenance IPF above.

Phase 1 could include up to 64 structures (including up to 62 WTGs and 1 or 2 ESPs). Recreational vessels within the SWDA would need to navigate around and between the foundations of the WTGs and ESPs. The offshore structures would impact recreation and tourism through increased navigational complexity; risk of allision or collision; attraction of recreational vessels to offshore wind structures for fishing and sightseeing; the adjustment of vessel routes used for sailboat races, sightseeing, and recreational fishing; the risk of fishing gear loss or damage by entanglement due to scour or cable protection; and potential difficulties in anchoring over scour or cable protection.

AIS transmissions found that 397 recreational vessel tracks were recorded within the SWDA during the 4-year period from 2016 through 2019, representing approximately 20 percent of all AIS vessel tracks within the SWDA during this time period. The vessels ranged in size from 15 to 300 feet, with most in the 45- to 60-foot range (COP Appendix III-I, Section 6.5; Epsilon 2023). The AIS transmissions do not include smaller vessels not required to carry an AIS transmitter. As discussed in Section 3.15.1, recreational boaters in the northeast region generally report fishing as their most common activity, followed by wildlife viewing and relaxing. Private and for-hire HMS fishing trips are especially likely to travel as far offshore as the SWDA. Long-distance sailing races are also known to use the area.

Recreational vessels are expected to continue to transit through the SWDA if Phase 1 is built, and continued recreational fishing is anticipated in the area (COP Appendix III-I, Section 9.2; Epsilon 2023). Some recreational anglers may avoid the SWDA due to concerns about their ability to safely fish within or navigate through the area. The navigational risks resulting from the offshore wind structures are described in greater detail in Section 3.13. For recreational anglers harvesting HMS such as tuna, sharks, and billfish, the spacing of the WTGs could affect access to fishing locations. The fishing methods used, and the size, strength, and swimming speed of these larger species requires significantly more space for fishing, compared to other species; as a result, the proposed separation between WTGs may be insufficient for this type of fishing. Anglers who fish within the SWDA would need to change their methods (i.e., they would not be able to allow their boats to drift and would need to correct course to avoid WTGs).

Although some recreational anglers would avoid the SWDA, scour protection around the foundations would likely attract forage fish, as well as game fish, which could provide new opportunities for certain recreational anglers. Evidence from Block Island Wind Farm indicates an increase in recreational fishing near the WTGs (Smythe et al. 2018). The fish aggregation and reef effects of Phase 1 could also create foraging opportunities for seals, small odontocetes, and sea turtles, attracting recreational boaters and sightseeing vessels. The magnitude of benefits on recreational fishing and sightseeing from the proposed Project's foundations would be reduced due to the distance from shore (Starbuck and Lipsky 2013).

For-hire fishing operations are part of the recreation and tourism industry and are included in the impacts on recreational boating and fishing anticipated in this section. The detailed discussion of impacts on for-hire fishing activities provided in Section 3.9 may also be applicable to impacts on recreational fishing in general. The impacts on recreational fishing, boating, and sailing in general would be minor, while the impacts on for-hire fishing would be moderate because these enterprises are more likely to be materially affected by displacement, competition for resources, and longer transit times in a manner similar to commercial fishing businesses. Overall, based on the impacts of the WTGs and ESPs on navigation and fishing (especially HMS fishing), the potential reef effects of these structures, and the risks to anchoring and gear loss associated with scour or cable protection, Phase 1 would have long-term, continuous, and minor impacts, both adverse and beneficial, on recreation and tourism.

The Phase 1 WTGs would also affect recreation and tourism through visual impacts. Based on the maximum nacelle-top height of 725 feet MLLW, the nacelle-top lights could be visible up to 37.5 miles away (COP Appendix III-H.a, Section 1.2; Epsilon 2023). Blade tips could be visible at greater distances; this Final EIS evaluates visual impact up to 46 miles from the WTGs (Section 3.16). Visual impacts of offshore WTGs would be limited to the southern shorelines on Martha's Vineyard, Nantucket Island, and nearby islands. Mainland Cape Cod is either behind Martha's Vineyard or beyond the theoretical area of nacelle visibility. The WTGs would be at least 21 miles from the nearest land on Martha's Vineyard and at least 25 miles from the nearest land on Nantucket. Views of the top of the nacelle are theoretically possible from the western Elizabeth Islands, about 31 miles from the nearest Phase 1 WTG (COP Appendix III-H.a, Section 1.2; Epsilon 2023). Based on typical atmospheric conditions, WTGs would be visible from Gay Head Lighthouse for approximately 36 percent of annual daylight hours, and from the Nantucket Historic District approximately 27 percent of annual daylight hours (COP Appendix III-H.a, Table 7; Epsilon 2023).

Recreational facilities in the geographic analysis area with potential views of WTGs include seven beaches along Martha's Vineyard's south coast (public or town residents only), four beaches on Nantucket's south coast, the Gay Head Lighthouse, resorts, walking and biking paths, and natural areas (COP Appendix III-H.a, Section 4.0; Epsilon 2023). Private residences with ocean views to the south may be used as vacation homes. Views of the WTGs could have a beneficial, adverse, or neutral impact on the quality of the recreation and tourism experience depending on the viewer's orientation, activity, and purpose for visiting the area. Some of the limited available research on the link between views of offshore wind structures and resultant impacts on recreation and tourism is summarized in Section 3.15.3. All coastal public viewpoints would be more than 20 miles from the closest Phase 1 WTGs. Moreover, the closest Phase 1 WTGs would be farther away than and only visible behind the WTGs of other offshore wind projects and would, thus, be less distinct. Research described in Section 3.15.2.1 suggests that at a distance of at least 15 miles, only 6 percent of beach visitors would select a different beach based on the presence of future offshore wind turbines.

The impact of visible WTGs on the use and enjoyment of recreation and tourism resources during operations would be long term, continuous, and negligible. While some visitors to south-facing coastal or elevated locations may alter their behavior, this changed behavior is unlikely to meaningfully affect the recreation and tourism industry as a whole. Coastlines and inland areas with no views of WTGs would not experience visual impacts, and beaches with views of Phase 1 WTGs could also gain trips from beach visitors for whom viewing the WTGs would be a positive result, offsetting some lost trips from visitors who consider views of WTGs to be negative (Parsons and Firestone 2018). None of the Phase 1 WTGs are within 15 miles of shore (Appendix E).

Upon completion of decommissioning, the Phase 1 WTGs would no longer be present, reversing the impacts on recreation and tourism that resulted from the presence of WTGs and ESPs. The impacts of the presence of Phase 1 structures on recreation and tourism during decommissioning would decrease from operations (minor) to no impact at the completion of decommissioning. Similarly, the presence of structures from other ongoing and planned activities, including Phase 1, would decrease from operations (minor to moderate) to no impact at the completion of decommissioning of all other offshore wind projects in the RI/MA Lease Areas.

Traffic: Phase 1 would contribute to increased vessel traffic and associated vessel collision risk along routes between ports and the offshore construction areas. Phase 1 would generate an average of 6 daily vessel trips during the entire construction period, with up to 15 average daily vessel trips during peak periods, passing through the offshore geographic analysis area as the vessels transit between ports and the offshore construction work areas (including the OECC and the SWDA).

The presence of vessels and worksites within the SWDA and along the OECC would affect recreational boaters, boat tours, and charter boats. Construction would take place over a roughly 2-year period, with an average of 30 and a maximum of 60 vessels present at offshore work areas (COP Volume I, Figure 3.1-3, and Volume III, Section 7.8.2.1; Epsilon 2023). Although boating activity within the SWDA is much lower in volume than in areas closer to the coast, it is traversed by recreational fishing vessels (especially HMS anglers), and other vessels operate within or near the SWDA (Section 3.15.1.2). At least three long-distance races may have routes through the SWDA; these races typically occur every 2 to 4 years and could occur during construction within the SWDA, but a diversion around the SWDA would not add appreciably to travel time (COP Appendix III-I, Section 6.5; Epsilon 2023).

Where established by the USCG, the applicant would use a flexible, temporary safety zone around active construction areas within 12 nautical miles (13.8 miles) of the coast. The applicant would work with the USCG to communicate these zones and all work areas farther offshore to the boating public via Broadcast Notice to Mariners and other standard communication means (COP Appendix III-I, Section 11.1; Epsilon 2023). The applicant would develop and implement a marine communications procedure for construction that would include a marine coordinator and coordination center, ongoing communication with the USCG, regular Offshore Wind Mariner Update Bulletins, regular notifications to local port communities and local media, and website updates (COP Appendix III-I, Section 11.2; Epsilon 2023). With implementation of the safety measures and notifications, recreational boaters in the geographic analysis area would experience minor inconvenience and increased risk due to the need to navigate in proximity to proposed Project-related vessels and avoid work areas, resulting in short-term, variable, and minor impacts.

Phase 1 operations would generate modest levels of vessel traffic. For regularly scheduled maintenance and inspections, the applicant anticipates approximately 290 vessel round trips from a port to the SWDA annually for Phase 1, or less than 1 round trip daily. For Phase 1 and 2 combined, the applicant anticipates approximately 590 vessel round trips annually or less than 2 round trips daily. SOVs would stay offshore for several days and up to several weeks at a time. Occasional larger service vessels would be needed that would also stay in the SWDA for several days. Therefore, while less than one daily vessel round trip to the SWDA is anticipated, an average of five are anticipated to be operating within the SWDA daily for Phase 1 and an average of seven vessels for Phases 1 and 2 combined (COP Volume III, Section 7.8.2.2.1; Epsilon 2023). More vessels may be needed for certain maintenance or repair scenarios, with no more than 15 vessels in the SWDA at any one time for Phases 1 and 2 combined. The portions of this vessel traffic that originate from Bridgeport Harbor, Vineyard Haven Harbor, or the Port of New Bedford would be consistent with the working seaport character of those ports and would not affect ongoing recreational use. Recreational vessels navigating within the SWDA would be able to navigate around Phase 1-related vessels working in the SWDA. Accordingly, traffic resulting from Phase 1 operations would have long-term and negligible impacts on onshore recreation and tourism.

Section 2.3, Non-Routine Activities and Low Probability Events, describes the non-routine activities associated with Phase 1. Activities requiring repair of WTGs, equipment or cables, or spills from maintenance or repair vessels would generally require intense, temporary activity to address emergency conditions or spills. In such situations, the unexpectedly frequent vessel activity in Vineyard Haven Harbor or the Port of New Bedford, and in offshore locations above the OECC or near individual WTGs, could temporarily prevent or deter recreation or tourist activities near the site of a given non-routine event. The impacts of non-routine activities on recreation and tourism would be temporary and minor.

Decommissioning would require vessel and equipment usage for removal of offshore structures, with impacts similar to construction. Provided that the applicant works with the USCG to establish safety zones and uses the same standard communication methods as for the construction stage, decommissioning of Phase 1 would have minor impacts on recreation and tourism from Phase 1.

Impacts of Phase 2

The impacts of Phase 2 on recreation and tourism would be the same as for Phase 1, except where specifically discussed in this section.

If the applicant includes the SCV as part of the final proposed Project design, impacts associated with the SCV may occur either in place of or in addition to the impacts associated with the Phase 2 OECC through Muskeget Channel. Except where specifically discussed in this section, the impacts of the SCV in federal waters (3 miles or greater from shore) would occur in different locations than the proposed OECC route through Muskeget Channel but would otherwise be the same magnitude as those described for Phase 1. The nearshore portion of the SCV (less than 3 miles from shore) and onshore components of the SCV have not yet been defined. BOEM will provide a more detailed analysis of the impacts of the SCV on recreation and tourism in a supplemental NEPA analysis, if the SCV is selected.

Cable emplacement and maintenance: While the Phase 2 OECR would use different potential routes than Phase 1, the impacts of the Phase 2 OECR would be the same as for Phase 1.

Onshore construction would affect recreation and tourism at the Dowses Beach Landfall Site. The Dowses Beach parking lot would experience disturbance during installation of the cable onshore/offshore transition vaults, as well as HDD or trenching in preparation for joining the onshore and offshore cables (COP Volume III, Section 7.5.2.1.1; Epsilon 2023). Construction would prevent the use of part of the beach parking lot and discourage beach or pier visitation due to noise and activity. These impacts would be temporary but unavoidable during construction. The applicant would not perform activities at the landfall site during the months of June through September, unless authorized by the Town of Barnstable (COP Volume III, Section 75.2.1.3; Epsilon 2023). Onshore construction would have temporary, localized, and moderate impacts on recreation and tourism at the landfall site.

During operations, offshore cable maintenance would require infrequent vessel traffic and trenching. Recreational vessels traveling near the route of the OECC would need to navigate around vessels and access restricted areas associated with OECC maintenance. Onshore facilities would be monitored and controlled remotely; if monitors determine that repair work is necessary, the repairs would typically involve accessing the cables through manholes within the beach parking lot used for the landfall site and along the OECR cable route, without affecting surrounding land uses. The operations at the manholes would result in limited disturbance of beach enjoyment and parking only when maintenance activities are required (COP Volume III, Section 7.5.2.2.1; Epsilon 2023). The localized, temporary disturbance to marine recreation and beach use due to cable maintenance would have short-term, infrequent, and minor impacts on recreation and tourism.

Lighting: During operations, nighttime aviation hazard lighting from Phase 2 WTGs could be visible from south-facing coastlines and elevated locations on Martha's Vineyard, Nantucket, and neighboring islands, depending on vegetation, topography, and atmospheric conditions (COP Appendix III-H.a, Section 5.2.1; Epsilon 2023). Phase 2 lighting (which would also employ ADLS) would be more distant from viewers than Phase 1 and would continue to have negligible impacts on recreation and tourism. The impacts of Phase 2 lighting in the context of other ongoing and planned activities would remain minor but could be reduced to negligible if other offshore wind projects also employ ADLS.

Presence of structures: Phase 2 could include up to 89 structures (including up to 88 WTGs and 2 or 3 ESPs), depending on the number of WTGs installed for Phase 1. Although Phase 2 would involve more WTGs, the impacts on recreation and tourism from the presence of these structures would be similar to those described for Phase 1: minor impacts on recreational fishing, boating, and sailing; moderate impacts on for-hire fishing (especially HMS fishing); minor beneficial impacts on for-hire fishing and wildlife viewing; negligible impacts due to visual effects; and minor impacts in the context of ongoing and planned activities. The impacts of decommissioning would also be the same as Phase 1: decreasing from minor to no impact for Phase 2 and decreasing from minor to moderate to no impact in the context of other ongoing and planned activities.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-12 in Appendix G would contribute to impacts on recreation and tourism through the primary IPFs of cable maintenance and emplacement, anchoring and gear utilization, noise, and the presence of structures. These impacts would primarily occur through impacts on recreational activities resulting from views of the WTGs and impacts on recreational vessel navigation due to the presence of structures and construction activities. The cumulative impacts of all IPFs from ongoing and planned activities would be moderate and minor beneficial.

Conclusions

Impacts of Alternative B. The impacts resulting from individual IPFs associated with the proposed Project, including Phases 1 and 2, would range from negligible to moderate impacts and negligible to minor beneficial impacts. Key short-term impacts during construction include noise, anchored vessels, and hindrances to navigation from the installation of the OECC and WTGs; key long-term impacts result from the presence of cable hard cover and structures during operations, with resulting impacts on recreational vessel navigation and visual quality. Beneficial impacts would result from the reef effect and sightseeing attraction of offshore wind energy structures.

Alternative B would have long-term and **moderate** impacts on recreation and tourism in the geographic analysis area due to the constraints on and greater navigational risks for recreational vessels within the SWDA, and the impact of up to 1,013 WTGs visible from coastal locations. It would also have long-term and **minor** beneficial impacts due to the fish aggregation and habitat conversion impacts of the WTGs and ESPs, resulting in new fishing and sightseeing opportunities. Alternative B would have short-term and minor impacts during construction due to the temporary impacts of noise and traffic on recreational vessel traffic, the natural environment, and species important for recreational fishing and sightseeing.

Cumulative Impacts of Alternative B. The cumulative impacts on recreation and tourism in the geographic analysis area from Alternative B combined with ongoing and planned activities would be **moderate** adverse and **minor** beneficial. The impact ratings include the long-term and minor to moderate adverse impacts and minor beneficial impacts associated with the presence of offshore structures and cable hard cover. The overall moderate impacts are also indicated by the short-term and minor to moderate impacts during construction from anchoring and gear utilization, cable emplacement and maintenance, noise, and traffic. Moderate impacts include both impacts on marine recreational activities and impacts on recreation and tourism in portions of the geographic analysis area resulting from the visual impact of WTGs. The minor beneficial impacts would result from a small but measurable benefit from the opportunities provided by future offshore wind structures for tours and recreational fishing.

3.15.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Recreation and Tourism

When analyzing the impacts of Alternative C on recreation and tourism, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for recreation and tourism. Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. These differences would not result in meaningfully different impacts compared to those of Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on recreation and tourism would be the same as those of Alternative B: **Moderate** and **minor** beneficial. Cumulative impacts on recreation and tourism would be **moderate** and **minor** beneficial.

3.15.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Recreation and Tourism with the Western Muskeget Variant Contingency Option

Impacts on recreation and tourism from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B.

- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H, Mitigation and Monitoring), as described under Alternative B. This would reduce the potential impacts on recreation and tourism by a negligible increment for both Phase 1 and Phase 2, as there could be two fewer structures (WTGs or ESPs) potentially installed in the SWDA.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on recreation and tourism relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **moderate** impacts and **minor** beneficial impacts on recreation and tourism within the geographic analysis area. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **moderate** and **minor** beneficial.

3.16 Scenic and Visual Resources

This section discusses the affected environment and potential impacts on seascape, open ocean, landscape character, and viewers from the proposed Project, alternatives, and ongoing and planned activities in the scenic and visual resources geographic analysis area using methodology recommended by Sullivan (2021) and the Landscape Institute and Institute of Environmental Management and Assessment (LI and IEMA 2013). The geographic analysis area for scenic and visual resources is described in Table D-1 in Appendix D, Geographical Analysis Areas, and is shown on Figure 3.16-1. Specifically, the geographic analysis area is the maximum theoretical area of WTG nacelle[44] visibility for offshore components and the maximum theoretical area of visibility of onshore aboveground equipment, including substations and related improvements. The applicant states that the tops of the proposed Project's WTG nacelles at 725 feet MLLW (where FAA-required aviation hazard lighting would be mounted) could be visible within a 37.5-mile radius from all proposed Project WTG positions (COP Appendix III-H.a; Epsilon 2023). The onshore geographic analysis area includes the area within view of the proposed substations, based on existing vegetation, topography, and the presence of structures not related to the proposed Project that could limit views of the proposed Project's onshore facilities. The onshore geographic analysis area does not include the OECR and OECC landfall sites because those components would be installed underground. The geographic analysis area encompasses the following locations:

- Martha's Vineyard, Nantucket, and adjacent islands;
- A portion of the Massachusetts mainland near Falmouth, as well as the Elizabeth Islands southwest of Falmouth; and
- Onshore locations adjacent to the West Barnstable Substation site in the Towns of Barnstable and West Barnstable, Massachusetts.

BOEM's methodology for evaluating the visible impacts of offshore wind projects combines two concepts (Sullivan 2021):

- **Seascape and Landscape Impact Assessment (SLIA):** "SLIA analyzes and evaluates impacts on both the physical elements and features that make up a landscape or seascape and the aesthetic, perceptual, and experiential aspects of the landscape or seascape that make it distinctive. These impacts affect the 'feel,' 'character,' or 'sense of place' of an area of landscape or seascape, rather than the composition of a view from a particular place. In SLIA, the impact receptors (the entities that are potentially affected by the proposed project) are the seascape and landscape itself and its components, both its physical features and its distinctive character."
- **Visual Impact Assessment (VIA):** VIA "analyzes and evaluates the impacts on people of adding the proposed development to views from selected viewpoints. VIA evaluates the change to the composition of the view itself and assesses how the people who are likely to be at that viewpoint may be affected by the change to the view. Enjoyment of a particular view is dependent on the viewer, and in VIA, the impact receptors are people."

[44] The nacelle refers to the housing located at the top of the WTG column, where the hub and blades are attached.

The BOEM methodology is consistent with methodology for evaluating impacts from proposed offshore wind projects in the United Kingdom and independent studies (LI and IEMA 2013; Scottish National Heritage 2012; Sullivan et al. 2012) to qualitatively assess potential seascape/landscape impacts, as well as potential visual impacts. Appendix I, Seascape, Landscape, and Visual Impact Assessment (SLVIA), contains a more detailed analysis of the SLIA and VIA for the proposed Project, and provides the applicant's visual simulations of the proposed Project and other offshore wind projects.

3.16.1 Description of the Affected Environment

3.16.1.1 Geographic Scope

BOEM's SLVIA methodology evaluates impacts within a zone of theoretical visibility, defined as "the viewshed that results from ignoring all screening elements except topography" (Sullivan 2021). The applicant's analysis instead uses a zone of visual influence (ZVI), which identifies portions of the offshore geographic analysis area within which there is a probability that all or a portion of the nacelles for the proposed Project's WTGs would be visible above the horizon from land-based vantage points. The applicant defined the ZVI, as shown on maps in the COP (Appendix III-H.a; Epsilon 2023), through geographic information system viewshed calculations, assuming clear atmospheric conditions, an observer height of 6 feet above ground level, and a coefficient of refraction (i.e., a measure of how the earth's atmosphere bends or curves light, thus affecting the distance at which objects are visible) of -0.088 (COP Appendix III-H.a; Epsilon 2023). While the zone of theoretical visibility and ZVI are not identical, they reflect comparable concepts, and the ZVI helps to frame the geographic extent of views of proposed Project components, particularly WTGs.

The blades of the proposed Project WTGs, which would extend up to 1,171 feet MLLW, would be visible from substantially farther away than the nacelles. For this assessment, 40 nautical miles (46 miles) was set as the limit for assessment of impacts. Studies of onshore and offshore visibility for smaller WTGs—onshore WTGs with maximum blade tip heights of up to 383 feet above ground (Sullivan et al. 2012) and offshore WTGs with maximum blade tip heights of 449 feet above the surface (Sullivan et al. 2013)—suggest that the extinction point for views of these shorter WTGs and other structures is much less than 40 nautical miles (46 miles). Based on these studies and BOEM's SLVIA methodology (Sullivan 2021), this EIS uses 40 nautical miles (46 miles) as an outer limit for visibility.

The applicant did not prepare a ZVI or other viewshed for onshore underground facilities because the OECR and grid interconnection cables would be installed within roads and utility ROWs and would not be visible. The applicant also did not prepare a ZVI for the Phase 1 onshore substation, although the COP (Appendix III-H.a; Epsilon 2023) includes simulations of the substation with and without potential future vegetative screening added by the applicant. The location of the Phase 2 onshore substation (if the Phase 1 substation location cannot be used for Phase 2) has not been identified (COP Appendix III-H.a; Epsilon 2023).

3.16.1.2 Existing Seascape, Open Ocean, and Landscape Character (Seascape and Landscape Impact Assessment Baseline)

Martha's Vineyard and Nantucket were formed by the last period of continental glaciation and the rise in sea level that followed. This created islands that are generally characterized by low elevations, with undulating hills and shallow depressions. Elevations range from sea level to an average of approximately 110 feet AMSL, with specific locations rising above 200 feet AMSL. Most of the oceanfront on these islands is fringed by barrier beaches and sand dunes. The western and northwestern parts of Martha's Vineyard are marked by ridges and hills that extend southwesterly and end at the high cliffs of Aquinnah (Gay Head), Nashaquitsa, and Squibnocket. The elevation of these hills averages approximately 200 feet AMSL but extends as high as 300 feet in some areas (COP Appendix III-H.a; Epsilon 2023).

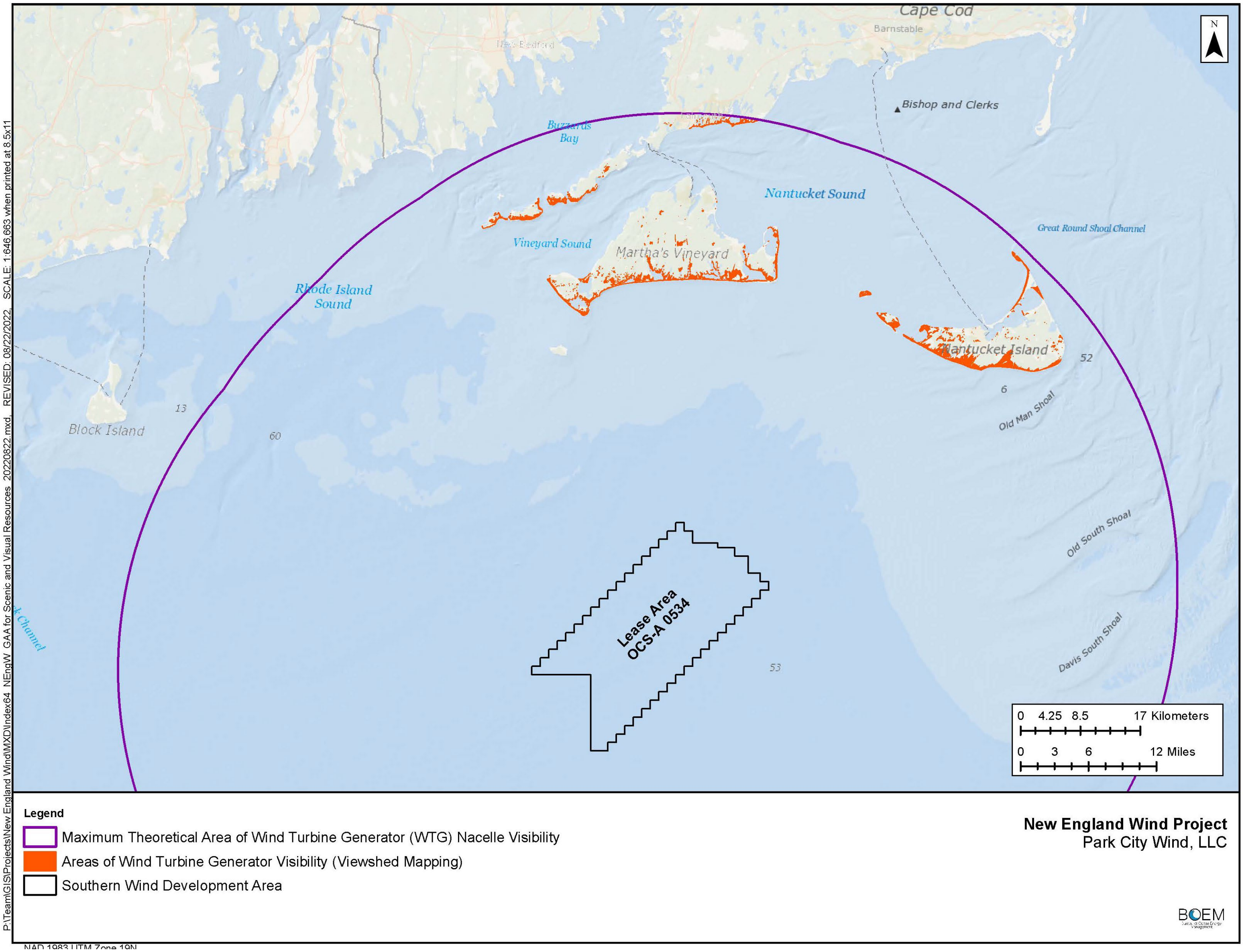


Figure 3.16-1: Geographic Analysis Area for Seascape, Landscape, and Visual Resources

The overall aesthetic character of Martha's Vineyard and Nantucket can generally be described as small-town landscapes with minimal urban development. Vegetation is characterized by a mix of scrub forest, upland heaths, sand plain grasslands, salt marshes, and open fields (agricultural and successional). Developed features include village centers, year-round and vacation homes, roads, and harbors/ports.

The horizon looking south toward the SWDA from the various coasts is typically defined by a view of the open ocean. Development and infrastructure at some of the viewpoints includes artificial lighting, which results in some light pollution; however, most daytime and nighttime views are typical of beaches and natural areas with little development. Lights from vessels can be seen from all coastal locations along the ocean horizon on most nights except in foggy conditions (COP Appendix III-H.a; Epsilon 2023).

The applicant classified the geographic analysis area according to landscape units, defined as "areas with common characteristics of landform, water resources, vegetation, land use, and land use intensity…a landscape unit is a relatively homogenous, unified landscape (or seascape) of visual character. Landscape units are established to provide a framework for comparing and prioritizing the differing visual quality and sensitivity of visual resources" (COP Section 2.1, Appendix III-H.a; Epsilon 2023).[45] Table 3.16-1 defines the landscape units (which also include ocean and shoreline areas).

Impacts on a particular seascape or landscape unit are a function of that unit's sensitivity to change, along with the magnitude of impacts. The sensitivity to change is a product of each unit's susceptibility to change and value. Susceptibility is the unit's "ability to accommodate the impacts of the proposed project without substantial change to the basic existing characteristics of the seascape/landscape" (Sullivan 2021). Value is assigned by society overall; higher values are associated with scenery that user groups feel to be distinctive, aesthetically appealing, or tranquil, or where the seascape or landscape contain important cultural or natural resources or characteristics (Sullivan 2021). Impact magnitude is a function of the size or scale of visible change, the geographic extent of the change, and the durability and reversibility of the change (Sullivan 2021).

Proposed Project visibility factors—the "variables affecting the actual visibility of an object in the landscape" or seascape (Sullivan 2021) can vary from day to day and throughout a single day. These factors include viewer characteristics, viewshed limiting factors (e.g., topographic and vegetative screening), lighting (e.g., weather and sun position), atmospheric conditions, viewing angles, the viewing backdrop, and the visual characteristics of the objects being viewed (e.g., size, scale, color, form, line, texture, and motion) (Sullivan 2021). BOEM conducted a meteorological study in 2017 to assess typical visibility conditions near the RI/MA Lease Areas at varying distances (BOEM 2017b). Table 3.16-2 summarizes these data at the Nantucket and Martha's Vineyard airports.

[45] The applicant's methodology for describing the affected environment differs from the methodology in Sullivan (2021); however, BOEM determined that the information provided by the applicant was sufficient to support analysis of seascape, landscape, and visual impacts for the proposed Project.

Table 3.16-1: Seascape, Open Ocean, and Landscape Units within the Geographic Analysis Area

Units	Description
Seascape Units	
Ocean Beach Unit	Miles of sand beaches are a defining aesthetic feature of Martha's Vineyard, Nantucket, and Cape Cod. Beaches are a significant attraction for sunbathers, surfers, fishermen, and beachcombers. During the summer season, certain stretches of the beach setting are at capacity. At other times of the year, beaches can be nearly deserted and appear in a seemingly pristine natural condition. As a daytime destination, visitors bring brightly colored umbrellas, coolers, folding chairs, towels, and recreational watercraft. Southerly views from the beach encompass views of the open water landscape across the Open Water/Ocean Unit. The beaches are both sandy (primarily on Nantucket, along the south coast of Cape Cod, the perimeters of the Elizabeth Islands, and the eastern portion of Martha's Vineyard) and rocky (primarily on the western portion of Martha's Vineyard). Breaking surf is a continuous and unique visual condition. Viewer activity is primarily recreational in nature including passive sunbathing, swimming, walking/beach combing, surf fishing, and surfing. Beaches are also used by recreational and commercial fishermen. Views are almost always unobstructed and considered highly scenic. Views extend up and down the coast and across open water as one looks out to sea. Inland views include grassy dunes and coastal scrub vegetation. Man-made structures are frequently visible from beach locations, although extended stretches of beachfront on Martha's Vineyard and Nantucket are located within protected open space areas with little to no man-made development within immediate view.
Coastal Bluff Unit	Portions of the coastal area are defined by a distinctive topographic rise in elevation from the beach below, with coastal scrub vegetation at the top of the bluffs. Dramatic coastal bluffs occur at the eastern end of Martha's Vineyard at Gay Head, Aquinnah, and Chilmark where the land rises steeply from sand or rocky beaches to elevation of 30 meters (100 feet) or more. Notable bluffs in this area include Gay Head Cliffs, Zacks Cliffs, Squibnocket Ridge, Nashaquitsa Cliffs, and Wequobsque Cliffs. Less dramatic bluffs are found at Wasque Point at the southern end of Chappaquiddick Island where topography steeply rises 15–30 meters (50–100 feet) above beach elevation. The Coastal Bluffs Unit is defined by scenic open vistas of the ocean and distant landscape from an elevated vantage point. Viewers frequently visit these areas specifically to enjoy scenic vistas over the ocean and long distance views up and down the coastline. Bluff vistas also commonly include man-made development including roads and vehicles, overhead utility lines, and residential development.
Open Ocean Unit	
Open Ocean Unit	The open water/ocean unit includes the open water of the Atlantic Ocean, Nantucket Sound, Vineyard Sound, Buzzards Bay, and Rhode Island Sound more than 3 nautical miles (3.5 miles) from shore. This unit is characterized by broad expanses of open water that forms the dominant foreground element in all directions. From all vantage points, the Project will be viewed over open water. In general, the waters of the Atlantic Ocean appear dark bluish-gray typical of northeastern U.S. oceanic water (as compared to the light greenish blue colors common to southeastern waters of the United States). Cloud cover, wind, sun reflectance, and surface glare affect the color of the water and often create patterns of color variation over the water surface. The visible texture of the water is affected by the action of waves, which can include flat water, rolling swells, and/or choppy white cap conditions. These factors contribute to an amalgam of shimmering colors and patterns of light that are of aesthetic interest and may command the attention of observers. The waters off Cape Cod, Martha's Vineyard, and Nantucket support a wide variety of human activities including water sports, recreational boating (sail and power craft), recreational and commercial fishing, ferry services, and commercial shipping, among others uses. Navigation through the area includes ocean going vessels headed to or from major ports (e.g., New York and Boston), commercial fishing vessels, ferry transport (Nantucket and Martha's Vineyard ferries), pleasure craft, and sport fishing boats. The ocean, sound, channels, harbors, and bays are marked with maritime aids (e.g., buoys, channel markers, warning lights).

Units	Description
Landscape Units	
Coastal Dunes Unit	The inland edge of the Ocean Beach Unit is defined by undulating sand dunes typically ranging in height from 3-6 meters (10-20 feet). Dunes are typically vegetated with low grasses and low shrubs. Coastal dunes typically occur along the shoreline between the ocean beaches and more inland landforms and are present throughout the study area on Cape Cod, especially in the easterly limit of the proposed APE, as well as on Martha's Vineyard and Nantucket. The dunes are typically traversed by narrow enclosed footpaths through the beach grass that provide public access to the beaches from inland roads and parking areas. Ocean views from the back side of the Coastal Dune Unit are largely restricted by the dune terrain. Viewer activity is almost exclusively recreational, focused on walking/sight-seeing and beach access from inland roads and parking areas.
Salt Pond/Tidal Marsh Unit	Salt ponds and tidal marshes inland of the Ocean Beach Unit are common throughout the coastal area. Disconnected from the ocean except during flooding events, or connected to the ocean by narrow tidal channels, these water features are defined by shallow open water and buffered by herbaceous grasses and other salt tolerant vegetation. In those with hydraulic connections to the ocean, water levels rise and fall with the tide, exposing mud flats. Views over the water body and flat marshland extend until interrupted by adjacent dunes and/or scrub vegetation. Residences often are present along the edges of the ponds, many with associated docks and boats. Recreational activities in this unit include walking, boating, clam digging, and bird watching.
Coastal Scrub Brush Unit	At varying distances inland from the Coastal Beach, Coastal Dunes, and Salt Pond/Tidal Marsh Units, the coastal landscape transitions into a more heavily vegetated scrub brush and low forest condition. The Coastal Scrub Brush Unit (and the Forest Unit described below) is characterized by low dense woody and herbaceous vegetation—the dominant forest is Pitch Pine-Oak forest, which occurs on Cape Cod, Martha's Vineyard, and Nantucket. Scrub vegetation is commonly found on upland dunes and plains above tidal conditions. Landform is often comprised of small hills and eroded hollows. Vegetation is often thick and nearly impenetrable, and views are frequently obstructed by dense foliage. Distant vistas may be limited to view corridors along roadways or where scrub brush transitions to open meadow. Viewer activity is typically limited to local travel and recreational use, such as walking and biking.
Forest Unit	Inland from various coastal units are extended wooded areas including both deciduous and coniferous species (e.g., oaks, hickories, and white pine). The understory is comprised of mixed shrubs, vines, and saplings. In areas exposed to coastal winds, trees are often irregular in form and stunted; trees located in better shielded inland areas are taller and more regular in form. Although this landscape type once dominated the interior of Martha's Vineyard, Nantucket, and Cape Cod, various forms of human development extensively encroach upon this area, and only a patchwork of mature forest remains. A variety of land use activities exist in the Forest Unit, including residential development, roads, small open yards and fields, and other land uses. Such conditions are not specifically identified as separate units due to the visual dominance of the surrounding forest. Topography in the Forest Unit is typically level to rolling with distinct ridges and gullies. Views are frequently restricted to openings in the forest canopy and axial views along roadways. Viewer activity includes residential uses and local travel. Recreational uses include walking and bicycling through the woods along local roads and trails.
Shoreline Residential Unit	Shoreline (or near shoreline) residential development is common in coastal areas not currently protected by public and private land conservation initiatives. Residential development ranges from small bungalow-style beach houses to large well-maintained vacation homes. The developments are a mix of densely developed areas, such as Falmouth Heights and Popponnesett (Mashpee) and Nantucket harbor, and low-density developments on the south shores of Martha's Vineyard and Nantucket. Although sometimes screened by coastal scrub vegetation, shoreline residences typically have panoramic views of the ocean, salt ponds/tidal marshes, and/or dune landscape. Architecture is a mixture of old and new construction and traditional/historic and contemporary styles. The local landscape is gently rolling with a mix of coastal scrub, heath, and dunes surrounding maintained residential landscapes. Larger trees are generally not present in beachfront locations. Shoreline residential homes are often used seasonally by owners or offered as vacation rentals. Visitors to these properties enjoy views of the ocean or beachfront landscape and frequently walk or drive from the residential property to the beach and other scenic coastal locations as part of their vacation routine.

Units	Description
Village/Town Center Unit	The Village/Town Center Unit includes clearly identifiable population centers including Vineyard Haven, Oak Bluffs, and Edgartown on Martha's Vineyard; Woods Hole and West Falmouth on Cape Cod; and Nantucket Village on Nantucket. This zone is comprised of moderate to high density residential and commercial development in a village setting. Vegetation most commonly includes street trees and residential landscaping yard trees. Buildings (typically two to three stories tall) and other man-made features dominate the landscape. Architecture is highly variable in size, style, and arrangement. Each town center on Martha's Vineyard and Nantucket maintains an individual and distinctive New England character. Village/Town Centers are widely recognized as quaint small town destinations and highly scenic places. On Martha's Vineyard and Nantucket, village and town centers are small coastal seaports with clusters of historic buildings focused around clearly defined and thriving downtown commercial districts. Side streets are characterized by well-maintained residential structures adjacent to the village center. Buildings are most commonly of a traditional New England architectural style and arranged in an organized pattern focusing views along the streets. Buildings, street trees, and local landscaping enclose and prevent long distance views.
Rural Residential Unit	The Rural Residential Unit is found along the frontage of rural roads through Cape Cod, Martha's Vineyard, and Nantucket, outside of the Village/Town Center Unit and the Suburban Residential Unit and inland from coastal areas. Structures are typically single family homes that vary widely in age and architectural style, from the traditional Cape style house to modern modular homes and historic farm houses. Residences tend to be larger and well maintained, often with a traditional New England character. Rural residences on Cape Cod vary in size from small Cape or ranch style homes to larger farm houses, and are generally located on paved roads. On Martha's Vineyard and Nantucket, the older homes vary in size, while newer seasonal homes are larger estates and located on large lots. Many rural roads on the islands are unpaved. Residential structures are often set back from the road and interspersed with hedgerows and small woodlots. Topography is characterized by relatively level to gently rolling landform typical of inland on Martha's Vineyard and Nantucket. Extended distance views are often restricted to open fields and axial views along residential uses are not typically oriented toward ocean views. Viewer activity includes common residential uses, recreation, and local travel.
Suburban Residential Unit	Suburban residential development includes medium- to high density single family residential neighborhoods that typically occur on the outskirts of villages and town centers, along secondary roads and cul-de-sacs. The Suburban Residential Unit is most commonly located on Cape Cod and around the perimeter of Village/Town Center Units on Martha's Vineyard and Nantucket. Buildings are most often one- and two-story wood framed structures with peaked roofs and clapboard or shingle siding. House styles are primarily capes, ranches, bungalows, salt boxes, and colonial residential structures. Suburban Residential Units are also found in coastal areas in relatively new clusters of homes designed for year-round, seasonal, or vacation use in areas proximate to beaches and other scenic and recreational resources. Suburban residential developments generally have regularly spaced homes surrounded by landscaped yards. Residential subdivisions are commonly located within forest areas or have pockets of remnant forest vegetation within developed areas. Streets are well-organized in layout, and are often curvilinear in form with well-defined access to collector streets. Activities include normal residential uses and local travel. Views are often limited by surrounding vegetation or adjacent structures. Suburban Residential Units are not typically oriented toward ocean views.
Agricultural/Open Field Unit	Agricultural land uses within the APE are limited to several small, generally level to gently sloping pastures and crop fields. Livestock and working farm equipment add to the visual interest of the open fields. This unit occurs primarily in inland portions of the APE as a minor component of the landscape on both Martha's Vineyard and Nantucket. Many of the agricultural landscapes are protected open space, either by public agencies, private land trusts, or non-profit organizations. Agricultural lands may offer long distance views. Adjacent forest, coastal scrub, and structures commonly frame/enclose views and provide significant screening. Because this unit largely inland, views to the ocean are relatively rare, with the exception of Bartlett's Farm on Nantucket and the Allen Farm on Martha's Vineyard.

Source: COP Appendix III-H.a; Epsilon 2023

APE = area of potential effects; COP = Construction and Operations Plan

Table 3.16-2: Visibility Conditions at the Nantucket and Martha's Vineyard Airports, 2017

Measure of Visibility	Martha's Vineyard Airport	Nantucket Airport
Average visibility distance in clear conditions	20 nautical miles (23 miles)	17 nautical miles (20 miles)
Number of days when visibility extends to 20 nautical miles (23 miles) for 50% or more of daylight hours	113 days/year	80 days/year
Days when visibility extends to 30 nautical miles (34.5 miles) for 50% or more of daylight hours	32 days/year	14 days/year

Source: BOEM 2017b

As shown in Table 3.16-2, average visibility is slightly lower at Nantucket as conditions allowing for visibility to 20 nautical miles (23 miles) are generally limited. The frequency of visibility conditions beyond 30 nautical miles (34.5 nautical miles) was not reported but is anticipated to be very rare.

View distances of the proposed Project from onshore locations in the geographic analysis area range from approximately 21.3 miles (at Squibnocket Point on the southwestern tip of Martha's Vineyard) to the 46-mile limit of theoretical visibility described in Section 3.16.1.1 (i.e., along the coast of mainland Cape Cod). At the 21.3-mile distance, the proposed Project would occupy 39 degrees (32 percent) of the typical human's 124-degree horizontal field of view. WTGs from other offshore wind projects in the RI/MA Lease Areas could be as close as 12.3 miles from Squibnocket Point and would occupy the entire 124-degree horizontal view. View angles, percentage of view, and other factors vary considerably from observation locations in the geographic analysis area, as discussed in Appendix I.

The visibility characteristics of WTGs similar in size to those included in the proposed Project and other offshore wind projects can be grouped by distance as follows:

- 0 to 5 miles from the observer: unavoidably dominant features in the view;
- 5 to 12 miles from the observer: strongly pervasive features between;
- 12 to 28 miles from the observer: clearly visible features;
- 28 to 31 miles from the observer: low on the horizon, but persistent features; and
- 31 to 40 miles: intermittently noticed features.

At distances of 12 miles or less, the form of the WTG may be the dominant visual element creating the visual contrast regardless of color. At greater distances, color may become the dominant visual element creating visual contrast under certain visual conditions that give visual definition to the WTG's form and line.

Table 3.16-3 summarizes the definitions of susceptibility levels for seascape, open ocean, and landscape units in the geographic analysis area. Table 3.16-4 summarizes the definitions of value levels for these units. Table 3.16-5 provides definitions of sensitivity and lists the types of locations in the geographic analysis area that meet these criteria.

Table 3.16-3: Seascape, Open Ocean, and Landscape Susceptibility

Setting	Definition
High Susceptibility	Seascape, open ocean, or landscape character are highly vulnerable to the type of change proposed and are distinctive and highly valued by residents and visitors.
Medium Susceptibility	Seascape, open ocean, or landscape character is reasonably resilient to the type of change proposed, moderately distinctive, and moderately valued by residents and visitors.
Low Susceptibility	Seascape, open ocean, or landscape character is unlikely to be affected by the type of change proposed and is common and unimportant to residents and visitors.

Table 3.16-4: Seascape, Open Ocean, and Landscape Value

Setting	Definition
High value	These are areas where character is judged to be distinctive and where scenic quality, wildness, tranquility, and natural or cultural heritage features make a particular contribution to the seascape or landscape. This can include special federal, state, or local designations (e.g., national parks or scenic overlooks) or areas where the seascape, open ocean, or landscape are valued for tourism, cultural or historic context, or other purposes. Most seascape units and the open ocean unit have high value, as do landscape units dominated by natural features, such as the Coastal Dunes, Salt Pond/Tidal Marsh, and Forest units.
Medium value	These are areas where scenic quality, and natural or cultural heritage features contribute to the seascape or landscape but where functional factors such as commerce or transportation also contribute to overall character. Landscape units with a mix of developed and natural-appearing conditions have medium value, including the Coastal Scrub Brush, Shoreline Residential, and Village/Town Center units.
Low value	These are areas where functional factors such as commerce or transportation are the dominant elements of landscape character and where characteristics such as solitude, tranquility and wildness are not expected or sought. Landscape units dominated by development, such as Rural Residential, Suburban Residential, and Agricultural units, have low value.

Source: Sullivan 2021

Table 3.16-5: Seascape, Open Ocean, and Landscape Sensitivity

Setting	Definition	Locations in the Geographic Analysis Area
High Sensitivity Seascape[a]	Seascape character is distinctive and highly valued by residents and visitors.	• Ocean shoreline, beach, and dune areas, and ocean areas • Moshup's Bridge and Vineyard Sound TCP, Nantucket Sound TCP • Native American lands: Chappaquiddick Island TCP, Wampanoag Tribe of Gay Head (Aquinnah) Tribal Lands, Wasque Reservation • Public walking and biking paths along the southern coasts of Martha's Vineyard and Nantucket • Federal, state, or locally designated lands with scenic and/or recreational values: Gay Head Lighthouse, Miacomet Heath WMA, Miacomet Moors WMA, Norton Point Beach, Smooth Hummocks Coastal Preserve, South Beach State Park, South Cape Beach State Park, Tom Nevers Field, Washburn Island State Park and Recreation Area, Wasque Point WMA • Other public, private, and residential beaches on southern shorelines of Martha's Vineyard, Nantucket, and mainland Cape Cod
High Sensitivity Open Ocean	Open ocean characteristics are pristine, highly distinctive, and highly valued by residents and visitors.	This includes ocean areas within the geographic analysis area.
High Sensitivity Landscape[b]	Landscape characteristics are highly distinctive, highly valued by residents and visitors, or within a designated scenic or historic landscape.	This includes scenic coastal areas, bays, islands, sounds, and adjoining estuaries with medium to high resident and visitor use volume. It also includes cemeteries, churches, historic sites, lighthouses, scenic overlooks, schools, town halls, and residential areas within the geographic analysis area.
Medium Sensitivity Seascape,[a] Open Ocean, and Landscape[a]	Seascape, open ocean, and landscape character is moderately distinctive and moderately valued by residents and visitors.	This includes moderately distinctive areas of medium scenic value and low resident or visitor use volume inland areas.
Low Sensitivity Seascape[a] Open Ocean, and Landscape[b]	Seascape, open ocean, and landscape character is common and unimportant to residents and visitors.	This includes indistinctive areas with low scenic value and limited to no resident or visitor use.

[a] Locations also listed under Seascape extend to both Landscape and Seascape.
[b] Locations also listed under Landscape extend to both Seascape and Landscape.
TCP = traditional cultural property; WMA = Wildlife Management Area

3.16.1.3 Existing Visual Experience (Visual Impact Assessment Baseline)

Impacts on the experience of viewers who may observe the proposed Project are a function of the sensitivity of viewers and the magnitude of the visual impacts. Viewer sensitivity reflects the susceptibility of viewers to change along with the value that those viewers place on individual views being evaluated. Table 3.16-6 describes the sensitivity levels and criteria used to assess visual impacts.

Table 3.16-6: View Receptor Sensitivity Ranking Criteria

Sensitivity	Ranking Criteria
High	This includes residents with views of the proposed Project from their homes; people with a strong cultural, historic, religious, or spiritual connection to landscape or seascape views; people engaged in outdoor recreation whose attention or interest is focused on the seascape and landscape and on particular views; visitors to historic or culturally important sites where views of the surroundings are an important contributor to the experience; people who regard the visual environment as an important asset to their community, churches, schools, cemeteries, public buildings, and parks; and people traveling on scenic highways and roads, or walking on beaches and trails, specifically for enjoyment of views.
Medium	This includes people engaged in outdoor recreation whose attention or interest is unlikely to be focused on the landscape and on particular views because of the type of activity; people at their places of livelihood, commerce, and personal needs (inside or outside) whose attention is generally focused on that engagement, not on scenery, and where the seascape and landscape setting is not important to the quality of their activity; and, generally, those commuters and other travelers traversing routes that are dominated by non-scenic developments.
Low	This includes people who regard the visual environment as an unvalued asset.

The applicant identified 21 key observation points (KOP) on Martha's Vineyard and Nantucket to evaluate the potential visual and scenic impacts of the proposed Project (KOPs 1 to 21 in Table 3.16-7). The KOPs for the proposed Project, which included many of the KOPs identified for and evaluated as part of the Final EIS for Vineyard Wind 1 (BOEM 2021), were selected to be representative of important individual resources and the diverse views of the proposed Project available from Martha's Vineyard and Nantucket. The KOPs were identified to avoid (to the degree possible) duplication of similar views, seascape or landscape units, and distances to the nearest WTG (John McCarty, Pers. Comm., May 18, 2022). In addition to the 21 KOPs identified by the applicant, KOP 22 represents a theoretical observer on a vessel offshore (not at any specific location) between the southern coasts of Martha's Vineyard or Nantucket and the SWDA. KOPs 23 through 25 were not listed in the COP (Appendix III-H.a; Epsilon 2023) as KOPs but provide potential views of the Phase 1 onshore substation and are thus included as KOPs in this analysis.

Table 3.16-7 lists the KOPs; seascape, open ocean, and landscape units; representative resource types; the type of simulation prepared by the applicant; and viewer sensitivity. Based on discussions with BOEM, the applicant prepared full panoramic simulations (124 × 55-degree field of view) from six KOPs, and single-frame photographic simulations from three additional KOPs (COP Appendix III-H.a; Epsilon 2023).

Offshore viewing receptors include the recreational, fishing, and other vessels (Section 3.13, Navigation and Vessel Traffic). Daytime and nighttime aircraft receptors include travelers arriving and departing at Martha's Vineyard Airport and Nantucket Memorial Airport and on limited other transiting flights (Section 3.14, Other Uses [National Security and Military Use, Aviation and Air Traffic, Offshore Cables and Pipelines, Radar Systems, Scientific Research and Surveys, and Marine Minerals]). Aircraft receptors are more frequently affected by view-limiting atmospheric conditions than are land and water receptors because aircraft operate within or above cloud cover.

Table 3.16-7: Key Observation Points

KOP	Seascape, Open Ocean, and Landscape Units	Resource Types	Simulation Type	Viewer Sensitivity Rating
1. Aquinnah Cultural Center	Coastal Bluffs	NNL, NRHP	Panoramic	High
2. Long Point Beach	Ocean Beach, Coastal Dunes, Salt Pond/Tidal Marsh	Wildlife Refuge, Recreation, Historic Resources	Single frame	High
3. South Beach	Ocean Beach, Coastal Dunes	Recreation	Panoramic	High
4. Wasque Reservation	Ocean Bluffs, Coastal Bluffs, Forest	Recreation, Open Space, Conservation	Panoramic	High
5. Madaket Beach	Ocean Beach, Coastal Dunes, Shoreline Residential	Recreation, Historic Resources	Panoramic	High
6. Miacomet Beach and Pond	Ocean Beach, Coastal Dunes, Salt Pond/Tidal Marsh	Recreation, Historic Resources	Single frame	High
7. Bartlett's Farm	Agriculture/Open Field	Historic Resources	Single frame	High
8. Tom Nevers Field	Coastal Bluffs, Coastal Scrub, Maintained Recreation	Recreation	Panoramic	High
9. Gay Head Cliffs Overlook	Coastal Bluffs	NNL, NRHP	None	High
10. Gay Head Lighthouse	Coastal Bluffs	NNL, NRHP	None	High
11. Squibnocket Beach	Ocean Beach	Recreation, Historic Resources	None	High
12. Lucy Vincent Beach	Ocean Beach, Coastal Dunes	Recreation, Historic Resources	None	High
13. Barn House/Skiff-Mayhew-Vincent House	Agriculture/Open Field	NRHP	None	High
14. Chappy Point, Gardner Beach	Village/Town Center	Recreation, Historic Resources	None	High
15. Cisco Beach	Ocean Beach, Coastal Dunes, Salt Pond/Tidal Marsh	Recreation	None	High
16. Surfside Beach	Ocean Beach, Coastal Dunes	Recreation, Historic Resources	None	High
17. Nobadeer Beach Pond Road	Ocean Beach, Coastal Dunes	Recreation, Historic Resources	None	High
18. Green Point Lighthouse	Ocean Beach, Coastal Dunes	NRHP, Recreation	None	High
19. Rock Landing	Ocean Beach, Coastal Bluff	NRHP, Recreation	None	High
20. Dowse's Beach	Ocean Beach, Coastal Dunes	NRHP, Recreation	None	High
21. Peaked Hill Reservation	Coastal Scrub Brush, Forested	Recreation	Panoramic	High
22. Representative Offshore View	Open Ocean	Recreation	None	High
23. Shootflying Hill Road (Existing Hotel)	Village/Town Center	Commercial	Single frame	Low
24. Shootflying Hill Road (ROW #343)	Coastal Scrub Brush, Forested	Utility Infrastructure	Single frame	Low
25. Exit 6 Park and Ride/ Highway Rest Area	Village/Town Center	Commercial	Single frame	Low

Source: COP Tables 8 and 9, Appendix III-H.a; Epsilon 2023

KOP = key observation point; NNL = National Natural Landmark; NRHP = National Register of Historic Places; ROW = right-of-way

3.16.2 Environmental Consequences

Definitions of impact levels for scenic and visual resources are described in Table 3.16-8. There are no beneficial impacts on scenic and visual resources.

Table 3.16-8: Impact Level Definitions for Scenic and Visual Resources

Impact Level	Impact Type	Definition
Negligible	Adverse	SLIA: There is very little or no impact on seascape/landscape unit character, features, elements, or key qualities either because unit lacks distinctive character, features, elements, or key qualities; values for these are low; or Project visibility would be minimal. VIA: There is very little or no impact on viewers' visual experience because view value is low, viewers are relatively insensitive to view changes, or Project visibility would be minimal.
Minor	Adverse	SLIA: The Project would introduce features that may have low to medium levels of visual prominence within the geographic area of an ocean/seascape/ landscape character unit. The Project features may introduce a visual character that is slightly inconsistent with the character of the unit, which may have minor to medium negative impacts on the unit's features, elements, or key qualities, but the unit's features, elements, or key qualities have low susceptibility or value. VIA: The visibility of the Project would introduce a small but noticeable to medium level of change to the view's character; have a low to medium level of visual prominence that attracts but may or may not hold the viewer's attention; and have a small to medium impact on the viewer's experience. The viewer receptor sensitivity/susceptibility/value is low. If the value, susceptibility, and viewer concern for change is medium or high, the nature of the sensitivity is evaluated to determine if elevating the impact to the next level is justified. For instance, a KOP with a low magnitude of change but a high level of viewer concern (combination of susceptibility/value) may justify adjusting to a moderate level of impact.
Moderate	Adverse	SLIA: The Project would introduce features that would have medium to large levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Project would introduce a visual character that is inconsistent with the character of the unit, which may have a moderate negative impact on the unit's features, elements, or key qualities. In areas affected by large magnitudes of change, the unit's features, elements, or key qualities have low susceptibility or value. VIA: The visibility of the Project would introduce a moderate to large level of change to the view's character; may have moderate to large levels of visual prominence that attracts and holds but may or may not dominate the viewer's attention; and has a moderate impact on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to low. Moderate impacts are typically associated with medium viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has medium levels of change, or low viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has large changes to the character. If the value, susceptibility, and viewer concern for change is high, the nature of the sensitivity is evaluated to determine if elevating the impact to the next level is justified.
Major	Adverse	SLIA: The Project would introduce features that would have dominant levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The Project would introduce a visual character that is inconsistent with the character of the unit, which may have a major negative impact on the unit's features, elements, or key qualities. The concern for change (combination of susceptibility/value) to the character unit is high. VIA: The visibility of the Project would introduce a major level of character change to the view; attract, hold, and dominate the viewer's attention; and have a moderate to major impact on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to high. If the magnitude of change to the view's character is medium but the susceptibility or value at the KOP is high, the nature of the sensitivity is evaluated to determine if elevating the impact to major is justified. If the sensitivity (combination of susceptibility/value) at the KOP is low in an area where the magnitude of change is large, the nature of the sensitivity is evaluated to determine if lowering the impact to moderate is justified.

KOP = key observation point; SLIA = Seascape and Landscape Impact Assessment; VIA = Visual Impact Assessment

3.16.2.1 Impacts of Alternative A – No Action Alternative on Scenic and Visual Resources

When analyzing the impacts of Alternative A on scenic and visual resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for scenic and visual resources (Table G.1 13 in Appendix G, Impact-Producing Factor Tables and Assessment of Resources with Minor [or Lower] Impacts). The cumulative impacts of Alternative A considered the impacts of Alternative A in combination with other planned non-offshore wind and offshore wind activities, as described in Appendix E, Planned Activities Scenario.

Under Alternative A, existing conditions for scenic and visual resources described in Section 3.16.1 would continue to follow current regional trends and respond to IPFs introduced by other ongoing non-offshore wind and offshore wind activities. Ongoing non-offshore wind activities within the geographic analysis area that contribute to impacts on scenic and visual resources include other offshore wind projects that could affect the same geographic analysis area for seascape, landscape, and visual resources may be proposed. Users/viewers would continue to pursue locations and activities that rely on the area's coastal and ocean environment scenic qualities.

The discussion of impacts on scenic and visual resources for Alternative A assumes ideal viewing conditions, including clear skies and an absence of obstructions. Actual views and impacts would depend on a variety of factors, including the character of existing daytime and nighttime visual conditions (i.e., whether existing light sources exist near a viewer or within a seascape or landscape) viewer distance and angle of view, and atmospheric conditions and environmental factors such as haze, sun angle, time of day, cloud cover, fog, sea spray, and wave action. The applicant's simulations of other offshore wind projects in the RI/MA Lease Areas are provided in Appendix I.

Ongoing offshore wind activities within the geographic analysis area that contribute to impacts on scenic and visual resources include ongoing construction of Vineyard Wind 1 in OCS-A 0501 and the South Fork Wind Project in OCS-A 0517. Construction of Vineyard Wind 1 and South Fork Wind Project, along with planned offshore wind activities, would affect scenic and visual resources through the primary IPFs described below.

Cumulative Impacts

Lighting: Future onshore components of offshore wind projects that could generate visual impacts include substations, operations facilities, and port upgrades. While the specific locations and design of these components have not been determined for all projects under Alternative A, these components could introduce additional lighting into the characteristic nighttime visual environment. Most onshore development for offshore wind projects would occur in areas of existing urbanized or industrial development where similar infrastructure and development exist. Therefore, additional nighttime lighting sources associated with infrastructure to support other offshore wind projects would be an incremental change over time and would have long-term impacts on the viewer's nighttime visual experience and nighttime seascape, open ocean, and landscape character, depending on the final location of infrastructure locations in relation to existing nighttime light sources.

Construction, operations, and decommissioning of future offshore wind projects would increase the amount of offshore light from vessels, area lighting, and the use of aircraft and vessel hazard/warning lighting on WTGs and ESPs during operations. Up to 963 WTGs would be added within the geographic analysis area. Of that total, 883 WTGs could be within 46 miles of onshore viewers in Martha's Vineyard and Nantucket (the theoretical limit for visibility).

Construction lighting would be most noticeable if construction activities occur at night. As shown in Appendix E, up to ten offshore wind projects could be constructed from 2023 through 2030 (with up to six projects other than the proposed Project simultaneously under construction in 2025). These projects would all require nighttime onshore and offshore construction lighting, as well as nighttime navigation and aviation hazard lighting during operations. Lighting associated with night construction and decommissioning of future projects would be localized and temporary, lasting only during nighttime construction. Depending on quantity, intensity, and location, construction light sources could be visible from unobstructed sensitive onshore and offshore viewing locations based on viewer distance. Sources of light would be limited to individual WTG or ESP sites under construction rather than the entire RI/MA Lease Areas.

Aircraft and vessel hazard lighting systems would be in use for the entire operations stage of each future offshore wind project, resulting in long-term impacts. The intensity of these impacts would be relatively low, as the lighting would consist of small intermittent flashing lights at a significant distance from the resources.

FAA hazard lighting systems would be used for the duration of operations for each ongoing and planned offshore wind project. This lighting would include synchronized flashing strobe lights affixed with a minimum of three red flashing lights at the mid-section of each tower and two at the top of each WTG nacelle. Field observations of FAA hazard lighting for the Block Island Wind Farm off the coast of Rhode Island were conducted in May 2019 (HDR 2019b). These observations, which occurred under clear sky conditions in open water, demonstrated that FAA hazard lighting (mounted at the nacelle top, approximately 328 feet AMSL) was visible up to 26.8 miles from the viewer (HDR 2019b). FAA hazard lighting for Alternative A would be mounted substantially higher (up to 725 feet MLLW) and would thus be visible from greater distances, although the contrast of this light would likely diminish at distances greater than 30 miles in all but ideal viewing conditions. This lighting would have long-term impacts.

Permanent aviation and vessel warning lighting would be required on all WTGs and ESPs built by future offshore wind projects. Up to 692 WTGs from other offshore wind projects would be within the geographic analysis area and close enough for the nacelle-top aviation warning lights to be visible from Martha's Vineyard or Nantucket. Navigation and aviation lighting would add a permanent developed-industrial visual element to views that were previously characterized by dark, open ocean. BOEM assumes that FAA hazard lighting for offshore wind projects in the RI/MA Lease Areas would use ADLS. ADLS would only activate FAA hazard lighting when aircraft enter a predefined airspace; studies for the proposed Project assumed a horizontal buffer of 3 nautical miles (4.1 miles) and a vertical buffer of 3,500 feet from any WTG (COP Appendix III-K; Epsilon 2023). Under these parameters, ADLS would be activated for the proposed Project less than 13 minutes per year, substantially less than 0.1 percent of annual nighttime conditions (COP Appendix III-K; Epsilon 2023). BOEM assumes that the use of ADLS for other wind energy projects would similarly limit the duration of WTG aviation warning lighting use throughout the RI/MA Lease Areas.

Lighting impacts would be most pronounced for open ocean, as well as seascapes and landscapes that can be currently characterized as undeveloped, where lighting from infrastructure and activities is not dominant or perceivable by the casual observer. Impacts on visually sensitive resources and seascapes would be short term during construction and long term during operations. Impacts during decommissioning would be similar to those described for construction, but all lighting impacts would cease as offshore wind project components are deactivated and removed.

Port utilization: Future offshore wind projects would support planned expansions and modifications at ports in the geographic analysis area (Section G.2.7, Land Use and Coastal Infrastructure). Improvements at these ports are expected to have similar visual characteristics as existing port facilities. As a result, these additional upgrades would not meaningfully change existing visual conditions at and near ports.

Presence of structures: Future offshore wind projects would add up to 963 WTGs and associated onshore substations to the landscape (Table E-1 in Appendix E). Of that total, 883 WTGs could be within 46 miles of onshore viewers in Martha's Vineyard and Nantucket (the limit for seaward views, as discussed in Section 3.16.1.2). WTGs visible from onshore locations would create long-term visual impacts. Structures associated with offshore construction activity from multiple projects could be visible simultaneously from some locations, depending on viewing conditions, although construction vessels and equipment would move throughout construction. The applicant's panoramic simulations in Attachment I-2 of Appendix I include views of the full array of WTGs in the RI/MA Lease Areas as viewed from KOPs 1, 3, 4, 5, 8, and 21 (Table 3.16-7). The magnitude of these impacts on viewers and seascape, open ocean, and landscape character would be related to the degree of the perceivable contrast, dominance, and scale of WTGs along the horizontal plane of the horizon, which depend on the viewer's proximity and orientation to the projects. Impacts would either increase or decrease as natural lighting angles and atmospheric conditions change throughout the day, and impacts would generally decrease with viewing distance (Section 3.16.3). The highest potential impacts would occur where seascape and open ocean views are present, such as in the open ocean, ocean beach, coastal bluffs, and shoreline residential units. The lowest impacts would occur for landscape character units with limited views of other offshore wind projects, such as inland forest areas.

Traffic: Future offshore wind project construction, decommissioning, and, to a lesser extent, operations, would generate increased vessel traffic that could add additional visual contrast for views within the geographic analysis area. The impacts would occur primarily during construction, along routes between ports and the future offshore wind construction areas. Some vessels (e.g., jack-up vessels) used for offshore wind project construction and decommissioning would differ in character from vessels normally present in the RI/MA Lease Areas; however, such vessels would be temporary features in any seaward view and would only be present during construction. Other vessels associated with offshore wind activity would be similar in appearance (except when viewed from the water at close range) to vessels already present in the RI/MA Lease Areas.

Conclusions

Impacts of Alternative A. Under Alternative A, seascape, landscape, and visual resources would continue to follow current regional trends and respond to current and future environmental and societal activities. While the proposed Project would not be built under Alternative A, ongoing activities would continue to shape onshore features, character, and viewer experience, and would therefore have continuing short- and long-term impacts on seascape, landscape, and visual resources.

The primary source of impacts from ongoing activities include the introduction of intrusive visual elements such as communication towers and new residential, commercial, or industrial development on land. Impacts from these activities could be **major** depending on the orientation from the resource, what seascape, open ocean, or landscape unit is being impacted, and the type of installation generating the visual impact. Most impacts on scenic and visual resources from ongoing activities would be concentrated in the open ocean, ocean beach, coastal bluffs, and shoreline residential units.

Cumulative Impacts of Alternative A. In addition to ongoing activities, planned activities would result in **major** impacts on scenic and visual resources, due to the addition of up to 883 WTGs (excluding the proposed Project) within 40 nautical miles (46 miles) of Martha's Vineyard and Nantucket by 2030 within seaward views, where few, if any, such structures currently exist. Impacts would differ throughout the seascape, open ocean, and landscape units, with the highest potential impacts occurring for open ocean and seascapes and landscapes with open ocean views, commonly found in the ocean beach, coastal bluffs, and shoreline residential units. Units located inland, such as forest and residential units away from the shoreline, would have the lowest impacts. Ongoing and planned activities in the geographic analysis area would result in **major** cumulative impacts. In clear viewing conditions, WTGs constructed in the RI/MA Lease Areas would be noticeable if not dominant in most south-facing seaward views in the geographic area. More important, the WTGs would introduce a visual character that is inconsistent with the character of seascape and open ocean units that have high levels of sensitivity.

3.16.2.2 Relevant Design Parameters, Potential Variances in Impacts, and Impact Level Definitions

The following proposed Project design parameters (Appendix C, Project Design Envelope and Maximum-Case Scenario) would influence the magnitude of the impacts on seascape, landscape, and visual resources:

- Use of WTGs other than the maximum height WTGs included in the PDE would reduce visual impacts by reducing the area of theoretical visibility, as well as the scale of WTGs visible from land.
- Use of the aboveground installation option for the Phase 1 OECR Centerville River crossing using a pipe utility bridge in the Town of Barnstable would increase visual impacts (COP Section 3.3.1.10, Volume I; Epsilon 2023).

3.16.2.3 Impacts of Alternative B – Proposed Action on Scenic and Visual Resources

This section identifies the potential impacts of Alternative B on seascape character, open ocean character, landscape character, and viewer experience in the geographic analysis area. When analyzing the impacts of Alternative B on scenic and visual resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for scenic and visual resources. Viewers or visual receptors within Alternative B's zone of theoretical visibility include:

- Residents living in coastal communities or individual residences;
- Tourists visiting, staying in, or traveling through the area;
- Recreational users of the seascape, including those using ocean beaches and tidal areas;
- Recreational boaters and other users of the open ocean;
- Recreational users of the landscape, including those using golf courses, trails, and paths;
- Tourists, workers, visitors, or local people using transport routes;
- People working in the countryside, commerce, or dwellings; and
- People working in the marine environment, such as those on fishing vessels and crews of ships.

As stated for Alternative A, the discussion of impacts on scenic and visual resources for Alternative B assumes ideal viewing conditions, including clear skies and an absence of obstructions. Actual views and impacts would depend on a variety of factors, including the character of existing daytime and nighttime visual conditions (i.e., whether existing light sources exist near a viewer or within a seascape, open ocean, or landscape) viewer distance and angle of view, and atmospheric conditions and environmental factors such as haze, sun angle, time of day, cloud cover, fog, sea spray, and wave action.

Impacts of Phase 1

Phase 1 would affect scenic and visual resources through the following primary IPFs during construction, operations, and decommissioning.

Lighting: Phase 1 would require nighttime lighting for construction vessels traveling and working within the RI/MA Lease Areas, as well as the incremental addition of hazard lighting systems at each WTG and ESP during a 2-year offshore construction period. This lighting could be visible and could impact a viewer's nighttime visual experience (from shore or at sea) and could also impact the nighttime seascape character. The VIA (COP Appendix III-H.a; Epsilon 2023) determined that nighttime lighting could affect residents and tourists in beachfront settings where they currently experience dark skies. Most year-round and vacation homes within the geographic analysis area are located inland, where topography, intervening vegetation and structures provide substantial or complete screening of the ocean; however, properties with unobstructed southern views, such as those along southern coastlines or in elevated areas, could view offshore lighting from Phase 1 (including direct views of lights and impacts such as glare or refraction off of clouds and the water). Such lighting would be more than 20 miles from the closest viewers but could still be noticeable due to the prevailing dark-sky conditions.

Light from onshore construction activities could temporarily affect viewers if they are near the landing site, OECR, and proposed onshore facilities. The applicant would install evergreen plantings between the proposed substation at 8 Shootflying Hill Road and adjacent residential properties to the west (COP Appendix III-H.a; Epsilon 2023), although these plantings may not fully mature during the construction period. However, there are no nighttime visually sensitive areas (public parks, beaches, recreational facilities, and areas of high public use) near the landing site, where nighttime construction could occur and would be limited due to the existing developed character of most of the Phase 1 OECR. Based on viewer location and perspective in relation to existing onshore light sources and the duration of effects, light from Phase 1 construction would have short-term, localized, and minor impacts on a viewer's offshore nighttime visual experience and nighttime seascape, open ocean, or landscape character. Light from Phase 1 would have short-term and negligible to minor impacts on onshore nighttime visual experience and nighttime character.

During operations, Phase 1 would contribute to nighttime lighting due to required FAA hazard lighting of up to 62 WTGs and 1 or 2 ESPs. USCG-required navigation warning lights would be mounted on the foundation on each WTG and ESP. The lighting is designed to be visible to at least 5 nautical miles (5.8 miles) during low visibility conditions and would be visible from further away under clear conditions (COP Appendix III-H.a; Epsilon 2023). This lighting could be visible to mariners at sea but would not be visible from coastal vantage points due to distance, the curvature of the earth, and the low mounting height of the lights (i.e., no more than 148 feet MLLW, based on the height of the WTG platform) (COP Section 3.2.1, Volume I; Epsilon 2023). Furthermore, the applicant's commitment to use ADLS would reduce impacts from FAA hazard lighting. During times when ADLS activates the Phase 1 FAA hazard lighting, this lighting would add a developed-industrial visual element to views that were previously characterized by dark, open ocean. Use of ADLS would result in shorter duration night sky impacts (predicted to be less than 13 minutes per year, or less than 0.1 percent of all annual nighttime conditions) on the viewer's visual experience and characteristic seascape.

Lights on WTG and ESP platforms used for periodic maintenance could potentially be visible from beaches and adjoining areas at night, either directly (in locations that have a direct line of sight to the WTG or ESP being maintained) or indirectly through reflection of light from the ocean surface or clouds. When illuminated, maintenance lighting or FAA hazard lighting would have major impacts on nighttime visual resources due to the presence of artificial lighting in an otherwise unlit area of the ocean. When not illuminated, the FAA hazard lighting would have a negligible impact, if any.

Nighttime security lighting for the proposed substation, while in use, could result in glare for nearby residential properties. Evergreen plantings installed during construction would shield residential properties west of the substation site from some of this lighting (COP Appendix III-H.a; Epsilon 2023), and mature vegetation throughout the area would screen most views of the lighting. BOEM may include the following mitigation and monitoring measure to address impacts on scenic and visual resources, as described in detail in Table H-2 of Appendix H, Mitigation and Monitoring. The Final EIS lists the mitigation and monitoring measures that BOEM could require as a condition of COP approval:

- Reduce lighting at onshore facilities, including, but not limited to, the use of the minimum number and intensity of lights necessary for safe nighttime operations and the use of full cut-off fixtures to prevent light from illuminating unnecessary areas.

The Phase 1 expansion of the West Barnstable Substation would not be adjacent to developed residential lots but would be separated from the existing homes by an undeveloped, wooded lot and the existing substation site. Additional substation lighting impacts would be minimal due to the distance from the residential lots to the new substation. BOEM would also require a lighting plan as listed in Appendix H, to ensure that lighting is shielded and directed to eliminate glare and spillover onto adjacent properties. Accordingly, with implementation of mitigation (Appendix H), security lighting for the new substation and expansion of the West Barnstable Substation would have a long-term, continuous, and negligible to minor impact on a viewer’s nighttime visual experience and nighttime seascape, open ocean, and landscape character.

Light associated with Phase 1 during decommissioning would have the same impacts as light for Phase 1 construction, with localized, short-term, and negligible impacts on scenic and visual resources.

Port utilization: Phase 1 staging and construction support would use several ports (Section G.2.7) and generate an average of 7 and a peak of 15 vessel round trips daily between ports and offshore construction work areas. Some ports potentially used for Phase 1 construction would be upgraded to support the offshore wind industry as a whole; however, Phase 1 would not include upgrades at specific ports. The use of and upgrades or expansions at these ports would continue the existing land use and visual character in these locations and would not introduce any contrasting visual elements. Construction of Phase 1 would, therefore, have a short-term and negligible impact on scenic and visual resources.

The applicant anticipates using Bridgeport Harbor as the operations base and Vineyard Haven Harbor for crew transfer and support vessels during Phase 1 operations (COP Section 7.8.2.1, Volume III; Epsilon 2023). Port utilization during operations would result in continuation of existing activities and no noticeable change in the visual character of port facilities. As a result, Phase 1 operations would have long-term, continuous, and negligible impacts on scenic and visual resources due to port utilization.

Decommissioning may result in increased use of port facilities, although upgrades discussed for offshore wind construction would already have occurred. Therefore, the impacts of port utilization for decommissioning of Phase 1 would have short-term and negligible impacts on scenic and visual resources.

Presence of structures: Up to 64 Phase 1 structures (including up to 62 WTGs and 1 or 2 ESPs) would be installed in the SWDA. During construction, offshore and onshore observers would view the upper portions of tall equipment such as mobile cranes and vessels, as well as WTGs, as they are erected. Construction vessels and equipment would move from each WTG and ESP location as the 2-year offshore construction period (and specifically the approximately 1 year required to construct ESPs and WTGs) progresses and, thus, would not be long-term fixtures. As a result, the presence of structures during Phase 1 construction would have short-term, localized, and minor impacts on the viewer’s offshore visual experience and seascape character.

Phase 1 substation construction at 8 Shootflying Hill Road would include the removal of an existing motel and the installation of the proposed improvements within a larger footprint, as well as a potential expansion of the existing West Barnstable Substation. The applicant would install evergreen plantings between the proposed substation at 8 Shootflying Hill Road and adjacent residential properties to the west (COP Appendix III-H.a; Epsilon 2023), although these plantings might not be fully mature during the construction period. Vegetation clearing and taller equipment (e.g., cranes) would be visible from certain vantage points during construction of the onshore facilities during the 2-year onshore construction period. During this period, there would be an immediate change in landscape character and the user's visual experience in the immediate foreground of the substation because of the removal of the motel. Due to low viewer sensitivity, low scenic value, and low landscape susceptibility to change, the impacts of the presence of structures on onshore visual experience and landscape character during construction of the Phase 1 substation would be short-term, localized, and negligible.

The offshore components of Phase 1 would be most visible from coastal locations on Martha's Vineyard and Nantucket. Visual simulations for the proposed Project (Section 3.16.1.3) demonstrate that Phase 1 and Phase 2 WTGs and ESPs (separate simulations were not prepared for Phase 1 and Phase 2) would be partially visible on the horizon from shore where generally unobstructed views are commonly found (COP Appendix III-H.a; Epsilon 2023). The 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 impacts of sun lighting, shade, and shadows would cause backlit contrasts and higher impacts for onshore and offshore views from northeast, north, and northwest of the proposed Project. The color contrast would vary due to sun angles, cloud cover, and atmospheric clarity, shifting from WTGs painted non-reflective white or light gray (Chapter 2, Alternatives) against a blue or gray backdrop to dark gray WTGs against a light gray backdrop. Observed from 21 miles away (i.e., the closest viewpoint on land), the width of a proposed Project WTG base would be equivalent to the width of a pencil viewed from 113 feet, while the WTG blade width would be equivalent to the width of a drinking straw 91 feet away (COP Appendix III-H.a; Epsilon 2023). Phase 1 and Phase 2 together would occupy approximately 10 to 20 percent of the 180-degree horizon line visible from any single location on Martha's Vineyard and Nantucket (Appendix I). Motion of the WTG blades, which cannot be shown in photo simulations, would draw attention, increasing visibility of the WTGs.

As shown in the representative visual simulations in the COP (Appendix III-H.a; Epsilon 2023), proposed Project WTGs would appear low on the horizon because of their distance from the KOPs (the nearest WTG would be a minimum of 22.8 miles from KOP 2 and a maximum of 30.9 miles from KOP 8), as well as the influence of the curvature of the earth, which affects the portion of the WTG structure visible above the horizon (e.g., tower, nacelle, and blades; nacelle and blades; or just blades). The WTGs would be more visually apparent as viewed from the north (e.g., KOPs 2, 3, and 4) primarily due to viewing distance. The scale of the WTGs and ESPs would become less perceivable in the seascape as the distance from viewer locations is increased. As stated previously, atmospheric and environmental factors would also influence visibility and perceivability from sensitive viewing locations. While Phase 1 would include up to 62 the 130 WTGs considered in the maximum-case scenario for scenic and visual resources (Appendix C), viewers would perceive Phase 1 WTGs as being "in front of" (i.e., closer to and potentially blocking) Phase 2 WTGs in most cases and would generate the bulk of the proposed Project's scenic and visual impacts under this IPF. The visual sensitivity of seascape, open ocean, and landscape units in the geographic analysis area is discussed in Section 3.16.1. The magnitude and overall impact of Alternative B on seascape, open ocean, and landscape units is summarized in Section 3.16.4.3. The impacts of Alternative B would only occur in locations where the proposed Project is visible. Thus, while some of the affected seascape, open ocean, and landscape units have high susceptibility, value, and sensitivity, Phase 1 would only affect a portion of most of these units. Considering these factors, as well as the applicant's simulations (COP Appendix III-H.a; Epsilon 2023), the presence of structures during Phase 1 operations would cause long-term and minor to moderate impacts on seascape/landscape resources (seascape, open ocean, and landscape units) and minor to major impacts on the users' visual experience for the life of Phase 1.

KOPs 23 through 25 (Table 3.16-7) provide views of the Phase 1 substation site. Attachment I-2 in Appendix I includes the applicant's single-frame simulations of these sites, which include the mature evergreen plantings installed along the substation property's western edge as part of the proposed Project (COP Appendix III-H.a; Epsilon 2023). The substation would differ substantially in visual character from the existing hotel (KOP 23) and the commercial structures and Park and Ride lot on the north side of U.S. Route 6 (KOP 25) and would introduce new industrial-utility structures into the landscape. These land uses have low susceptibility to change in the landscape and low scenic value. At KOP 24, the substation would differ in visual character from the trees that it would replace at the edge of ROW #343 but would generally be similar in character (especially color, texture, and form) to the transmission towers visible within ROW #343.

The Phase 1 substation would be most noticeable to the residents living along Shootflying Hill Road and those traveling to their homes on adjacent streets. These views would occur on the north and west side of the proposed site. The evergreen buffer on the western and northern boundaries of the substation site—to be installed by the applicant as part of the proposed Project—would provide visual screening for existing residences and Shootflying Hill Road. Land abutting 6 Shootflying Hill Road is undeveloped and wooded. Because the southern boundary of the substation site extends into ROW #343, no vegetated screening would be possible in that location; however, the ROW already contains aboveground structures and utility lines that are part of the existing landscape and visual character of the area. Where visible at foreground distances (i.e., less than 0.5 mile away), the substation would introduce new industrial-utility structures into the landscape but would not be out of scale or character with nearby development such as the existing transmission equipment in ROW #343, the U.S. Route 6 corridor or the nearby Park and Ride and rest area. Due to low viewer sensitivity, low scenic value, and low landscape susceptibility to change, the impacts of the presence of structures on onshore visual experience and landscape character during construction of the Phase 1 substation would be short term, localized, and negligible.

If the applicant installs the Phase 1 OECR crossing of the Centerville River using a pipe utility bridge, the resulting structure would add an industrial structure immediately adjacent to the existing road bridge that carries Craigville Beach Road across the river. This structure would be visible from residences near the bridge and by other user groups traveling on Craigville Beach Road and in the Centerville River; however, the extent and duration of views would be limited to the immediate vicinity of the east side of the bridge. This option is not the applicant's preferred installation method (COP Section 3.3.1.10, Volume I; Epsilon 2023). For these reasons, operations of the Phase 1 substation would result in long-term and negligible impacts on the onshore viewer's visual experience and landscape character at all identified KOPs, except for localized and minor impacts if the aboveground Centerville River crossing is installed.

Visual impacts from Phase 1 decommissioning would be similar to construction activities. The Phase 1 substation structures may remain, subject to discussions with the Town of Barnstable (COP Appendix III-H.a; Epsilon 2023). As a result, impacts from the presence of structures on onshore visual experience and landscape character during Phase 1 decommissioning would be short term or long term (depending on whether the substation remains in place), localized, and negligible.

Traffic: Phase 1 construction would contribute to increased vessel traffic that could add additional visual contrast at identified views within the geographic analysis area, similar to the impacts described for Alternative A. Phase 1 would result in short-term, variable, and negligible impacts on offshore visual experience and seascape character.

Phase 1 operations would contribute to increased vessel traffic. This vessel traffic would be less than, but otherwise similar to, the traffic described for the construction phase. As a result, vessel operations from Phase 1 would result in short-term, variable, and negligible impacts on offshore visual experience and open ocean and seascape character.

The impacts of vessel traffic during decommissioning would be the same as that described for construction.

Impacts of Phase 2

The impacts of Phase 2 construction, operations, and decommissioning would be similar to those described for Phase 1. While Phase 2 would involve the construction, operations, and decommissioning of more WTGs (88 versus 62) and ESPs (up to three versus up to two), the incremental differences in activity between Phase 2 and Phase 1 would not change any of the impact magnitudes described for Phase 1 construction.

If the applicant includes the SCV as part of the final proposed Project design, construction of the SCV OECC would result in the presence of structures (i.e., temporarily stationary vessels and onshore structures in Bristol County, Massachusetts) and vessel lights in a different location than the proposed Phase 2 OECC. The impacts of this activity on seascape, landscape, and visual resources would be similar to those described for Phase 1 and Phase 2. Implementation of the SCV would impact onshore seascape, landscape, and visual resources in Bristol County. If the SCV is selected, those impacts will be evaluated in a supplemental NEPA analysis once the onshore route is identified.

Cumulative Impacts

The cumulative impacts of Alternative B considered the impacts of Alternative B in combination with other ongoing and planned wind activities. Ongoing and planned non-offshore wind activities described in Table G.1-13 in Appendix G would contribute to impacts on scenic and visual resources through the primary IPFs of lighting and the presence of structures. Onshore construction associated with other offshore wind projects is not expected to occur in the same area as Alternative B onshore construction and, thus, would not generate cumulative impacts. Construction and operational lighting from other offshore wind projects (i.e., navigation lights and aviation hazard lights) would often be visible at the same time as lighting from Alternative B. As stated in Section 3.16.2.1, BOEM assumes that all offshore wind projects in the RI/MA Lease Areas would use ADLS, which would greatly limit the frequency and duration of aviation hazard lighting use. During the daytime, WTGs from Phase 1 would be perceptible but indistinguishable from the WTGs of other projects. Proposed Project WTGs would generally be “behind” the WTGs from other projects and would, thus, contribute only incrementally to the overall seascape, landscape, and visual impacts.

Based on these considerations, ongoing and planned activities in the geographic analysis area, including Alternative B and other offshore wind projects combined with ongoing activities, would have long-term and minor to major impacts on visual experience and seascape, open ocean, and landscape character. Moderate impacts would be concentrated in open ocean and seascape and landscape units near the shore, while minor impacts would be concentrated in units located further inland. Short-term and **major** impacts would occur when aviation hazard lights are illuminated. Onshore facilities would have long-term, localized, and negligible impacts.

Conclusions

Impacts of Alternative B. Based on the IPFs described for Alternative B, Table 3.16-9 summarizes the SLIA magnitude ratings for each seascape, open ocean, and landscape unit within the geographic analysis area. These ratings only apply to locations within units that have views of the proposed Project and other offshore wind projects. Areas with no views of a WTG would experience no seascape/landscape impacts. Table 3.16-10 describes the VIA impact ratings for each KOP for which simulations (single frame or panoramic) were prepared.

Construction, operations, and decommissioning would introduce visible vessels, structures, and hazard lighting to the geographic analysis areas. The most substantial seascape/landscape and visual impacts would occur due to the presence of structures, specifically the proposed Project's WTGs and onshore substation. As described for the IPFs above, the incremental impacts resulting from Alternative B would range from short term to long term and from minor to major, depending on the seascape, open ocean, or landscape unit affected and the exact location of a viewer. Appendix I provides a more detailed description of this range of impacts. Alternative B, in combination with ongoing offshore wind projects, could have long-term and major impacts on seascape/landscape resources and long-term and major impacts on viewer experience. Overall, the impacts of Alternative B on scenic and visual resources would be long term and **major**, primarily due to the impacts on open ocean and seascape units (Table 3.16-9). In clear viewing conditions, the proposed Project's WTGs would be noticeable (although not dominant) for most south-facing seaward views in the geographic area. More important, the WTGs would introduce a visual character that is inconsistent with the character of the affected seascape and open ocean units, all of which have high levels of sensitivity.

Cumulative Impacts of Alternative B. The incremental impacts of individual IPFs from ongoing and planned activities would range from minor to major. Alternative B when combined with ongoing and planned activities would have **major** cumulative impacts on the viewer's visual experience and moderate impacts on the seascape, open ocean, and landscape character. This determination reflects the cumulative moderate impacts of other offshore wind projects and the minor impacts of the proposed Project alone. Proposed Project WTGs would be perceptible but indistinguishable from the WTGs of other projects. Proposed Project WTGs would generally be "behind" the WTGs from other projects and would, thus, contribute incrementally to the overall seascape, landscape, and visual impacts.

Table 3.16-9: Seascape and Landscape Impacts from Presence of Structures

Impact Level[a]	Seascape and Landscape Units Impacted: Proposed Project	Seascape and Landscape Units Impacted: Proposed Project and Other Offshore Wind Projects
Negligible	Forest	Forest
Minor	Salt Pond/Tidal Marsh, Coastal Scrub Brush, Shoreline Residential, Village/Town Center, Rural Residential, Suburban Residential, Agricultural/Open Field	Village/Town Center, Rural Residential, Suburban Residential, Agricultural/Open Field
Moderate	Coastal Dunes	Coastal Dunes, Salt Pond/Tidal Marsh, Shoreline Residential, Coastal Scrub Brush
Major	Ocean Beach, Coastal Bluffs, Open Ocean	Ocean Beach, Coastal Bluffs, Open Ocean, Coastal Dunes

[a] This is applicable to portions of each seascape or landscape unit where views of the proposed Project and other offshore wind projects would be visible. No impacts would occur where offshore wind projects are not visible.

Table 3.16-10: Visual Impacts from Presence of Structures

KOP	Impact Magnitude: Proposed Project	Impact Magnitude: Proposed Project and Other Offshore Wind Projects
1. Aquinnah Cultural Center	Minor	Major
2. Long Point Beach	Minor	Moderate
3. South Beach	Minor	Major
4. Wasque Reservation	Minor	Major
5. Madaket Beach	Minor	Major
6. Miacomet Beach and Pond	Minor	Moderate
7. Bartlett's Farm	Minor	Minor
8. Tom Nevers Field	Minor	Moderate
21. Peaked Hill Reservation	Minor	Major
22. Representative Offshore View[a]	Major	Major
23. Shootflying Hill Road (Existing Hotel)	Moderate	NA[b]
24. Shootflying Hill Road (Transmission Corridor)	Minor	NA[b]
25. Exit 6 Park and Ride/Highway Rest Area	Minor	NA[b]

KOP = key observation point; NA = not applicable

[a] Noticeable elements for offshore viewers would vary based on the location of the viewer relative to the offshore wind projects. Based on the likely sizes of WTGs (Table I-12 in Appendix I), all elements of an individual WTG would be visible within approximately 14.6 miles of that WTG position (COP Appendix III-H.a, Section 3.2; Epsilon 2023). Visibility rating reflects closest possible views (i.e., adjacent to or within the WTG array) but could range from 1 to 6 depending on the viewer's location.

[b] No other offshore wind projects would interconnect at the Phase 1 substation; therefore, there is no impact rating for the proposed Project in combination with other offshore wind projects.

3.16.2.4 Impacts of Alternative C – Habitat Impact Minimization Alternative on Scenic and Visual Resources

When analyzing the impacts of Alternative C on scenic and visual resources, BOEM considered the impacts of ongoing activities, including ongoing non-offshore wind and ongoing offshore wind activities, on existing conditions for scenic and visual resources Alternatives C-1 and C-2 would not affect the number or placement of WTGs or ESPs or the location or character of substation facilities for the proposed Project compared to Alternative B. Alternatives C-1 and C-2 would alter the exact routes of export cables through Muskeget Channel and could affect the exact length of cable installed and area of ocean floor disturbed or the exact location of construction or maintenance vessel activity. These differences would not result in meaningfully different impacts compared to Alternative B. Therefore, the impacts of Alternatives C-1 and C-2 on scenic and visual resources would be the same as those for Alternative B: **major**. Cumulative impacts of Alternative C on scenic and visual resources would also be **major**.

3.16.2.5 Impacts of the Preferred Alternative – Habitat Impact Minimization Alternative on Scenic and Visual Resources with the Western Muskeget Variant Contingency Option

Impacts on scenic and visual resources from the Preferred Alternative would be as follows:

- The Preferred Alternative cable alignment would be identical to Alternative C-1 (Scenario 1 for Phase 2) if the Western Muskeget Variant Contingency Option were not exercised, resulting in impacts from cable placement that would align with those described for Alternative C-1.
- The Preferred Alternative cable alignment would be identical to Alternative B (Scenario 2 for Phase 2) if the Western Muskeget Variant Contingency Option were exercised, resulting in impacts from the cable placement that would align with those described for Alternative B.

- The Preferred Alternative would not allow for the co-location of ESPs at up to two locations, resulting in 130 WTG or ESP positions, as opposed to the potential of up to 132 WTG or ESP positions (Table H-2 in Appendix H), as described under Alternative B. This would reduce the potential impacts on scenic and visual resources by a negligible increment for both Phase 1 and Phase 2, as there could be two fewer structures (WTGs or ESPs) potentially installed in the SWDA.

While the Preferred Alternative would slightly reduce the extent of adverse impacts on scenic and visual resources relative to Alternative B, the general scale, nature, and duration of impacts are comparable to those described for Alternative B. The Preferred Alternative would have **major** impacts on scenic and visual resources within the geographic analysis area. The cumulative impacts of the Preferred Alternative would be similar to those of Alternative B: **major**.

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