VINEYARD NORTHEAST

CONSTRUCTION AND OPERATIONS PLAN
VOLUME II

MARCH 2024

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VINEYARD OFFSHORE

PUBLIC VERSION

Vineyard Northeast COP

Volume II

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Prepared for:
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March 2024

Revision	Date	Description
0	July 2022	Initial submission.
1	March 2023	Updated to address Bureau of Ocean Energy Management (BOEM) and United States Coast Guard (USCG) Round 1 Comments (dated January 13, 2023) and make minor corrections.
2	April 2023	Updated to address BOEM Round 1 Comments (dated January 13, 2023) and Round 2 Comments (dated March 1, 2023), made minor revisions to the Massachusetts and Connecticut Offshore Export Cable Corridors (OECCs) as well as the [redacted], made updates consistent with revisions to the Volume II Appendices, and made other minor corrections.
3	November 2023	Updated to address BOEM and USCG Round 3 Comments (dated August 8, 2023) and Round 4 Comments (dated September 29, 2023), to reflect revisions to the onshore Project Design Envelope, and to reflect the revised maximum monopile diameter of 14 m (46 ft). Made other minor revisions.
4	March 2024	Made minor revisions.

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List of Acronyms

AC	alternating current
ACK	Nantucket Memorial Airport
ACS	American Community Survey
ADLS	Aircraft Detection Lighting System
AEP	auditory evoked potential
AGL	above ground level
AIANNH	American Indian/Alaska Native/Native Hawaiian Areas
AIS	Automatic Identification Systems
ALARP	As Low As Reasonably Practical
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMSL	above mean sea level
ANSI	American National Standards Institute
APE	Area of Potential Effects
APLIC	Avian Power Line Interaction Committee
ARSR	air route surveillance radar
ARTCC	Air Route Traffic Control Center
ASLF	Ancient Submerged Landform Feature
ASMFC	Atlantic States Marine Fisheries Commission
ASR	airport surveillance radar
ATON	Aids to Navigation
BA	Biological Assessment
BACT	Best Available Control Technology
BAG	Bathymetric Attributed Grid
BIA	Biologically Important Areas
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CBRA	Cable Burial Risk Assessment
CEQ	Council of Environmental Quality
CeTAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
CGS	Connecticut General Statute
CH_4	methane
CI	credible interval
CL	carapace length
CLCPA	Climate Leadership and Community Protection Act
CMECS	Coastal and Marine Ecological Classification Standards
CMP	Construction Management Plan
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COA	Corresponding Onshore Area

List of Acronyms (Continued)

COP	Construction and Operations Plan
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CO-OPS	Operational Oceanographic Products and Services
CPT	cone penetration test
CSIRO	Commonwealth Scientific and Industrial Research Organization
CT	Connecticut
CT DEEP	Connecticut Department of Energy and Environmental Protection
CTSHPO	Connecticut State Historic Preservation Office
CTV	Crew Transfer Vessel
CVA	Certified Verification Agent
CVOW	Coastal Virginia Offshore Wind
CWIS	cooling water intake structure
DAC	Disadvantaged Communities
DAS	distributed acoustic sensing
dB	decibel
DC	direct current
DCR	(Massachusetts) Department of Conservation and Recreation
DECD	(Connecticut) Department of Economic Community Development
DFO	Department of Fisheries and Oceans Canada
DHS	Department of Homeland Security
DIN	dissolved inorganic nitrogen
DIP	dissolved inorganic phosphorus
DMA	Dynamic Management Areas
DME	Distance Measuring Equipment
DMM	discarded military munitions
DO	dissolved oxygen
DoD	Department of Defense
DP	dynamic positioning
DPS	distinct population segment
DTD	difficult to drive
DTS	distributed temperature sensing
EC	East Coast
EEA	Energy and Environmental Affairs
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EJMAP	Environmental Justice: Mapping, Assessment, and Protection
EJScreen	Environmental justice screening tool
EM	electromagnetic
EMF	electromagnetic field
EO	Executive Order

List of Acronyms (Continued)

EPA	Environmental Protection Agency
ER	exposure range
ES	Executive summary
ESA	Endangered Species Act
ESP	electrical service platform
EWR	Early Warning Radar
FAA	Federal Aviation Administration
FCP	fisheries communication plan
FDR	Facility Design Report
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Act
FIR	Fabrication and Installation Report
FL	Fisheries Liaison
FMP	fishery management plan
FR	Federal Regulation
FR	Fisheries Representative
ft	feet
FTE	full-time equivalent
GARFO	Greater Atlantic Regional Fisheries Office
GDP	gross domestic product
GHG	greenhouse gas
GIS	Geographic Information Systems
GWSA	Global Warming Solutions Act
HAP	hazardous air pollutant
HAT	Highest Astronomical Tide
HC	hydrocarbon
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HF	high frequency
HMS	highly migratory species
HRG	high resolution geophysical
HRVEA	Historic Resources Visual Effects Assessment
HSD	HydroSound Dampers
HSE	Health, Safety, and Environmental
HVAC	high voltage alternating current
HVDC	high voltage direct current
Hz	hertz
IEA	International Energy Agency
IFR	instrument flight rules
IMO	International Maritime Organization
in	inches
IOOS	Integrated Ocean Observing System

List of Acronyms (Continued)

IPaC	Information for Planning and Consultation
IPF	impact producing factor
IR	infrared
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
IWG	Interagency Working Group on Social Cost of Greenhouse Gases
kg	kilogram
km	kilometer
km^2	square kilometer
KOP	Key Observation Points
KP	kilometer post
kV	kilovolt
LAER	Lowest Achievable Emission Rate
lb	pound
L_E	sound exposure level
LF	low-frequency
LID	low-impact development
LiDAR	Light Detection and Ranging
LMA	Lobster Management Area
LNM	Local Notice to Mariner
Lp	root mean square sound pressure
L_{pk}	peak sound pressure
m	meter
m^2	square meter
MA	Massachusetts
MA CZM	Massachusetts Office of Coastal Zone Management
MA DMF	Massachusetts Division of Marine Fisheries
MA NHESP	Massachusetts Natural Heritage and Endangered Species Program
MA WEA	Massachusetts Wind Energy Area
MAB	Mid-Atlantic Bight
MARA	Marine Archaeological Resources Assessment
MARCO	Mid-Atlantic Council on the Ocean
MARIPARS	Massachusetts and Rhode Island Port Access Route Study
MARPOL	International Convention for the Prevention of Pollution from Ships
MASHPO	Massachusetts State Historic Preservation Office
MassCEC	Massachusetts Clean Energy Center
MassDEP	Massachusetts Department of Environmental Protection
MCS	multichannel seismic reflection
MDAT	Marine-life Data and Analysis Team
MF	mid-frequency
MF	magnetic field
mG	milliGauss

List of Acronyms (Continued)

mg/L	milligrams per liter
mi	mile (statute)
MLLW	Mean Lower Low Water
mm	millimeter
MMIS	Marine Mineral Information System
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MMT	million metric tons
MP	monopile
MRASS	Mariner Radio Activated Sound Signals
MRIP	Marine Recreation Information Program
MSIR	Marine Site Investigation Report
MSL	Mean Sea Level
MVA	minimum vectoring altitude
MVY	Martha's Vineyard Airport
MW	megawatts
NA	not applicable
NAAQS	National Ambient Air Quality Standards
NABat	North American Bat Monitoring Program
NAICS	North American Industry Classification System
NAMMCO	North Atlantic Marine Mammal Commission
NARW	North Atlantic right whale
NAS	noise abatement system
NAVFAC	Naval Facilities Engineering Systems Command
NCCA	National Coastal Conditions Assessment
NDBC	National Data Buoy Center
NDDB	Natural Diversity Database
NEAq	New England Aquarium
NEAMAP	NorthEast Area Monitoring and Assessment Program
NEFSC	Northeast Fisheries Science Center
NEODP	Northeast Ocean Data Portal
NEPA	National Environmental Policy Act
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NEXRAD	Next Generation Radar
NHESP	National Heritage and Endangered Species Program
NHPA	National Historic Preservation Act
NJ	New Jersey
NJWP	New Jersey Wind Port
NLCD	National Land Cover Database
NLPSC	Northeast Large Pelagic Survey Collaborative
NM	nautical mile
NMFS	National Marine Fisheries Service

List of Acronyms (Continued)

NMS	noise mitigation system
N_2O	nitrous oxide
NOAA	National Oceanic and Atmospheric Administration
NOx	nitrogen oxides
NORM	Navigational and Operational Risk Model
NOS	National Ocean Service
NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Service
NRHP	National Register of Historic Places
NROC	Northeast Regional Ocean Council
NSRA	Navigation Safety Risk Assessment
NTIA	National Telecommunications and Information Administration
NTM	Notice to Mariners
NVD	night vision devices
NW	Northwestern
NWS	National Weather Service
NY	New York
NYS	New York State
NYSCJWG	New York State Climate Justice Working Group
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
OBIS	Ocean Biodiversity Information System
OCS	Outer Continental Shelf
OE/AA	Obstruction Evaluation/Airspace Analysis
OECC	offshore export cable corridor
OES	Ocean Energy Systems
OFL	Onboard Fisheries Liaison
OLPD	online partial discharge
OMP	Ocean Management Plan
OPAREA	Operating Areas
OSP	optimal sustainable population
OSRP	Oil Spill Response Plan
OTR	Ozone Transport Region
OWET	Oregon Wave Energy Trust
PAL	Public Archaeology Laboratory
PAM	passive acoustic monitoring
PAPE	Preliminary Area of Potential Effects
PATON	Private Aid to Navigation
PBR	potential biological removal
PDE	Project Design Envelope
PK	peak
PM	particulate matter

List of Acronyms (Continued)

POI	point of interconnection
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
PSO	Protected Species Observer
PTS	permanent threshold shift
PVC	polyvinyl chloride
PW	Phocid pinnipeds
QMA	Qualified Marine Archaeologist
RI	Rhode Island
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area
RIDEM	Rhode Island Department of Environmental Management
ROTV	remotely operated towed vehicles
ROV	remotely operated vehicle
ROW	right-of-way
RSD	rippled scour depressions
RSZ	rotor swept zone
SAR	search and rescue
SAR	stock assessment report
SATV	service accommodation and transfer vessel
SC	Special Concern
SCADA	supervisory control and data acquisition
SC-GHG	social cost of greenhouse gases
SCL	straight carapace lengths
SD	standard deviation
SEFSC	Southeast Fisheries Science Center
SEIS	Supplemental Environmental Impact Statement
SEL	sound exposure level
SF_6	sulfur hexafluoride
SFS	Space Force Station
SFV	Sound Field Verification
SGCN	Species of Greatest Conservation Need
SHPO	State Historic Preservation Officer
SL	sound levels
SLVIA	Seascape, Landscape, and Visual Impact Assessment
SMA	Seasonal Management Area
SMAST	University of Massachusetts Dartmouth School of Marine Science and Technology
SNE	southern New England
SOSUS	Sound Surveillance System
SO_2	sulfur dioxide
SOV	service operation vessel
SPCC	Spill Prevention, Control, and Countermeasure

List of Acronyms (Continued)

SPL	sound pressure level
SPUE	sightings per unit effort
STSSN	Sea Turtle Stranding and Salvage Network
TARA	Terrestrial Archaeological Resources Assessment
TCP	traditional cultural property
TDWR	Terminal Doppler Weather Radar
TED	Turtle Excluder Device
TEWG	Turtle Expert Working Group
THPO	Tribal Historic Preservation Officer
TMP	Traffic Management Plan
tpy	tons per year
TRACON	Terminal Radar Approach Control
TSS	total suspended solids
TSS	traffic separation scheme
TTS	temporary threshold shift
UK	United Kingdom
ULSD	ultra-low sulfur diesel
UME	Unusual Mortality Event
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCG	United States Coast Guard
USD	United States Dollar
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UUU	Newport State Airport
UXO	unexploded ordnance
VGP	Vessel General Permit
VHF	very high frequency
VMS	vessel monitoring system
VOC	volatile organic compounds
VOR	Very High Frequency Omnidirectional Range
VSA	visual study area
VTR	vessel trip report
WDA	Wind Development Area
WEA	Wind Energy Area
WFO	Weather Forecast Office
WHOI	Woods Hole Oceanographic Institution
WNS	white-nose syndrome
WOA	World Ocean Atlas
WSR	Weather Surveillance Radar
WTG	wind turbine generator

List of Acronyms (Continued)

WTRIM	Wind Turbine Radar Interference
ZLV	Zone of Likely Visibility
ZTV	Zone of Theoretical Visibility

1 Introduction

1.1 Overview of Vineyard Northeast

Vineyard Northeast LLC (the "Proponent") proposes to develop, construct, and operate offshore renewable wind energy facilities in Bureau of Ocean Energy Management (BOEM) Lease Area OCS-A 0522 (the "Lease Area") along with associated offshore and onshore transmission systems. This proposed development is referred to as "Vineyard Northeast."

Vineyard Northeast includes 160 total wind turbine generator (WTG) and electrical service platform (ESP) positions within the Lease Area. Up to three of those positions will be occupied by ESPs[1] and the remaining positions will be occupied by WTGs. As proposed, the WTGs and ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with 1 nautical mile (NM) (1.9 kilometer [km]) spacing between positions. The WTGs and ESP(s) will be supported by monopiles or piled jacket foundations. The base of the foundations may be surrounded by scour protection. Submarine inter-array cables will transmit power from groups of WTGs to the ESP(s). If two or three ESPs are used, they may be connected with inter-link cables. Offshore export cables will then transmit the electricity collected at the ESP(s) to shore.

The WTGs, ESP(s), and their foundations as well as the inter-array cables, inter-link cables (if used), and a portion of the offshore export cables will be located in Lease Area OCS-A 0522. The Lease Area is within the Massachusetts Wind Energy Area (MA WEA) identified by BOEM, following a public process and environmental review, as suitable for offshore wind energy development. At its closest point, the 536 square kilometer (km^2) (132,370 acre) Lease Area is approximately 46 km (29 miles [mi]) from Nantucket. Between the Lease Area and shore, the offshore export cables will be installed within two offshore export cable corridors (OECCs)—the Massachusetts OECC and the Connecticut OECC—that connect to onshore transmission systems in Massachusetts and Connecticut.

The Massachusetts OECC travels from the northernmost tip of the Lease Area along the northeastern edge of the MA WEA and Rhode Island/Massachusetts (RI/MA) WEA and then heads across Buzzards Bay towards the Horseneck Beach Landfall Site in Westport, Massachusetts. Up to two high voltage direct current (HVDC) cable bundles or up to three high voltage alternating current (HVAC) cables may be installed within the Massachusetts OECC. If HVAC offshore export cables are used, the cables would connect to a booster station in the northwestern aliquot[2] of Lease Area OCS-A 0534 to boost the electricity's voltage level, reduce transmission losses, and enhance grid capacity. From the Horseneck Beach Landfall Site, onshore export cables will connect to a new onshore substation in Westport, Fall River, or

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1 If two or three ESPs are used, they may be located at separate positions or two of the ESPs may be co-located at the same grid position. Co-located ESPs would be smaller structures installed on monopile foundations.

2 An aliquot is 1/64th of a BOEM Outer Continental Shelf (OCS) Lease Block.

Somerset, Massachusetts. Grid interconnection cables will connect the onshore substation to one of three potential points of interconnection (POIs): the existing Pottersville Substation, a planned substation near Brayton Point, or the existing Bell Rock Substation.

Up to two HVDC offshore export cable bundles may be installed within the Connecticut OECC. The Connecticut OECC travels from the southwestern tip of the Lease Area along the southwestern edge of the MA WEA and then heads between Block Island and the tip of Long Island towards potential landfall sites near New London, Connecticut. As the Connecticut OECC approaches shore, it splits into three variations to connect to three potential landfall sites: the Ocean Beach Landfall Site, the Eastern Point Beach Landfall Site, and the Niantic Beach Landfall Site. Onshore export cables will connect one of the landfall sites to a new onshore substation in Montville, Connecticut, which will be connected to the POI at the existing Montville Substation by grid interconnection cables.

Vineyard Northeast is being developed and permitted using a Project Design Envelope (PDE) based on expected commercial and technological advancements. The PDE outlines a reasonable range of project design parameters (e.g., multiple foundation types) and installation techniques (e.g., use of various cable installation tools). The Proponent has developed the PDE and sited Vineyard Northeast's facilities based on feedback from multiple agencies and stakeholders. For example, the Proponent modified and refined the OECCs through numerous consultations with federal and state agencies as well as fishermen and, based on their feedback, consolidated the offshore export cables with other developers' proposed cables to the extent feasible. Key elements of Vineyard Northeast's PDE are summarized in Table 1.1-1. For a complete description of Vineyard Northeast's offshore and onshore facilities, see Construction and Operations Plan (COP) Volume I.

Table 1.1-1 Summary of the Project Design Envelope

Parameter	Project Design Envelope
Maximum number of WTG/ESP positions	160
Wind Turbine Generators	
Maximum number of WTGs	160
Maximum rotor diameter	320 meters (m) (1,050 feet [ft])
Maximum tip height	400 m (1,312 ft)
Minimum tip clearance	27 m (89 ft)

Table 1.1-1 Summary of the Project Design Envelope (Continued)

Parameter	Project Design Envelope
Electrical Service Platforms and Booster Station	
Number of ESPs	0–3 (ESP equipment may be integrated onto WTG foundation[s])[1]
Maximum number of booster stations	1 (only for HVAC transmission)
Maximum topside height above Mean Lower Low Water[2]	70 m (230 ft)
Foundations and Scour Protection	
Maximum pile diameter	Monopiles: 14 m (46 ft) Piled jackets: 4.25 m (14 ft)
Maximum area of scour protection	monopiles: 7,238 square meters (m^2) (1.8 acres) WTG piled jackets: 11,660 m^2 (2.9 acres) ESP piled jackets: 32,577 m^2 (8.1 acres) Booster station piled jackets: 18,427 m^2 (4.6 acres)
Offshore Cables	
Maximum total inter-array cable length	356 km (192 NM)
Maximum total inter-link cable length	120 km (65 NM)
Maximum number of offshore export cables	Massachusetts OECC: 3 HVAC cables or 2 HVDC cable bundles Connecticut OECC: 2 HVDC cable bundles
Maximum total offshore export cable length[3]	Massachusetts OECC: 436 km (235 NM) Connecticut OECC: 421 km (227 NM)
Target burial depth beneath stable seafloor[4]	1.5–2.5 m (5–8 ft)
Onshore Facilities	
Massachusetts landfall site	Horseneck Beach Landfall Site
Connecticut landfall site	Ocean Beach Landfall Site, Eastern Point Beach Landfall Site, or Niantic Beach Landfall Site
Massachusetts onshore cable route	Horseneck Beach Eastern Onshore Cable Route or Horseneck Beach Western Onshore Cable Route (including variants)
Connecticut onshore cable route	Ocean Beach Onshore Cable Route, Eastern Point Beach Onshore Cable Route, or Niantic Beach Onshore Cable Route

Table 1.1-1 Summary of the Project Design Envelope (Continued)

Parameter	Project Design Envelope
Onshore Facilities (Continued)	
Onshore substation site envelopes[5]	Massachusetts: [redacted] Connecticut: [redacted]
POIs	Massachusetts: Pottersville POI, Brayton Point POI, or Bell Rock POI Connecticut: Montville POI

Notes:

1. As described in Section 3.4 of COP Volume I, this concept entails placing ESP equipment on one or more expanded WTG foundation platforms rather than having a separate ESP situated on its own foundation.
2. Height includes helipad (if present), but may not include antennae and other appurtenances.
3. Includes the length of the offshore export cables within the Lease Area.
4. Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.
5. Since the Proponent has not yet secured site control for the onshore substation sites, the Proponent has identified one or more "onshore substation site envelopes" for each POI.

1.2 Construction

Construction of Vineyard Northeast will likely start with the onshore cables and onshore substations. The onshore cables are expected to be installed primarily underground within public roadway layouts or within existing utility rights-of-way (ROWs) via open trenching. The onshore cables may be installed in a duct bank (i.e., an array of plastic conduits encased in concrete) or within directly buried conduit(s). In most instances, underground trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies). However, the northern crossing of the Taunton River [redacted] may require a segment of overhead transmission lines.[3] Construction of the onshore substations is expected to involve site preparation (e.g., land clearing and grading), installation of the substation equipment and cables, commissioning, and site clean-up and restoration.

[3] As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

Offshore construction will likely begin with offshore export cable installation and/or foundation installation (including scour protection installation). Once the foundations are in place, the WTGs, ESP topside(s), and booster station topside can be installed. Inter-array cables may be installed before or after the WTGs are installed on their foundations. WTG commissioning is expected to take place after the inter-array cables are installed.

Prior to offshore cable installation, the cable alignments may require sand bedform dredging and boulder clearance. Following those activities, pre-lay grapnel runs and pre-lay surveys will be performed to confirm that the cable alignments are suitable for installation. The offshore cables will then be buried beneath the stable seafloor at a target depth of 1.5 to 2.5 meters (m) (5 to 8 feet [ft])[4] likely using jetting techniques or a mechanical plow. While every effort will be made to achieve sufficient burial, a limited portion of the offshore cables may require cable protection if a sufficient burial depth cannot be achieved. At the landfall sites, the offshore export cables are expected to transition onshore using horizontal directional drilling (HDD) to avoid or minimize impacts to the beach, intertidal zone, and nearshore areas. The offshore export cables will connect to the onshore export cables in underground transition vaults at the landfall sites.

The foundations, WTGs, ESP topside(s), and booster station topside (if used) may be staged at a United States (US) or Canadian port or delivered directly to the Lease Area. The Proponent has identified several potential staging ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Canada that may be used for frequent crew transfer and for offloading/loading, storing, and pre-assembling components, among other activities (see Section 3.10.1 of COP Volume I). The foundations, WTGs, and topside(s) will be installed by jack-up vessels or heavy lift vessels using dynamic positioning (DP) or anchors along with necessary support vessels (e.g., tugboats). Seabed preparation may be required prior to foundation installation. Scour protection, which would likely consist of loose rock material placed around the foundation, will likely be needed for monopiles, but may or may not be needed for the smaller diameter jacket pin piles. Once set onto the seabed by the crane of the main installation vessel(s), monopiles or jacket pin piles will be installed using impact pile driving,[5] which will begin with a soft-start (i.e., the impact hammer energy level will be gradually increased). Noise mitigation systems are expected to be applied during pile driving. If monopile foundations are used, a transition piece will be installed on top of the monopile using a vessel's crane (unless an extended monopile concept is employed). Once the foundations are installed, the WTGs, ESP topside(s), and booster station topside will be lifted and secured onto their foundations. Then, the WTGs, ESP(s), and booster station will be

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4 Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

5 Prior to impact pile driving, a vibratory hammer or other tool could be used to slowly lower the pile through the top layers of the seabed in a controlled fashion to avoid the potential for a "pile run" (see Section 3.3 of COP Volume I)

commissioned to confirm that they are functioning correctly and ready for energy production. To aid safe navigation, the WTGs, ESP(s), booster station, and their foundations will be equipped with marine navigation and aviation lighting, marking, and signaling in accordance with BOEM, US Coast Guard (USCG), and Federal Aviation Administration (FAA) guidance.

1.3 Operations and Maintenance

Vineyard Northeast's facilities are expected to operate for approximately 30 years. During operations, the offshore and onshore facilities will be continuously remotely monitored from one or more control center(s) located at the Proponent's operations and maintenance (O&M) facilities and/or a third party's facilities.

The WTGs, ESP(s), and booster station will be designed to operate autonomously and will not be manned. The offshore facilities will be equipped with a supervisory control and data acquisition (SCADA) system. The SCADA system will notify operators of alarms or warnings and enable the operators to remotely interact with and control devices (e.g., sensors, valves, motors), override automatic functions, reset systems, and shut down equipment for maintenance or at the request of grid operators or agencies. The Proponent anticipates that the offshore cables will include a monitoring system, such as distributed temperature sensing (DTS), online partial discharge (OLPD) monitoring, and/or distributed acoustic sensing (DAS), to continuously monitor the cables' status.

The Proponent will regularly conduct inspections and preventative maintenance, including foundation and scour protection inspections, offshore cable surveys, safety inspections and tests, electrical component service, and replacement of consumables, among other activities. Offshore, most scheduled maintenance activities will be performed using service operation vessels (SOVs), service accommodation and transfer vessels (SATVs), crew transfer vessels (CTVs), and/or helicopters. Unscheduled repairs or component replacement may also be necessary, which may require jack-up vessels or other larger vessels similar to those used during construction. The Proponent expects to use one or more onshore O&M facilities to support offshore operations. The O&M facilities, which could be located at or near any of the ports identified in Section 4.4.1 of COP Volume I, would likely be used for dispatching technicians and crew exchange, bunkering, and loading supplies and spare parts onto vessels. The Proponent may also lease space at an airport hangar for aircraft (e.g., helicopters) used to support operations. Onshore maintenance and repair activities are expected to require minimal use of worker vehicles and construction equipment.

1.4 Decommissioning

Decommissioning of the offshore and onshore facilities at the end of their operational life is essentially the reverse of the construction process. The WTGs, ESP(s), and booster station (if used) will be disconnected from the offshore cables, disassembled, and removed from their foundations. The foundations will be cut and removed to a depth of 4.5 m (15 ft) below the mudline, unless otherwise authorized by the Bureau of Safety and Environmental Enforcement

(BSEE). The removed WTG, ESP, booster station, and foundation components will be shipped to shore and properly disposed of or recycled. The offshore cables may be removed or retired in place (if authorized by BOEM and other appropriate agencies). Any scour protection or cable protection may be removed or left in place, depending on input from federal and state agencies and relevant stakeholders. The onshore facilities could be retired in place or retained for future use, subject to discussions with local agencies.

1.5 Summary of the Maximum Design Scenario for Resource Assessments

The benefits and potential impacts of Vineyard Northeast to physical, biological, socioeconomic, visual, and cultural resources, which are discussed in the following sections, are based on the "maximum design scenario" for each resource. The maximum design scenario, which is based on the PDE described in Sections 3.2 through 3.10 of COP Volume I, allows analysis of the maximum impacts that could occur from Vineyard Northeast:

- For the offshore facilities, the maximum design scenario is the full buildout of all 160 WTG/ESP positions within the Lease Area. Up to three of those positions will be occupied by ESPs and the remaining positions will be occupied by WTGs. If two or three ESPs are used, they may be co-located at the same grid position (co-located ESPs would only be installed on monopiles). In addition, the Proponent may install a booster station in the northwestern aliquot of Lease Area OCS-A 0534. As a result, Vineyard Northeast could include up to 162 monopile foundations (assuming the use of co-located ESPs) or up to 161 piled jacket foundations as well as associated scour protection. The maximum design scenario also includes three HVAC offshore export cables in the Massachusetts OECC (with a maximum total length of 436 km [235 NM]) and two HVDC offshore export cable bundles in the Connecticut OECC (with a maximum total length of 421 km [227 NM]), up to 356 km (192 NM) of inter-array cables, up to 120 km (65 NM) of inter-link cables, and associated cable protection.[6]

- For the onshore facilities, the maximum design scenario is the construction of two landfall sites (the Horseneck Beach Landfall Site in Massachusetts and either the Ocean Beach Landfall Site, the Eastern Point Beach Landfall Site, or the Niantic Beach Landfall Site in Connecticut), two onshore cable routes (one in Massachusetts and one in Connecticut), and two new onshore substations (one in Westport, Fall River, or Somerset, Massachusetts and one in Montville, Connecticut).

[6] The length of the offshore export cables includes the length of the cables within the Lease Area.

2 Summary of Vineyard Northeast's Benefits

Vineyard Northeast will generate clean, renewable electricity by as early as 2030 to assist Northeastern states and/or other offtake users in achieving their renewable energy and carbon emission reduction goals. The electricity generated by the wind turbine generators (WTGs) will displace electricity from fossil fuel power plants, resulting in a significant net reduction in air emissions from the regional electric grid. Vineyard Northeast is expected to reduce carbon dioxide equivalent (CO_2e) emissions from the electric grid by approximately 4.9 million tons per year (tpy), or the equivalent of taking approximately 970,000 cars off the road (see Section 3.1.2.2).[7] This reduction in greenhouse gas (GHG) emissions will help mitigate additional effects of ongoing climate change (e.g., more frequent and dangerous storms, severe heat waves and droughts, sea level rise and increased flooding, changes in agricultural productivity, shifts in species' distributions, and increases in energy system costs) that are impacting the environment and public health. Vineyard Northeast will also reduce regional emissions of air contaminants such as nitrogen oxides (NOx) and sulfur dioxide (SO_2), which contribute to acid rain, ocean acidification, and ground level ozone/smog and are linked to increased rates of early death, heart attacks, stroke, and respiratory disorders. By decreasing reliance on fossil fuels, Vineyard Northeast will also help diversify states' electricity supply, increase the reliability of the electric grid, and contribute to greater domestic energy security.

Vineyard Northeast offers several other environmental benefits. As detailed throughout Section 4, the Proponent has performed extensive environmental surveys to help inform understanding of the marine environment. For example, from June 2019 to July 2021, the Proponent conducted 32 high-resolution digital aerial surveys to provide data on bird, marine mammal, and sea turtle use of Lease Area OCS-A 0522 (the "Lease Area"). The Proponent also contracted the University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST) to perform seasonal trawl surveys of the Lease Area starting in spring 2019 through fall 2021. The Proponent expects to conduct or contribute to additional resource studies and monitoring programs pre- and post-construction, including providing scientific, technical, and financial support for regional studies. Additionally, as described in Section 4.6, the foundations may function as fish aggregating devices, resulting in increases in biodiversity and abundance of fish and thereby improving the recreational fishing experience within the Lease Area (Riefolo et al. 2016; Raoux et al. 2017; BOEM 2012).

Beyond these important environmental, public health, and energy reliability benefits, Vineyard Northeast is expected to result in significant long-term economic benefits (see Section 5.1). Vineyard Northeast is expected to provide steady, well-paying jobs that will have direct positive and stabilizing impacts on the workforce within the Onshore Development Area and will result in significant growth in sectors servicing the offshore wind industry. Vineyard Northeast is expected to support a minimum of 15,894 direct, indirect, and induced full-time equivalent

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7 Assuming the minimum nameplate capacity of Vineyard Northeast.

(FTE) job-years[8] during pre-construction and construction. Construction of Vineyard Northeast is also estimated to generate at least ~$1.63 billion in total labor income and ~$4.65 billion in output.[9] The operation of Vineyard Northeast is projected to generate approximately 17,046 FTE job-years assuming a 30-year operational life (equivalent to 568 direct, indirect, and induced FTEs annually), as well as at least ~$1.19 billion in total labor income and ~$4.62 billion in output.

In addition, the Proponent expects to support (e.g., through funding, provision of resources, collecting and analyzing data) environmental research and conservation, supply chain and workforce development, and/or mitigation in connection with Vineyard Northeast. For example, in accordance with the Proponent's Good Neighbor Agreement with the Town and County of Nantucket, the Maria Mitchell Association, and the Nantucket Preservation Trust (collectively the "Nantucket Parties"), the Nantucket Parties have established the Nantucket Offshore Wind Community Fund to support projects and initiatives related to protecting, restoring, and preserving cultural and historic resources, coastal resiliency, climate adaptation, and renewable energy. Vineyard Northeast will contribute $6 million to the Nantucket Offshore Wind Community Fund at financial close. As the development progresses, additional commitments are expected, and this section will be updated as needed.

Lastly, each of the following sections contains a summary of avoidance, minimization, and mitigation measures, many of which provide benefits to the human or natural environment.

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8 One FTE job-year is the equivalent of one person working full time for one year (2,080 hours).

9 Output is the estimated value of all goods and services sold (i.e., expenditures other than payroll).

3 Physical Resources

3.1 Air Quality

This section addresses the potential impacts and benefits of Vineyard Northeast on air quality in the Offshore Development Area and Onshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to air quality during the construction, operation, and decommissioning of Vineyard Northeast.

The clean, renewable offshore wind energy produced by Vineyard Northeast will displace electricity from fossil fuel power plants, resulting in a significant net reduction in air emissions from the regional electric grid (see Section 3.1.2.2 for additional details). However, there will be air emissions from vessels, equipment, aircraft, and vehicles used during the construction, operations and maintenance (O&M), and decommissioning of Vineyard Northeast. The Bureau of Ocean Energy Management (BOEM) only regulates air emissions from facilities located on the Outer Continental Shelf (OCS) in the Gulf of Mexico west of 87°30'W longitude and areas offshore the North Slope of Alaska. The Environmental Protection Agency (EPA) regulates air quality in all other portions of the OCS. Therefore, emissions from Vineyard Northeast on the OCS are regulated through EPA's OCS Air Permit process under the OCS Air Regulations (40 CFR Part 55). Per BOEM's (2020) Construction and Operations Plan (COP) guidelines, the Proponent will provide a copy of Vineyard Northeast's OCS Air Permit application(s) to BOEM when submitted to EPA.

Although BOEM does not have jurisdiction to regulate air emissions in the Offshore Development Area or Onshore Development Area, BOEM will assess Vineyard Northeast's potential benefits and impacts to air quality as part of the National Environmental Policy Act (NEPA) process. This section provides an analysis of all potential air emissions from Vineyard Northeast (both emissions regulated and not regulated by the OCS Air Regulations) within the United States (US) to support BOEM's assessment. The air quality information presented in this section is supplemented by Appendix II-A, which contains a preliminary inventory of Vineyard Northeast's anticipated emission sources and describes the methodology used to estimate emissions generated during the construction and operation of Vineyard Northeast. Appendix II-A also describes the method used to quantify emissions from fossil fuel power plants that are expected to be avoided as a result of Vineyard Northeast's clean, renewable energy.

3.1.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. For the purposes of assessing effects to air quality, the Offshore Development Area includes all federal and state waters within the US Exclusive Economic Zone (out to ~200 nautical miles [NM] [~370 kilometers] from shore) where Vineyard Northeast-related vessels, equipment, and aircraft may operate. This includes emissions from vessels traveling to and at the ports that may be used for Vineyard Northeast (see Sections 3.10.1 and 4.4.1 of COP Volume I).

The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection in Bristol County, Massachusetts, and New London County, Connecticut, as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities. With respect to air quality, the Onshore Development Area includes the communities surrounding Vineyard Northeast's onshore facilities, O&M facilities, construction staging areas, and port facilities.

In general, air pollutants within the Offshore Development Area and Onshore Development Area derive from both naturally occurring (biogenic) and human-made (anthropogenic) sources. Vessels are the predominant anthropogenic sources of air emissions in state and federal waters. Onshore, anthropogenic emission sources include cars and trucks, fossil fuel power plants, factories, office buildings, and homes, among many other sources.

To monitor the impacts of these emission sources on ambient air quality, air quality within a region is measured against National Ambient Air Quality Standards (NAAQS), which EPA has established to protect public health and welfare. EPA has set NAAQS for six criteria air pollutants that are considered harmful to public health and the environment: sulfur dioxide (SO_2), two types of particulate matter (PM) (smaller than 10 microns as PM_{10} and smaller than 2.5 microns as $PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), lead (Pb),[10] and ozone (O_3). Typically, ozone is not emitted directly into the air; instead, ground-level ozone primarily forms from the reaction of volatile organic compounds (VOCs) and nitrogen oxides (NOx) in sunlight. VOCs and NOx, which are often emitted directly into the air, are commonly referred to as ozone precursors. Therefore, emissions of the precursors to ozone are quantified instead of ozone.

NAAQS have been developed for various durations of exposure and consist of primary and secondary standards. Primary standards are intended to protect human health. Secondary standards are intended to protect public welfare from known or anticipated adverse effects associated with the presence of air pollutants, such as damage to property or vegetation. The NAAQS are summarized in Table 3.1-1 below.

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[10] Pb is regulated as both a criteria pollutant and a hazardous air pollutant (discussed further below). The removal of Pb from motor vehicle gasoline and other regulatory restrictions on Pb emissions have resulted in a 98% reduction in ambient concentrations of Pb between 1980 and 2014 (EPA 2022b). Because of this, Pb is now generally not addressed as a criteria pollutant but continues to be addressed as a component of HAP emissions.

Table 3.1-1 National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS[10] (µg/m³)	
		Primary	Secondary
NO_2	Annual[1]	100	Same
	1-hour[2]	188	None
SO_2	3-hour[3]	None	1,310
	1-hour[4]	196	None
$PM_{2.5}$	Annual[5]	12	15
	24-hour[6]	35	Same
PM_{10}	24-hour[7]	150	Same
CO	8-hour[3]	10,000	None
	1-hour[3]	40,000	None
Ozone	8-hour[8]	137.4	Same
Pb	3-month[9]	0.15	Same

Notes:
1. Annual mean.
2. 98th percentile of 1-hour daily maximum concentrations, averaged over three years.
3. Not to be exceeded more than once per year
4. 99th percentile of 1-hour daily maximum concentrations, averaged over three years.
5. Annual mean, averaged over three years.
6. 98th percentile, averaged over three years.
7. Not to be exceeded more than once per year on average over three years.
8. Annual fourth-highest daily maximum 8-hour concentration, averaged over three years.
9. Not to be exceeded.
10. Source: EPA 2022c. µg/m³ = micrograms per cubic meter of air.

To assess compliance with the NAAQS, the concentrations of criteria pollutants in ambient (outdoor) air are measured by a network of onshore monitoring stations. EPA uses this air quality data to classify all areas of the country as in *attainment*, *nonattainment*, or *unclassified* with the NAAQS. When the monitored pollutant levels in an area exceed the NAAQS for any pollutant, the area is classified as in "nonattainment" for that pollutant. For some standards, nonattainment areas are categorized by the severity of the pollution. These classifications, in order of increasing severity, are: marginal, moderate, serious, severe, and extreme. An attainment area is defined as an area that meets or is cleaner than the NAAQS. An unclassified area is defined as an area that cannot be classified as meeting or not meeting the NAAQS based on available information and is treated as an attainment area. Note that an area can be in attainment/unclassified for some pollutants and in nonattainment for others. Additionally, an area that was previously in nonattainment but is currently in attainment or unclassified may be designed as a maintenance area (EPA 2010). An area's attainment status can be found in Designation of Areas for Air Quality Planning Purposes (40 CFR Part 81).

Although there are no monitoring stations offshore, for coastal areas, the nonattainment or maintenance area boundary extends to the state's seaward boundary, which is 3 NM (~5.6 kilometers [km]) for most states (EPA 2010). The EPA does not designate attainment statuses for federal waters. However, the attainment designations described below effectively characterize air quality throughout the Offshore Development Area.

Attainment designations for all US counties where Vineyard Northeast air emissions may occur (due to onshore construction, vessel activity, and port usage) are summarized in Table 3.1-2. When EPA designates a new NAAQS, older standards are not automatically revoked. As a result, there are two different 8-hour ozone standards (the 2008 and 2015 standards) and three different $PM_{2.5}$ standards (the 1997, 2006, and 2012 standards). All counties potentially affected by Vineyard Northeast emissions are in attainment with the NAAQS for Pb, SO_2, and NO_2, which are not included in the following table. Similarly, all counties (except Delaware, Pennsylvania) are in attainment with the 2012 $PM_{2.5}$ standard.

Table 3.1-2 Air Quality Designations for Areas Where Vineyard Northeast Emissions May Occur

County	Potential Vineyard Northeast Activities	Attainment Status[1]	Criteria Pollutants (Year of Standard)[2,3]				
			O_3 (2008)	O_3 (2015)	$PM_{2.5}$ (1997 & 2006)	PM_{10} (1987)	CO (1971)
Massachusetts							
Bristol	Onshore construction, port usage, and vessel transits	Nonattainment					
		Maintenance					
		Attainment	x	x	x	x	x
Dukes	Port usage and vessel transits	Nonattainment	MG				
		Maintenance					
		Attainment		x	x	x	x
Essex, Nantucket	Port usage and/or vessel activity	Nonattainment					
		Maintenance					
		Attainment	x	x	x	x	x
Rhode Island							
All Rhode Island Counties	Port usage and/or vessel transits	Nonattainment					
		Maintenance					
		Attainment	x	x	x	x	x
Connecticut							
New Haven	Port usage and vessel transits	Nonattainment	SV	MD			
		Maintenance			x		x
		Attainment				x	
Middlesex	Vessel transits	Nonattainment	SV	MD			
		Maintenance					x
		Attainment			x	x	
Fairfield	Port usage and vessel transits	Nonattainment	SV	MD			
		Maintenance			x		x
		Attainment				x	
New London	Onshore construction, port usage, and vessel transits	Nonattainment	S	MD			
		Maintenance					
		Attainment			x	x	x

Table 3.1-2 Air Quality Designations for Areas Where Vineyard Northeast Emissions May Occur (Continued)

County	Potential Vineyard Northeast Activities	Attainment Status[1]	Criteria Pollutants (Year of Standard)[2,3]				
			O_3 (2008)	O_3 (2015)	$PM_{2.5}$ (1997 & 2006)	PM_{10} (1987)	CO (1971)
New York							
Bronx, Kings, Richmond, Queens, Westchester	Port usage and/or vessel transits	Nonattainment	SV	MD			
		Maintenance			x		x
		Attainment				x	
Rockland	Vessel transits	Nonattainment	SV	MD			
		Maintenance			x		
		Attainment				x	x
New York	Vessel transits	Nonattainment	SV	MD		MD	
		Maintenance			x		x
		Attainment					
Suffolk	Port usage and vessel transits	Nonattainment	SV	MD			
		Maintenance			x		
		Attainment				x	x
Orange	Vessel transits	Nonattainment					
		Maintenance			x		
		Attainment	x	x		x	x
Albany, Rensselaer, Putnam, Dutchess, Columbia, Ulster, Greene	Port usage and/or vessel transits	Nonattainment					
		Maintenance					
		Attainment	x	x	x	x	x
New Jersey							
Bergen, Hudson, Middlesex, Monmouth	Vessel transits	Nonattainment	SV	MD			
		Maintenance			x		x
		Attainment				x	
Cape May, Cumberland	Vessel transits	Nonattainment	MG	MD			
		Maintenance					
		Attainment			x	x	x
Salem	Port usage and vessel transits	Nonattainment	MG	MD			
		Maintenance					x
		Attainment			x	x	
Gloucester	Port usage and vessel transits	Nonattainment	MG	MD			
		Maintenance			x		
		Attainment				x	x
Delaware							
Kent	Vessel transits	Nonattainment					
		Maintenance					
		Attainment	x	x	x	x	x
Sussex	Vessel transits	Nonattainment	MG				
		Maintenance					
		Attainment		x	x	x	x

Table 3.1-2 Air Quality Designations for Areas Where Vineyard Northeast Emissions May Occur (Continued)

County	Potential Vineyard Northeast Activities	Attainment Status[1]	Criteria Pollutants (Year of Standard)[2,3]				
			O_3 (2008)	O_3 (2015)	$PM_{2.5}$ (1997 & 2006)[4]	PM_{10} (1987)	CO (1971)
Delaware (Continued)							
New Castle	Vessel transits	Nonattainment	MG	MD			
		Maintenance			x		
		Attainment				x	x
Pennsylvania							
Delaware	Vessel transits	Nonattainment	MG	MD			
		Maintenance			x[5]		
		Attainment				x	x

Notes:
1. Counties depicted as in attainment may be in attainment or unclassified.
2. MG = marginal nonattainment; MD = moderate nonattainment, S = serious nonattainment, SV = severe nonattainment, and X = maintenance, attainment, or unclassified.
3. Source: EPA 2022d.
4. The $PM_{2.5}$ (1997) standard is revoked for attainment and maintenance areas.
5. Also a maintenance area for the 2012 $PM_{2.5}$ standard.

In addition to the attainment designations provided in Table 3.1-2, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, and Pennsylvania are part of the Ozone Transport Region (OTR). The OTR was established in Section 184(a) of the Clean Air Act (CAA) to address ozone formation and pollution due to transport from upwind states to downwind states. Prevailing southwest to west winds carry air pollution in the form of NOx and VOCs from emission sources located outside of Northeastern state boundaries into the Northeast, contributing to high ozone concentrations in these areas. For states that are members of the OTR, counties or areas designated as unclassifiable/attainment for the 2008 and 2015 ozone standards are treated as moderate nonattainment areas for ozone (see CAA § 184(b)(2)).

Although several counties in the Offshore Development Area and Onshore Development Area are in nonattainment with the various NAAQS (see Table 3.1-2),[11] in general, air quality in the Northeast has been improving over the last decade. This trend is illustrated in Figure 3.1-1, which shows the ambient air concentrations of key criteria pollutants measured at several monitoring stations closest to the Lease Area and OECCs over the last decade.[12]

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11 The General Conformity regulations (40 CFR Part 93, Subpart B and 40 CFR Part 51, Subpart W) ensure that federal actions do not interfere with states' or Native American tribes' plans to attain and maintain the NAAQS in areas that are or have been classified as nonattainment for those standards. The activities for which BOEM has authority are outside of any nonattainment or maintenance area; therefore, BOEM has determined that it is not required to demonstrate conformity.

12 Based on ambient air quality data from EPA (2021).

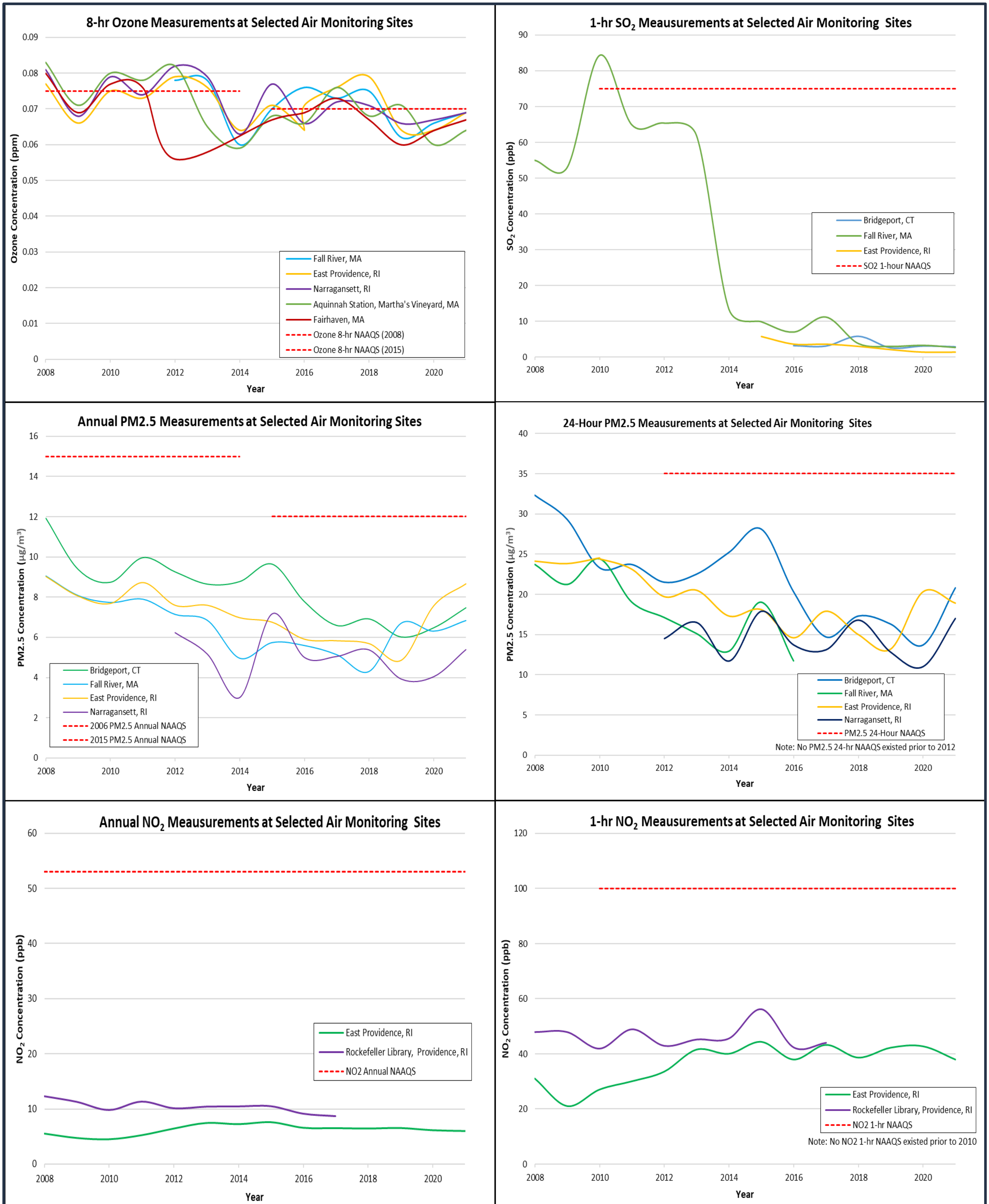

Figure 3.1-1
Ambient Air Quality Near the Offshore Development Area

VINEYARD NORTHEAST
VINEYARD OFFSHORE

In addition to criteria air pollutants, the assessment of potential air quality impacts from Vineyard Northeast addresses hazardous air pollutants (HAPs) and greenhouse gases (GHGs). Although there are no NAAQS for HAPs and GHGs, emissions of these pollutants are regulated through state and federal emission standards (e.g., National Emission Standards for Hazardous Air Pollutants [NESHAPS]) and permit requirements. EPA has developed a list of 188 HAPs, also known as toxic air pollutants or air toxics, that are known or suspected to cause cancer or other serious health effects (e.g., reproductive health effects, birth defects, adverse environmental effects, etc.). HAPs are a subset of VOCs and PM. As stated by EPA (2022a), nationwide, "from 1990 to 2017 emissions of air toxics declined by 74 percent, largely driven by federal and state implementation of stationary and mobile source regulations."

GHGs, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and sulfur hexafluoride (SF_6), accumulate in the atmosphere and trap heat that would otherwise escape into space. This "greenhouse effect" is the main driver of global climate change (MassDEP 2022). CO_2, which is a product of combustion, accounts for the majority of GHGs (EPA 2016). Because GHGs have different radiative properties and lifetimes in the atmosphere, GHGs differ in their ability to trap heat in the atmosphere. Therefore, to express their warming influences in a common metric, GHG emissions are calculated as carbon dioxide equivalents (CO_2e).

Some Northeastern states have made greater progress towards their GHG emissions reduction goals than others. Between 1990 and 2019, GHG emissions in Massachusetts decreased by 23.4% from 93.5 to 71.6 million metric tons (MMT) of CO_2e (MassDEP 2022). Accordingly, Massachusetts is close to meeting its target of reducing GHG emissions 25% below the 1990 baseline level by 2020 and is progressing towards reducing GHG emissions 80% below 1990 levels by 2050, as required by the Massachusetts Global Warming Solutions Act (GWSA). In Rhode Island, GHG emissions fell from 12.48 to 11.02 MMT CO_2e between 1990 and 2016, but increased to 12.70 MMT CO_2e in 2018 (RI DEM 2022). This recent uptick in GHG emissions is 1.76% above the State's 1990 baseline, which is not in line with the State's mandatory emissions reduction goals set forth in the 2021 Act on Climate to reduce GHG emissions 10% below 1990 levels by 2020 and ultimately reach net-zero emissions by 2050 (RI DEM 2022). Connecticut is similarly not on track to meet its GWSA targets of reducing GHG emissions 10% below 1990 levels by 2020, 45% below 2001 levels by 2030, and 80% below 2001 levels by 2050 (CT DEEP 2021). Annual GHG emissions in Connecticut generally increased from 1990 to 2004, reaching a peak of approximately 55.5 MMT CO_2e in 2004, before decreasing to approximately 40.6 MMT CO_2e in 2017, or 11% below 1990 levels. Although the 2020 goal was met briefly in 2017, GHG emissions were higher in 2018 primarily due to increases in residential and commercial fossil fuel consumption (CT DEEP 2021).

New York is making modest progress towards the ambitious goals set forth in the State's Climate Leadership and Community Protection Act (CLCPA), which requires statewide GHG emissions to be reduced 40% by 2030 and 85% by 2050 relative to 1990 levels (NYSDEC 2021a). In New York, GHG emissions generally increased from 1990 to 2005 and then decreased from 2005 to 2019 (NYSDEC 2021b). In 2019, the State's gross emissions were ~379

MMT CO_2e, or 6% lower than 1990 levels according to the methods outlined in the CLCPA. The New Jersey Global Warming Response Act requires the State to reduce GHG emissions below 1990 levels by 2020, 50% below 2006 levels by 2030, and 80% below 2006 levels by 2050 (NJ DEC). Between 1990 and 2006, GHG emissions in New Jersey generally increased from 111.4 to 121.1 MMT CO_2e, then decreased to 98.5 MMT CO_2e in 2019, or 12% below the 1990 level (NJDEP 2022). New Jersey attained its 2020 GHG reduction goal years ahead of schedule (NJDEP 2022). Delaware has made some progress towards its goal of reducing GHG emissions 30% from 2008 levels by 2030, with a reduction of GHG emissions from ~16.6 to ~15.0 MMT CO_2e between 2008 and 2017 (DNREC 2020, DNREC 2014). While current policies and actions are expected to nearly achieve Pennsylvania's goal of reducing GHG emissions 26% from 2005 levels by 2025, projected emission reductions based on business-as-usual fall far short of the target to reduce emissions 80% by 2050 (PA DEP 2021).

3.1.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect air quality during the construction, O&M, and/or decommissioning of Vineyard Northeast are presented in Table 3.1-3.

Table 3.1-3 Impact Producing Factors for Air Quality

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Air Emissions	•	•	•
Avoided Air Emissions from Renewable Energy Production		•	

Potential effects to air quality were assessed using the maximum design scenario for Vineyard Northeast's offshore and onshore facilities as described in Section 1.5. To account for the envelope of possible ports used during construction and operations (see Sections 3.10.1 and 4.4.1 of COP Volume I), the emissions estimates assume the use of the port with the longest transit distances to and from the Offshore Development Area (within US waters) that may be used for each individual activity, within reason.

3.1.2.1 Air Emissions

Offshore, air emissions will primarily come from the main engines and auxiliary engines on vessels used during the construction, operation, and decommissioning of Vineyard Northeast. Vessel emissions will occur within the Lease Area and OECCs, during vessel transits to and from port, and while certain vessels are in port. There may also be emissions from other construction equipment used aboard vessels (e.g., engines used to power pile driving hammers, motion compensation system engines, etc.). Additional offshore emissions are expected to come from diesel generators used to temporarily supply power to the wind turbine generators (WTGs), electrical service platform(s) (ESP[s]), and booster station as well as helicopters. Vessels, offshore equipment, and aircraft used during construction, O&M, and decommissioning are further described in Sections 3.10.4, 4.4.2, and 5.2.5 of COP Volume I, respectively.

Emission sources from onshore construction, O&M, and decommissioning activities will include construction equipment (e.g., cranes, excavators, backhoes, trenchers, drilling tools, forklifts, etc.) and vehicles (e.g., worker vehicles, concrete delivery trucks, dump trucks, etc.). See Sections 3.10.5, 4.4.3, 5.2.5 of COP Volume I for additional description of onshore equipment and vehicles that may be used for Vineyard Northeast activities. There may also be some fugitive emissions (e.g., from incidental solvent release) as well as particulate emissions from construction dust. A more complete inventory of Vineyard Northeast's potential emission sources, along with assumed engine sizes, hours of operation, load factors, emission factors, and fuel consumption rates, can be found in Appendix II-A.

Air emissions from the construction and operation of Vineyard Northeast were estimated by calculating the duration and intensity of emission-generating activities and multiplying those estimates by appropriate emission factors (see Appendix II-A for a description of the calculation methodologies). Table 3.1-4 provides an estimate of emissions within the US (onshore and offshore) from the construction of Vineyard Northeast. These construction emissions were assumed to be distributed over a three-year period.

Table 3.1-4 Estimated Air Emissions from the Construction of Vineyard Northeast

	NOx	VOCs	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2e
Year 1 construction emissions (US tons)	61	3	25	37	37	0.1	1	49,148
Year 2 construction emissions (US tons)	10,867	246	2,569	408	394	83	35	772,393
Year 3 construction emissions (US tons)	6,436	144	1,514	222	214	50	20	451,018

Table 3.1-5 provides an estimate of potential emissions from the O&M of Vineyard Northeast, including an estimate of air emissions for a typical year of operation (for planned, routine O&M activities) as well as an estimate of the maximum annual operational air emissions (assuming several repair activities occur all within the same year).

Table 3.1-5 Estimated Air Emissions from the Operation of Vineyard Northeast

	NOx	VOCs	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2e
Operational emissions, typical year (US tons per year [tpy])	591	11	153	20	19	2.1	1.6	74,810
Operational emissions, maximum year (US tpy)	773	14	196	26	25	2.6	2.2	86,780

Most of the air emissions from the construction and operation of Vineyard Northeast will occur offshore within the Lease Area, OECCs, and surrounding waters. Only a limited proportion of the emissions reported in Tables 3.1-4 and 3.1-5 will occur at ports. Table 3.1-6 quantifies the subset of emissions that could occur within 5.6 km (3 NM) of the ports used during the construction and operation of Vineyard Northeast. Due to the uncertainty regarding the combination of ports that may be used for Vineyard Northeast, it is conservatively assumed that these estimated construction and operational emissions could all occur at one port (in a maximum case scenario) or be spread amongst several of the ports identified in Sections 3.10.1 and 4.4.1 of COP Volume I.

Table 3.1-6 Estimated Air Emissions from Activities in Port

	NOx	VOCs	CO	PM_{10}	$PM_{2.5}$	SO_2	HAPs	CO_2e
Total Port-Related Emissions[1]								
Total port-related construction emissions (US tons)	605	10	148	20	19	1.1	2	41,476
Total port-related operational emissions, maximum year (US tpy)	37	0.6	10	1.2	1.1	0.1	0.1	2,501

Note:

1. Includes emissions from onshore equipment and vehicles at a port as well as emissions from vessels hoteling, maneuvering, and transiting within 5.6 km (3 NM) of a port.

Air emissions from decommissioning are not quantified at this time due to the level of uncertainty regarding the types of vessels and equipment that will be available at the time of decommissioning. The Proponent anticipates that technological advances in methods and equipment servicing the offshore industry may result in increased efficiency, and historically, engine emission standards have become increasingly stringent over time. For these reasons, the Proponent anticipates that emissions from decommissioning will be less than during construction.

Prevailing winds are expected to predominantly transport Vineyard Northeast's air emissions away from shore, although wind directions may shift and transport emissions toward shore (BOEM 2014). However, given the distance between the Lease Area and shore (~46 km [~29 miles] from Nantucket), emissions within the Lease Area (where the majority of emissions will occur) are unlikely to markedly affect any onshore areas when winds transport emissions toward shore. Furthermore, emissions from Vineyard Northeast will be dispersed over a large area, further minimizing ambient air quality impacts.

Vineyard Northeast is an air quality impact avoidance measure; the electricity generated by the WTGs will displace electricity produced by fossil fuel power plants and avoid regional emissions resulting from those power plants (see Section 3.1.2.2). Vineyard Northeast's construction emissions are temporary and will be quickly offset by these regional net emission reductions during the operational period. Nevertheless, the Proponent will seek to avoid, minimize, and mitigate air emissions wherever feasible.

Most emissions will come from internal combustion engines, including marine engines, diesel engines on construction equipment, and diesel generators. Internal combustion engine manufacturers use minimization and mitigation techniques specific to their engine type to ensure compliance with air quality regulatory standards. Emissions of CO, PM, and VOCs are generally minimized by ensuring complete combustion. NOx emissions are minimized by reducing the combustion temperature and controlling the mixing of fuel and oxygen during combustion to avoid hot spots that generate NOx. Such techniques include water injection and exhaust gas recirculation. Engine manufacturers can also use add-on pollution controls to mitigate air emissions formed during the combustion process. For example, selective catalytic reduction can be used to convert NOx to nitrogen and water in the presence of a catalyst. Oxidation catalysts can also be used to eliminate products of incomplete combustion (e.g., CO, VOCs, and PM) using technology similar to the catalytic converter found in cars. PM emissions can be removed from some engine exhausts using a diesel particulate filter.

The engines used for Vineyard Northeast activities will meet or emit less than the applicable on-road, non-road, and marine engine emission standards for NOx, CO, VOCs (as hydrocarbons [HC]), and PM. The Proponent will minimize SO_2 and PM emissions through the use of clean, low-sulfur fuels in compliance with federal and international air pollution requirements. To minimize GHG emissions and other air pollutants, the Proponent will require its contracted vessels to use good combustion practices and operate their engines in the most efficient configuration, in accordance with applicable federal and international requirements. Key marine and non-road engine emission standards and fuel standards include:

- **International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI:** Annex VI of the International Maritime Organization's (IMO's) MARPOL treaty is the main international treaty that addresses air pollution from marine vessels. Annex VI establishes global limits on the sulfur content of fuel oil used aboard any foreign or domestic vessel and NOx emissions limits for foreign vessels built after 2000 with engine sizes greater than 130 kilowatts (~174 horsepower). The IMO has also adopted legally binding energy efficiency measures as amendments to MARPOL Annex VI. In the US, MARPOL Annex VI is implemented through the Act to Prevent Pollution from Ships (33 U.S.C. §§ 1901-1905) and Control of NOx, SOx, and PM Emissions from Marine Engines and Vessels Subject to the MARPOL Protocol (40 CFR Part 1043). Any foreign and domestic vessel used during Vineyard Northeast will comply with the Annex VI fuel oil sulfur content limit for the North American Emission Control Area of 1,000 parts per million (ppm).

- **Control of Emissions from New and In-Use Marine Compression-Ignition Engines and Vessels (40 CFR Part 1042):** This US regulation sets emission standards and certification requirements for marine diesel engines. The emission standards are structured as a tiered progression, with each tier of emission standards becoming increasingly stringent. Each tier phased in over several years. These standards are primarily a function of the size, engine displacement, and age of the marine diesel engine.

- **Control of Emissions from New and In-Use Nonroad Compression-Ignition Engines (40 CFR Part 1039):** This US regulation sets emission standards and certification requirements for non-road diesel engines. Like the marine engine standards above, these tiered non-road engine standards are a function of engine size and model year.
- **Regulation of Fuels, Fuel Additives, and Regulated Blendstocks (40 CFR Part 1090):** This US regulation sets fuel sulfur content standards for diesel fuel and certain marine fuels. Applicable engines used during Vineyard Northeast will comply with the fuel sulfur content limit of 15 ppm under 40 CFR Part 1090, Subpart D.

Some offshore emissions from Vineyard Northeast will also be regulated under the OCS Air Regulations through EPA's OCS Air Permit process. The OCS Air Regulations, which implement Section 328 of the CAA, establish federal air pollution control requirements for OCS sources located in federal waters. The CAA defines an OCS source as "any equipment, activity, or facility which–(i) emits or has the potential to emit any air pollutant, (ii) is regulated or authorized under the Outer Continental Shelf Lands Act [43 U.S.C. 1331 et seq.], and (iii) is located on the Outer Continental Shelf or in or on waters above the Outer Continental Shelf" (42 U.S.C. § 7627(a)(4)(C)). Pursuant to 40 CFR Part 55, the definition of OCS source only includes vessels when they are permanently or temporarily attached to the seabed, erected thereon, and used for the purpose of exploring, developing, or producing resources therefrom, or are attached to an existing OCS source. However, emissions from all vessels servicing or associated with an OCS source (when within 25 NM [~46 km]) are considered potential emissions from the OCS source. Because the definition of potential emissions under the OCS Air Regulations includes temporary construction emissions and mobile source emissions (unlike in onshore air permitting), the Proponent expects to trigger major source permitting requirements under the Prevention of Significant Deterioration (PSD) program at 40 CFR § 52.21. The PSD regulations will require a demonstration that Vineyard Northeast's OCS sources meet Best Available Control Technology (BACT).

Under 40 CFR Part 55, OCS sources located within 25 NM (~46 km) beyond a state's seaward boundary are also required to comply with the state air quality requirements of the Corresponding Onshore Area (COA). If Vineyard Northeast includes an OCS source within 25 NM of a state's seaward boundary, the Proponent expects Massachusetts (the Nearest Onshore Area to the Lease Area) to be designated as the COA. If Massachusetts is designated as the COA, some or all of Vineyard Northeast's OCS sources would be required to comply with applicable Massachusetts air quality regulations under 310 CMR § 7.00,[13] including

[13] Only the sections of 310 CMR § 7.00 that are incorporated by reference into 40 CFR Part 55, Appendix A.

Nonattainment New Source Review and Comprehensive Plan Approval. These programs would require a demonstration that Vineyard Northeast's OCS sources meet BACT and Lowest Achievable Emission Rate (LAER), as applicable.

Based on the OCS Air Permits issued for Vineyard Wind 1, South Fork Wind, and Revolution Wind, the Proponent expects the following requirements would also apply to Vineyard Northeast's OCS sources to meet BACT and potentially LAER, which would minimize Vineyard Northeast's emissions:

- **For engines on the WTGs, ESP(s), and booster station (if used):** Use of engines that are certified to meet or exceed the highest applicable emission limits at 40 CFR Part 1042 and/or 40 CFR Part 1039 and use of ultra-low sulfur diesel (ULSD) with a maximum sulfur content of 15 ppm.

- **For engines on applicable tugboats, crew and supply vessels, dredge vessels, and barges:** Use of vessels with the highest EPA Tier marine engines available (starting with Tier 4 or Tier 3, depending on engine size), and no lower than EPA Tier 2 marine engines. The primary crew transfer vessel must have the highest applicable EPA Tier marine engines.

- **For all other domestic and foreign-flagged vessels:** Use of vessels with engines meeting EPA's or MARPOL Annex VI's highest applicable marine emission standards, where available, and no lower than EPA Tier 1 or MARPOL Annex VI Tier I marine engines.

The Proponent expects that its OCS Air Permit(s) will also contain, at a minimum, monitoring, testing, and reporting requirements.

PM emissions from onshore construction activities will be minimized through best management practices, such as removing waste in covered trailers, wetting exposed soils, and minimizing the storage of construction waste onsite. The Proponent will require contractors to minimize vehicle idling in accordance with applicable state and local regulations. Any onshore substation equipment containing SF_6 will meet any applicable state regulations. For all SF_6-containing equipment, the Proponent will follow manufacturer-recommended maintenance and removal procedures and best industry practices to avoid any potential leakage. The Proponent will also consider alternatives to the use of SF_6 gas in switchgear, only if such alternatives are technically feasible and commercially available.

3.1.2.2 Avoided Air Emissions from Renewable Energy Production

Vineyard Northeast will generate clean, renewable energy that will significantly reduce air emissions from the regional electric grid by displacing electricity produced by fossil fuel power plants. Table 3.1-7 quantifies the NOx, SO_2, and GHG (as CO_2e) emissions that are expected to be avoided by using electricity generated from Vineyard Northeast. The analysis is based on the minimum nameplate capacity for the entire Lease Area, assuming an annual capacity factor of 50%,[14] and New England air emissions data from EPA's (2023) Emissions & Generation Resource Integrated Database (eGRID2021). See Appendix II-A for additional description of the method used to quantify avoided emissions.

Table 3.1-7 Avoided Air Emissions Resulting from Vineyard Northeast

	NOx	SO_2	CO_2e
Emissions Avoided Annually (US tons/year)	2,233	706	4,917,613

Based on air emissions data from eGRID2021, electricity from Vineyard Northeast would displace 13% of NOx emissions, 15% of SO_2 emissions, and 18% of GHG emissions produced by New England's electric grid annually. This reduction in regional NOx and SO_2 emissions provides a considerable air quality benefit, as these pollutants are known to contribute to acid rain, ocean acidification, and ground level ozone/smog and are linked to increased rates of early death, heart attacks, stroke, and respiratory disorders.

The reduction in regional GHG emissions, which is roughly equivalent to taking 970,000 cars off the road, will help mitigate additional effects of ongoing climate change that are impacting the environment and public health, such as sea level rise and increased flooding, changes in agricultural productivity, shifts in species' distributions, and increases in energy system costs. Table 3.1-8 presents the monetary value of estimated climate change damages, known as "the social cost of GHGs" (SC-GHG), that would be avoided by Vineyard Northeast (assuming the minimum nameplate capacity). The estimates of avoided social costs differ by the type of GHG (e.g., CO_2, CH_4, and N_2O), the year in which the emissions change occurs, and the discount rate applied (i.e., how future damages are converted into present-day values). The annual estimates of avoided social costs are presented for the years 2030, 2040, and 2050 and for multiple discount rates using SC-GHG estimates from two sources: the Interagency Working Group (IWG) on Social Cost of Greenhouse Gases and EPA. Based on IWG's estimates, the total avoided social costs (for CO_2, CH_4, and N_2O combined) range from $85 million to $518 million annually between 2030 and 2050. Based on EPA's estimates, the total avoided social costs range from $624 million to $2.1 billion annually between 2030 and 2050. While there is considerable variability in the estimates presented below, regardless of the metric used, Vineyard Northeast will provide significant societal benefits by avoiding additional climate change damages. See Appendix II-A for additional details regarding the methods used to estimate avoided social costs.

[14] Capacity factor refers to the ratio of Vineyard Northeast's annual power production to its nameplate production potential.

Table 3.1-8 Estimated Social Costs Avoided by Vineyard Northeast

	Annual Avoided Social Costs (2020 dollars)[1]	
Year[2]	IWG[3] (Discount Rates of 2.5–5.0%)	EPA[4] (Discount Rates of 1.5-2.5%)
	CO_2	
2030	$84,329,000 – $395,015,000	$621,372,000 – $1,686,580,000
2040	$110,959,000 – $457,152,000	$754,523,000 – $1,908,499,000
2050	$142,028,000 – $514,851,000	$887,674,000 – $2,130,417,000
	CH_4	
2030	$338,000 – $900,000	$684,000 –$1,151,000
2040	$468,000 – $1,115,000	$971,000 – $1,511,000
2050	$612,000 – $1,367,000	$1,259,000 – $1,907,000
	N_2O	
2030	$346,000 – $1,464,000	$1,996,000 – $4,436,000
2040	$444,000 – $1,730,000	$2,440,000 – $5,323,000
2050	$577,000 – $1,996,000	$2,928,000 – $6,210,000
	Total GHGs	
2030	$85,013,000 – $397,379,000	$624,052,000 – $1,692,167,000
2040	$111,871,000 – $459,997,000	$757,934,000 – $1,915,333,000
2050	$143,217,000 – $518,214,000	$891,861,000 – $2,138,534,000

Notes:
1. The avoided social costs are calculated from the avoided emission estimates presented in Table 3.1-7. The avoided emission estimates are based on the minimum nameplate capacity of Vineyard Northeast and 2021 air emissions data for the New England electric grid, not future projections of emissions from the electric grid.
2. A sampling of years during which Vineyard Northeast could be operational. Avoided social costs for other years are provided in Appendix II-A.
3. From IWG's (2021) *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* using discount rates of 5% to 2.5%. Avoided social costs using the 95th percentile of estimates based on a 3% discount rate are even greater (see Appendix II-A).
4. From EPA's (2022e) *Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* using discount rates of 2.5% to 1.5%.

As described in Section 3.1.1, many Northeastern states are not on track to meet their GHG emission reduction goals. As discussed in the Rhode Island Department of Environmental Management's (2022) 2018 Rhode Island Greenhouse Gas Emissions Inventory, "The state's recent rise in GHG emissions further demonstrates the need to invest in renewable energy, electric transportation, and protected land." Similarly, the results of Connecticut's most recent Greenhouse Gas Emissions Inventory, which revealed that the State is not on track to meet its

2030 and 2050 GWSA targets, "underscore[s] the urgency of authorizing and implementing the emissions-reduction strategies recommended by the Governor's Council on Climate Change" (CT DEEP 2021). Procuring offshore wind energy is one of those key emissions-reduction strategies. Accordingly, Vineyard Northeast's considerable contribution towards reducing GHGs (and other harmful air pollutants) is critical to helping Northeastern states and/or other offtake users achieve their GHG emission reduction goals.

3.1.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to air quality during Vineyard Northeast are summarized below:

- Vineyard Northeast is an air quality impact avoidance measure; the electricity generated by the WTGs will displace electricity produced by fossil fuel power plants and avoid regional emissions resulting from those power plants. Vineyard Northeast is expected to reduce CO_2e emissions from the electric grid by approximately 4.9 million tons per year (tpy), or the equivalent of taking approximately 970,000 cars off the road. Vineyard Northeast is also expected to reduce regional emissions of NOx by 2,233 tpy and SO_2 by 706 tpy.

- The engines used for Vineyard Northeast activities will meet or emit less than the applicable on-road, non-road, and marine engine emission standards. In addition, emissions from Vineyard Northeast's OCS sources will be regulated through the OCS Air Permit(s). The Proponent expects that the OCS Air Permit(s) will require a demonstration that the OCS sources meet BACT and potentially LAER.

- The Proponent will minimize SO_2 and PM emissions through the use of clean, low-sulfur fuels in compliance with federal and international air pollution requirements.

- The Proponent will require its contracted vessels to use good combustion practices and operate their engines in the most efficient configuration, in accordance with applicable federal and international requirements, to minimize GHG emissions.

- The Proponent will use best management practices, such as removing waste in covered trailers, wetting exposed soils, and minimizing the storage of construction waste onsite, to minimize PM emissions.

- The Proponent will require contractors to minimize vehicle idling in accordance with applicable state and local regulations.

- Any onshore substation equipment containing SF_6 will meet any applicable state regulations. For all SF_6-containing equipment, the Proponent will follow manufacturer-recommended maintenance and removal procedures and best industry practices to avoid any potential leakage. The Proponent will also consider alternatives to the use of SF_6 gas in switchgear, only if such alternatives are technically feasible and commercially available.

3.2 Water Quality and Physical Oceanography

This section addresses the potential impacts of Vineyard Northeast on water quality and physical oceanography in the Offshore Development Area and Onshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to water quality during the construction, operation, and decommissioning of Vineyard Northeast.

Freshwater resources are also discussed in Section 4.1.

3.2.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. For the purposes of assessing effects to water quality and physical oceanography, the Offshore Development Area includes federal and state waters within the Lease Area and along the Massachusetts OECC and Connecticut OECC. The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut, as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities.

The water quality parameters assessed in this section have been collected from available data sources and existing literature for coastal and offshore marine waters in the southern New England coastal and outer continental shelf areas. Primary datasets reviewed for this analysis include:

- Northeast Fisheries Science Center (NEFSC) Ecosystem Monitoring (EcoMon) Program
- World Ocean Atlas (WOA) climatology dataset
- National Oceanic Atmospheric Administration (NOAA) National Data Buoy Center (NDBC)
- Environmental Protection Agency's (EPA) 2015National Coastal Condition Assessment
- Massachusetts Department of Environmental Protection (MassDEP) Water Supply Protection Areas

- Connecticut Department of Energy and Environmental Protection (CT DEEP) Surface Water Protection Areas

Each available data source provides certain water quality parameters, including temperature, salinity, dissolved oxygen, dissolved inorganic nitrogen, dissolved inorganic phosphorus, and turbidity.

Existing literature was reviewed to describe the physical oceanography and potential effects associated with Vineyard Northeast-related activities.

3.2.1.1 Offshore Development Area

NEFSC Ecosystem Monitoring Data

The NEFSC conducts shelf-wide fisheries surveys for the Ecosystem Monitoring (EcoMon) Program up to seven times a year over the continental shelf from Cape Hatteras, North Carolina to Cape Sable, Nova Scotia. Since 1977 this survey has collected sea surface and bottom temperature and salinity data in addition to zooplankton and ichthyoplankton distribution and abundance data (NEFSC 2019). Results shown in Table 3.2-1 are from approximately 150 sample stations located within 15 kilometers (km) (8.1 nautical miles [NM]) of the Lease Area (see Figure 3.2-1).

Table 3.2-1 Mean and Standard Deviation for Seasonal Temperature Data and Salinity Data from the NEFSC EcoMon Survey (2000-2019)

Months	Average Bottom Depth (meters)	Layer	Temperature (°C) (Mean ± 1 SD)	Surface Salinity (psu) (Mean ± 1 SD)
January-March	93 (305 ft)	Surface	6.4 ± 2.3	32.9 ± 1.1
		Bottom	7.1 ± 2.3	33.4 ± 1.0
April-June	101 (331 ft)	Surface	10.0 ± 4.2	32.3 ± 1.0
		Bottom	7.9 ± 2.7	33.1 ± 1.0
July-September	88 (289 ft)	Surface	20.8 ± 3.7	32.2 ± 1.0
		Bottom	12.5 ± 4.4	33.1 ± 1.1
October-December	101 (331 ft)	Surface	14.2 ± 3.0	32.7 ± 1.0
		Bottom	12.5 ± 3.4	33.4 ± 1.1

C:\Users\Stephen.Davies\Documents\MXD Vineyard Northeast\Figure 1 Ecomon sampling stations.mxd

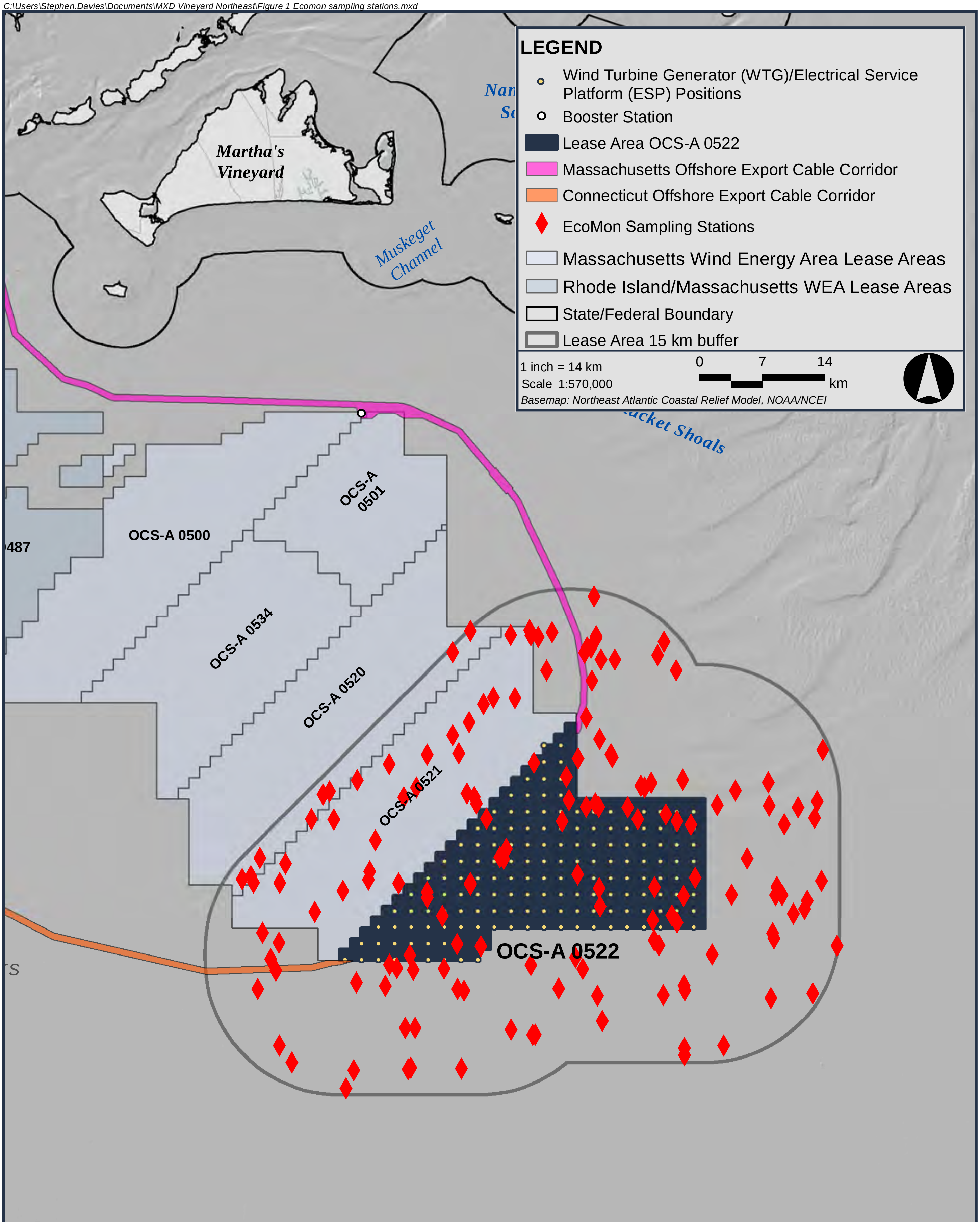

Figure 3.2-1

NEFSC EcoMon Zooplankton Sampling Stations within 15 km of the Lease Area (2000-2019)

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The temperature data in Table 3.2-1 show seasonal changes in mean surface temperatures, with the highest surficial temperatures recorded during the summer months. Salinity often changes in conjunction with water temperatures as higher water temperatures result in increased evaporation and therefore a slight increase in salinity levels. The NEFSC EcoMon data confirms this seasonality change between summer and winter months as the lowest mean surface salinity was observed in July-September and the highest mean surface salinity was observed in the months of January-March.

WOA Data

Data obtained from the WOA climatology dataset near the Lease Area shows the monthly sea surface temperature typically ranging from 5°C to 25°C, increasing from early spring and peaking in late summer (Zweng et al. 2018 and Locarnini et al. 2018). Sea surface salinity ranges from 32.0 to 33.2 parts per thousand (ppt).

NOAA NDBC Data

The NOAA NDBC maintains buoys throughout the Offshore Development Area that record meteorological and oceanographic observations. The closest buoys to the Lease Area and OECCs include Buoy 44097 and Buoy MTKN6[15] (see Figure 3.2-2).

Buoy 44097 is located east of the Lease Area, approximately 50 km (27 NM) Northwest of the Lease Area in 51 meters (m) (167 feet [ft]) of water (see Figure 3.2-2). Data were downloaded from the NOAA NDBC website (NDBC 2022) for the period from January 2018 through December 2021 with monthly values shown in Table 3.2-2.

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15 NOAA NDBC has one Coastal Marine Automated Network Station (BUZM3) located in the vicinity of the Massachusetts OECC; however, this buoy has not collected water temperature data or any other applicable parameters in recent years.

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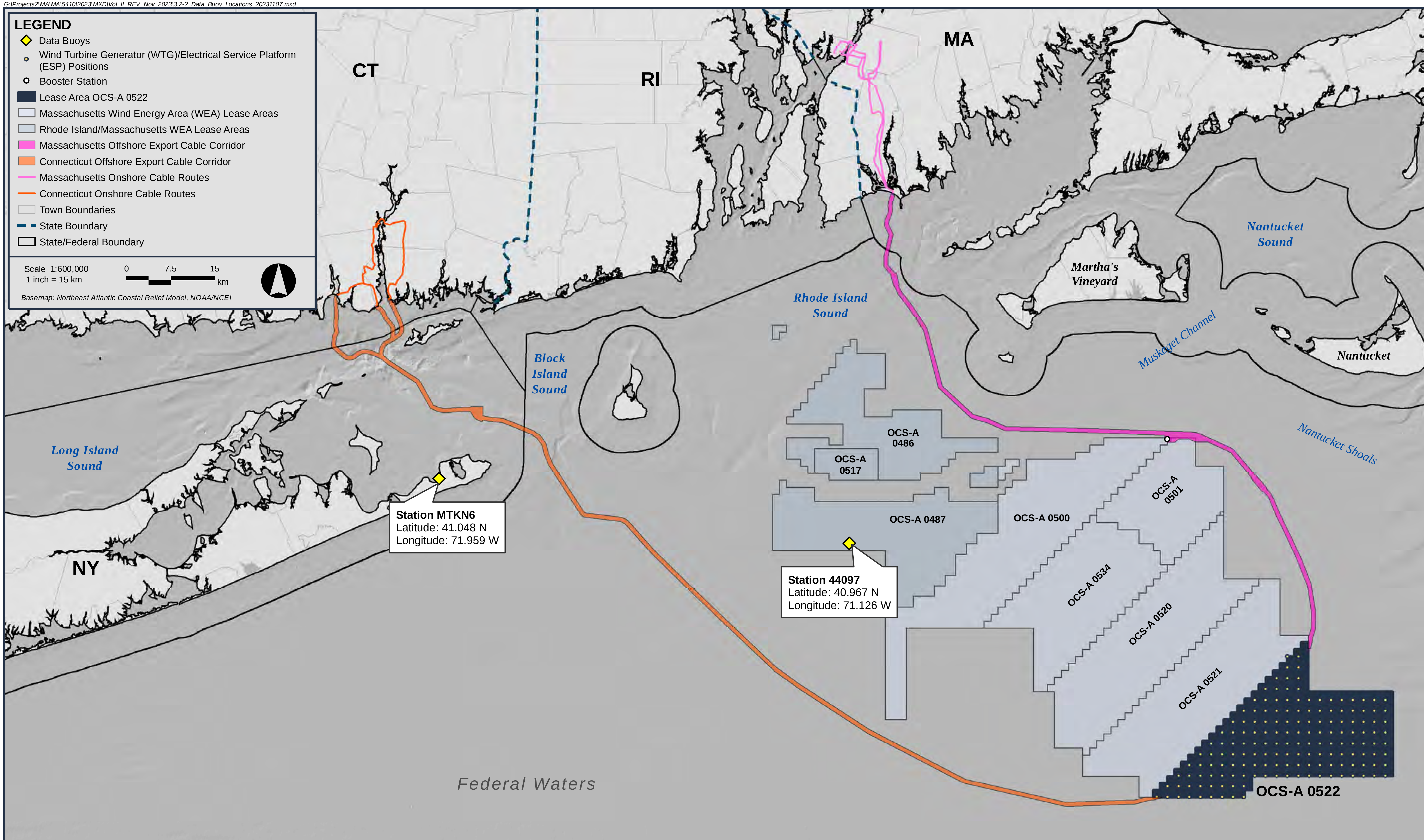

Figure 3.2-2

NOAA NDBC Buoy Locations near the Offshore Development Area

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Table 3.2-2 Mean Monthly Surface Temperature Data from the NOAA NDBC Buoy 44097 (Block Island) from January 2018 through December 2021

Month	Mean Surface Temperature (°C)				
	2018	**2019**	**2020**	**2021**	**2018-2021**
January	5.9	7.4	7.6	8.6	7.4
February	4.3	5.6	6.7	4.6	5.3
March	4.6	5.3	6.6	5.6	5.5
April	5.6	7.3	7.0	7.3	6.8
May	10.4	10.5	9.9	11.6	10.6
June	14.9	15.7	17.0	17.0	16.2
July	21.4	21.2	22.0	20.8	21.4
August	23.2	23.2	21.9	21.6	22.5
September	20.5	19.8	20.2	21.2	20.4
October	17.3	16.5	17.7	18.4	17.5
November	13.3	14.0	14.6	14.7	14.2
December	9.8	10.2	11.7	12.0	10.9
Year	**8.7**	**8.8**	**13.6**	**10.3**	**10.3**

Buoy (MTKN6) is located in 2m (6 ft) of water within Long Island Sound off the coast of Montauk, approximately 11.2 km (6.0 NM) to the southwest of the Connecticut OECC. These data were downloaded from the NDBC website (NDBC 2022) for the period from January 2018 through December 2021 with monthly values shown in Table 3.2-3.

Table 3.2-3 Mean Monthly Surface Temperature Data from the NOAA NDBC Buoy MTKN6 (Montauk, NY) from January 2018 through December 2021

Month	Mean Surface Temperature (°C)				
	2018	**2019**	**2020**	**2021**	**2018-2021**
January	1.1	3.8	4.8	5.1	3.7
February	2.9	2.4	4.7	3.0	3.2
March	4.0	3.9	6.2	4.2	4.6
April	6.1	7.9	7.9	10.7	8.1
May	11.0	11.4	10.8	12.3	11.4
June	15.8	16.3	16.9	17.0	16.5
July	20.8	21.4	21.2	20.9	21.1
August	23.2	21.9	22.5	22.4	22.5
September	21.6	20.6	20.5	21.9	21.2
October	17.3	16.7	17.4	18.9	17.6
November	10.7	11.1	12.7	13.3	11.9
December	6.2	6.6	8.1	9.0	7.5
Year	**11.5**	**11.3**	**12.2**	**13.2**	**12.1**

EPA Coastal Conditions Assessment

The EPA National Coastal Conditions Assessment (NCCA) 2015 Report (EPA 2021) provides regional assessments of water quality for estuarine and coastal regions in the United States (US). EPA's Northeast Estuarine Region includes coastal and estuarine data locations along the northeast coast of the US from Virginia to Maine. As shown on Figure 3.2-3, NCCA stations are located in the vicinity of the nearshore waters of the Massachusetts OECC and Connecticut OECC. Table 3.2-4 presents a summary of water quality parameters and associated characterization for the Northeast Estuarine Region, which provides indicative water quality conditions of the nearshore waters within the Offshore Development Area.

Table 3.2-4 EPA NCCA 2015 Water Quality Indicator Parameters for the Northeast Estuarine Region

Parameter	Definition	Benchmark Ranges	EPA NCCA Water Quality Indicator
Eutrophication index	The eutrophication index is a combined assessment of water quality for the measurements and concentrations of the following parameters: dissolved oxygen, chlorophyll a, dissolved inorganic nitrogen, dissolved inorganic phosphorus, and water turbidity to determine an overall eutrophication status.	Good: A maximum of one indicator is rated fair; no indicators are rated poor. Fair: One of the indicators is rated poor; or two or more indicators are rated fair. Poor: Two or more of the component indicators are rated poor	48.4% Good; 44.6% Fair; 6.9% Poor
Dissolved oxygen (DO)	DO is the amount of oxygen within a water column generated from atmospheric oxygen exchange and photosynthetic processes from plants and phytoplankton.	Good: >5; Fair: 2-5; Poor: <2 (mg/L)	74.3% Good; 13.8% Fair; 4.9% Poor
Chlorophyll a	Chlorophyll *a* concentration is indicative of high nutrient levels, which can stimulate an overproduction of algae, creating algal blooms which block sunlight for underwater plants and deplete oxygen levels in the water column.	Good: <5; Fair: 5-20; Poor: >20 (ug/L)	45.0% Good; 43.1% Fair; 11.9% Poor
Dissolved inorganic nitrogen (DIN)	DIN is a common form of nitrogen found in coastal environments and contributes to the proliferation of algal blooms.	Good: <0.1; Fair: 0.1-0.5; Poor: >0.5 (mg/L)	92.1% Good; 6.0% Fair; 2.8% Poor

Table 3.2-4 EPA NCCA 2015 Water Quality Indicator Parameters for the Northeast Estuarine Region (Continued)

Parameter	Definition	Benchmark Ranges	EPA NCCA Water Quality Indicator
Dissolved inorganic phosphorus (DIP)	DIP is another nutrient that is used by photosynthetic organisms like phytoplankton.	Good: <0.01; Fair: 0.1-0.5; Poor: >0.5 (mg/L)	39.2% Good; 50.4% Fair; 8.0% Poor
Turbidity (water clarity or Secchi disk reading)	Turbidity is the number of suspended solids within a water column which is measured by the depth of the water column at which sunlight no longer penetrates. This assessment calculates turbidity as the percent of incident light remaining after passing through 1 meter of water.	*Good: Normal Turbidity > 20%; Fair: Normal Turbidity 10% – 20%; Poor: Normal Turbidity < 10%;	75.7% Good; 9.9% Fair; 13.7% Poor

Note:

1. Additional categories to assess high turbidity levels and areas with submerged aquatic vegetation are included in the EPA NCCA 2015 report.

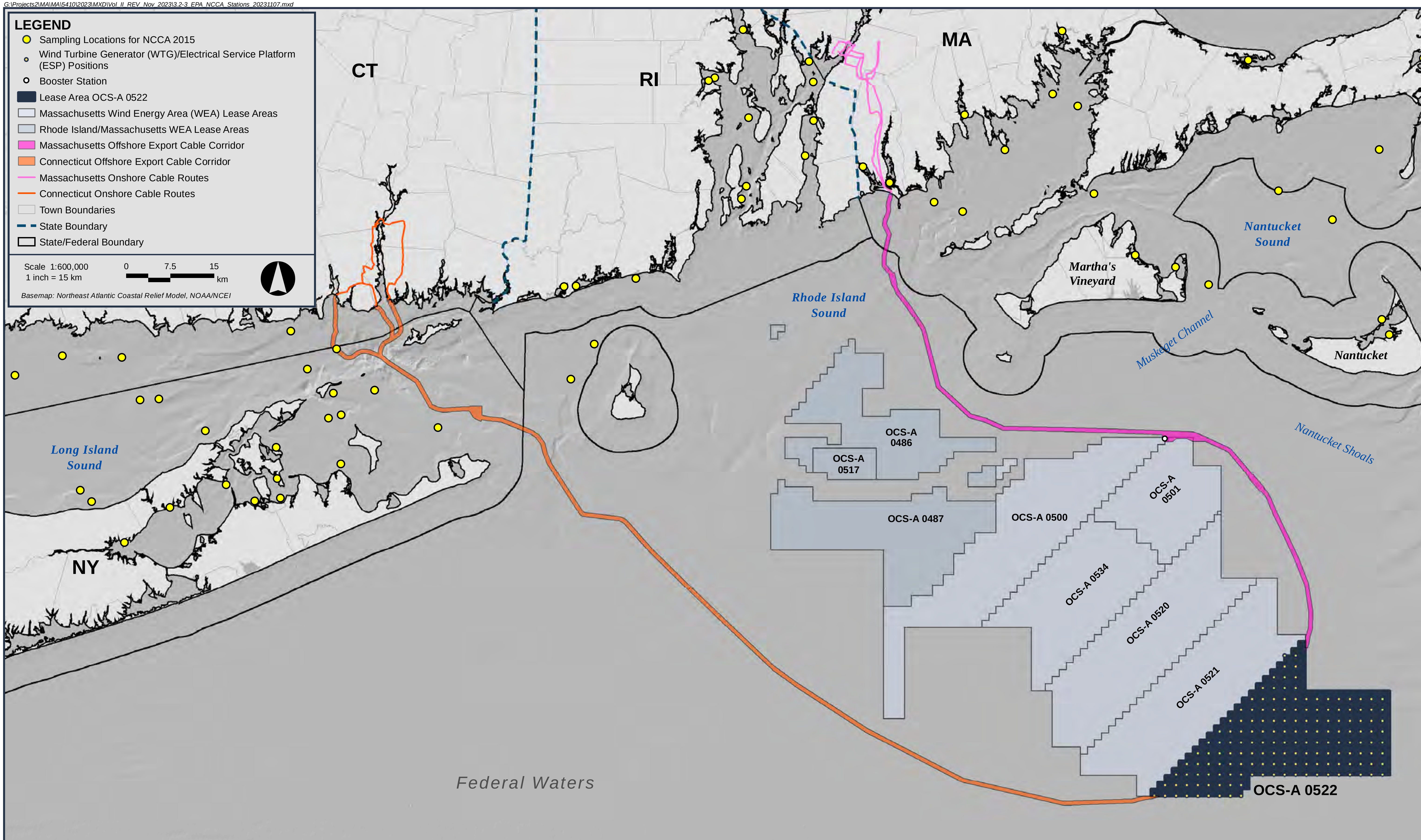

Figure 3.2-3

EPA National Coastal Conditions Assessment 2015 Data Locations Near the Offshore Development Area

3.2.1.2 Onshore Development Area

Massachusetts Onshore Development Area

Mapped water resource areas in Massachusetts include wellhead protection areas and surface water protection areas identified by MassDEP, such as Zone I[16] and II[17] areas and Surface Water Supply Protection Areas (Zone A,[18] Zone B,[19] or Zone C[20]). As shown on Figure 3.2-4, portions of the Massachusetts onshore cable routes pass through wellhead protection areas and surface water protection areas. An approval of an easement from MassDEP may be required for the limited sections of cable routes which pass through Zone I areas. Further assessment of local and regional onshore water resources will occur during the state permitting process for Vineyard Northeast.

Connecticut Onshore Development Area

Mapped water resource areas in Connecticut include Aquifer Protection Areas determined and mapped by CT DEEP. As shown on Figure 3.2-5, the Connecticut onshore cable routes do not pass through any Aquifer Protection Areas. Additionally, there are currently no EPA Sole Source Aquifers near the Connecticut onshore cable routes (EPA 2022). Further assessment of local and regional onshore water resources will occur during the state permitting process for Vineyard Northeast.

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16 As defined in 310 CMR 22.02, Zone I "means the protective radius required around a public water supply well or Wellfield…"

17 As defined in 310 CMR 22.02, Zone II "means that area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated (180 days of pumping at approved yield, with no recharge from precipitation). The Zone II must include the entire Zone I area…"

18 Zone A represents a) the land area between the surface water source and the upper boundary of the bank; b) the land area within a 400 foot lateral distance from the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a); and c) the land area within a 200 foot lateral distance from the upper boundary of the bank of a tributary or associated surface water body

19 Zone B represents the land area within one-half mile of the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a), or edge of watershed, whichever is less. Zone B always includes the land area within a 400 ft lateral distance from the upper boundary of the bank of a Class A surface water source.

20 Zone C represents the land area not designated as Zone A or B within the watershed of a Class A surface water source, as defined in 314 CMR 4.05(3)(a).

3.2.1.3 Offshore Development Area Oceanographic Features

The Offshore Development Area is located south of Nantucket Island in the Mid-Atlantic Bight (MAB) region which extends from Cape Hatteras, North Carolina to Cape Cod, Massachusetts. The depth-averaged mean currents over the MAB shelf are usually southwestward and follow the same bathymetric contour lines. This flow turns offshore near Cape Hatteras and is entrained into the Gulf Stream. The dynamics of this mean circulation is not entirely forced by the local wind stress, but wind stress forces the near-surface offshore flow. The observed mean circulation flows westward/southwestward on the New England shelf, opposing the local wind stress (see Figure 3.2-6). The depth-averaged along-shelf flow over the MAB are mainly driven by a balance between an along-shelf pressure gradient and mean wind stress (which acts in the opposite direction of pressure gradient force; Lentz 2008).

The shelf waters of the MAB also show a significant seasonal variation in terms of temperature and stratification (Beardsley et al. 1985). Because of strong surface heating and weak wind stresses during summer months, water remains warm and thermally stratified during that season. However, in winter months, the water becomes cold and weakly stratified caused by stronger wind stresses and surface cooling. Because of the river discharges in MAB, salinity near the coast is relatively lower (32 ppt) compared to water near the shelf break where salinity is approximately 34 ppt (Chapman and Beardsley 1989). A front, located near the shelfbreak of MAB, separates the cooler, fresher shelf water from the warmer, saltier slope water (Linder and Gawarkiewicz 1998). Based on the analysis of satellite imagery for the Northeast coast of the US, Ullman and Cornillon (2001) identified fronts that separate cool water inshore from warmer outer shelf water are likely to be found near the 50m isobath. The study also suggests the fronts in the vicinity of the Nantucket Shoals region are aligned in the cross-isobath direction as opposed to their usual orientation parallel to the bottom topography. This unusual orientation of the front region indicates augmented flow across the isobath. The shallow areas of Nantucket Shoals are dominated by the strong rotary tidal currents (10-20 km in diameter) which keep the water column well-mixed (Potter and Lough 1987; Lough and Manning 2001; White and Veit 2020). Wilkin (2006) suggested that the balance between strong tidal stirring and summertime solar heating can form a tidal mixing front between the well-mixed and stratified areas. This temperature front on the western edge of the Nantucket Shoals enhances productivity with observations of an abundant amphipod population (Veit et al. 2016; White and Veit 2020).

Another important oceanographic feature of the MAB water is the Cold Pool, a 20–60 m (66–197 ft) thick band of cold water near the bottom over the midshelf and outer shelf, which extends from the southern flank of Georges Bank to near Cape Hatteras for approximately 1,000 km (621 miles) (see Figure 3.2-7). Although the Cold Pool is essentially remnant winter water, it persists from spring to fall and is bounded above by the seasonal thermocline and offshore by warmer slope water (Lentz 2017). The seasonal patterns in atmospheric forcing

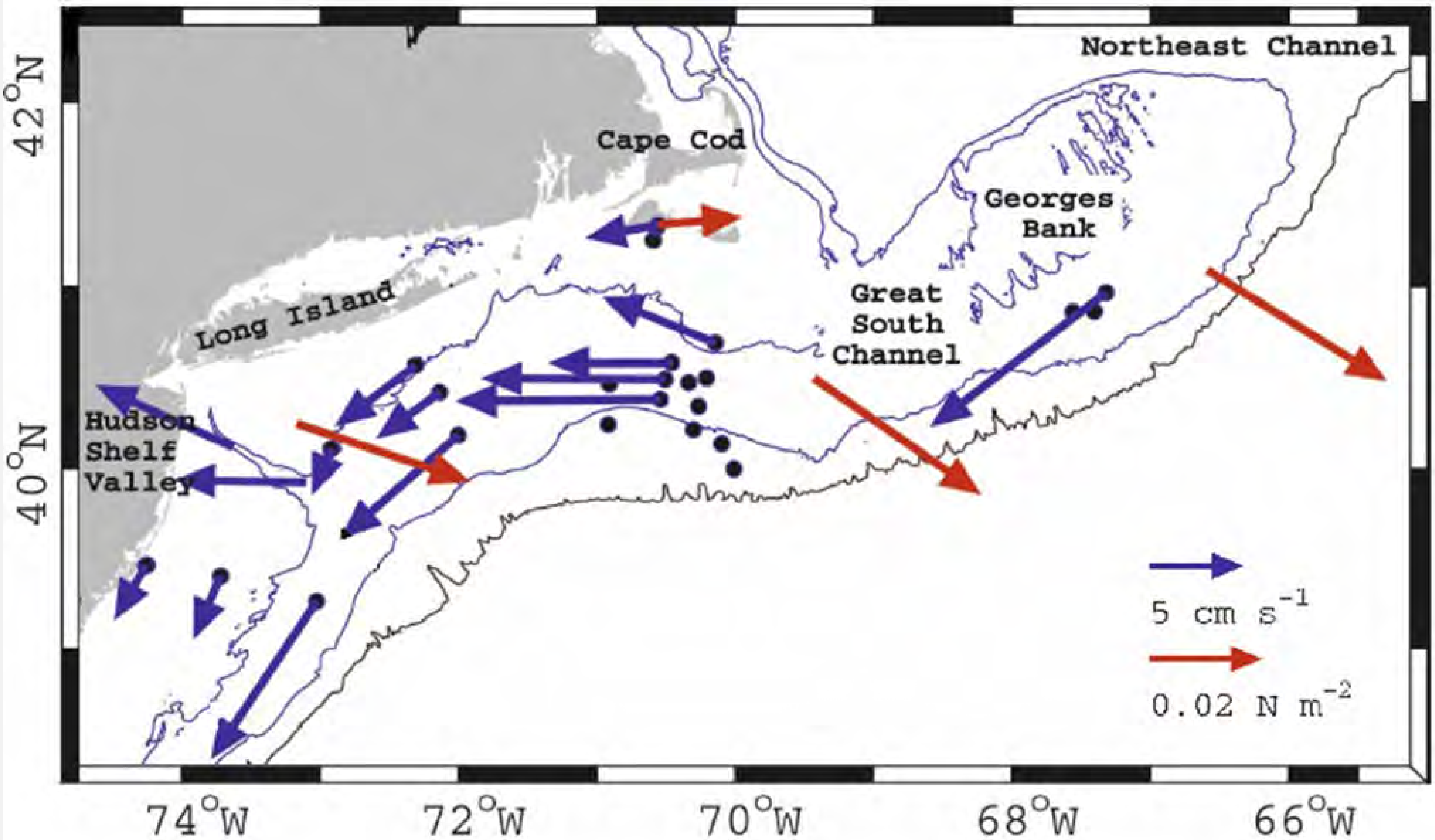

Figure 3.2-6

Map of the Mid-Atlantic Bight Showing Mean Depth-Averaged Crrent Vectors in Blue and Mean Wind Stress Vectors in Red Based on Observations (modified from Lentz 2008)

VINEYARD NORTHEAST

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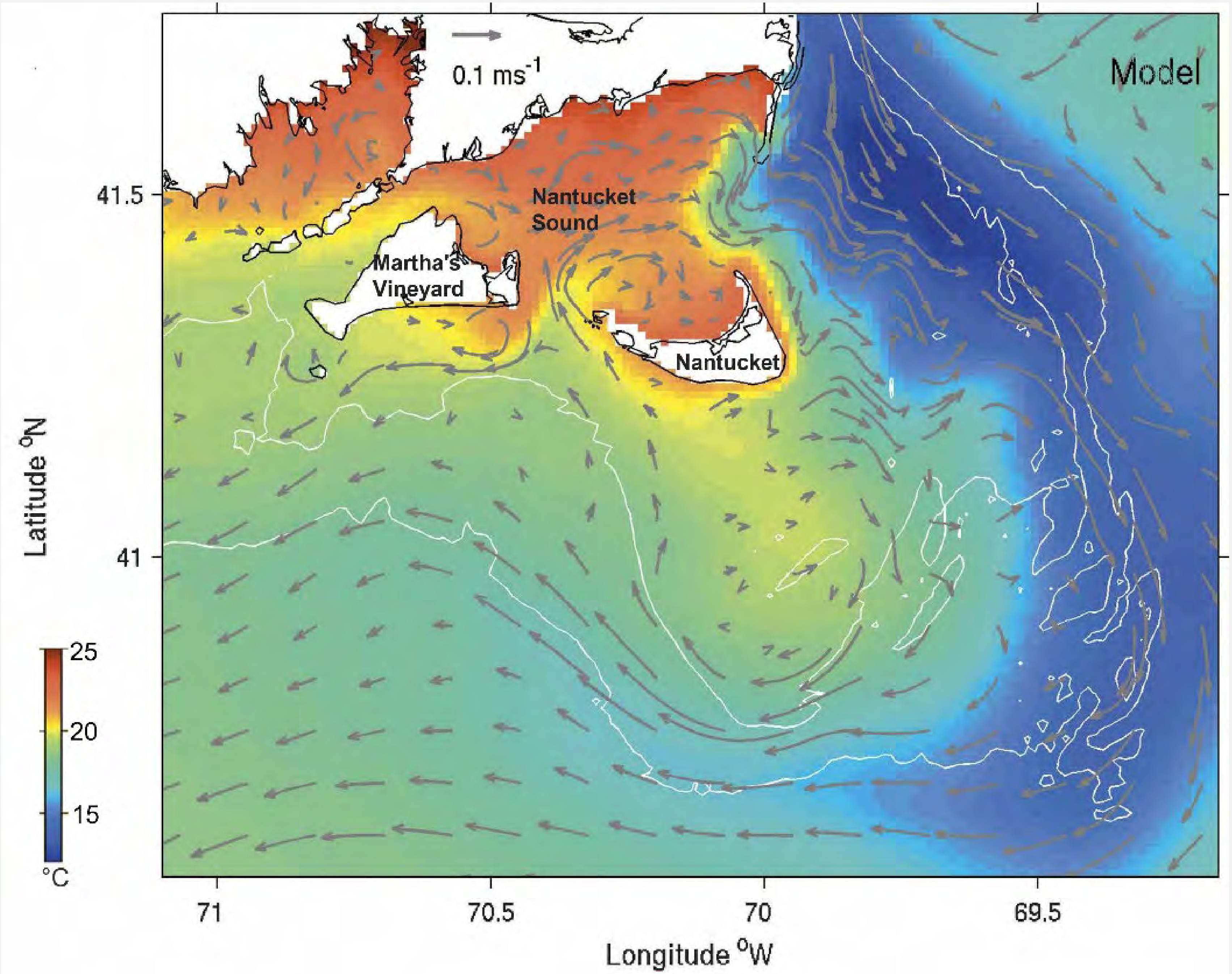

Figure 3.2-7

Depiction of Model-Derived Mean Currents (as Arrows) at 2 m Depth and a Colormap of Surface Temperature During the Summer (Wilkin 2006)

VINEYARD NORTHEAST

(solar heating and wind) play an important role in the creation and evolution of Cold Pool. At the start of spring, reduced mixing and increased solar heating cause the water column to become stratified (Lentz 2017). Additionally, freshwater runoff (usually dominated by the Hudson River) in the spring can further strengthen the stratification (Castelao et al. 2010). Cold Pool waters are nutrient-enriched and, when upwelled toward the surface, can drive phytoplankton growth and high concentrations of particulate organic matter in the water column (Voynova et al. 2013); thus, creating unique habitat conditions that provide thermal refuge to colder water species in the ecosystem of MAB (Lentz 2017).

3.2.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect water quality during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 3.2-5.

Table 3.2-5 Impact Producing Factors for Water Quality

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Suspended Sediments and Deposition	•	•	•
Ground Disturbance	•	•	•
Discharges	•	•	•
Presence of Structures		•	

Potential effects to water quality were assessed using the maximum design scenario for Vineyard Northeast's onshore and offshore facilities as described in Section 1.5.

3.2.2.1 Suspended Sediments and Deposition

Temporary increases in suspended sediments and subsequent sediment deposition may occur in the Lease Area and OECCs from the installation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, foundations, and scour protection. Specifically, sediment is expected to be suspended temporary into the water column during cable pre-installation activities (e.g., sand bedform dredging, boulder clearance, and a pre-lay grapnel run), cable installation, seabed preparation prior to foundation installation (if needed), installation of cable protection (where required), the use of other equipment that contacts the seafloor (e.g., jack-up vessels, vessel anchors, or spud legs), and excavation of the temporary horizontal directional drilling (HDD) exit pit. Although not anticipated, if detailed engineering for the Connecticut landfall sites determines that HDD is technically infeasible, offshore open trenching may be used to bring the offshore export cables onshore[21] which may cause in temporary sediment suspension. Most of these activities would occur during construction, with potential for limited seafloor disturbance during operations if cables require repair or maintenance; however, any maintenance impacts would be expected to be far less than those from construction activities. Impacts from suspended sediments and deposition would generally be temporary and confined to a small area close to the location of the installation or maintenance activity. Other potential impacts during operations, such as the potential for scour and the resulting suspended sediments, are also considered and discussed.

To assess the impacts of suspended sediments and deposition, sediment transport modeling was completed for three activities: export cable and inter-array cable installation, HDD exit pit construction,[22] and sand bedform dredging (see Appendix II-P). Activities were modeled separately within the Lease Area, Massachusetts OECC, and the Connecticut OECC. Model results provided the following estimates of the durations and concentrations of suspended sediment during construction:

- **Export and inter-array cable installation:** Above-ambient total suspended solids (TSS) concentrations substantially dissipate within one to two hours and fully dissipate in less than four to 12 hours. The modeling analyses predict that suspended sediment concentrations induced by installation of the cables will largely be of short duration, confined to the near-bottom portion of the water column, and will return to ambient conditions within several hours after the installation device has passed. Additionally, if a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), it is anticipated this would occur with sufficient time for any suspended sediment concentrations to return to ambient conditions prior to cable installation.

- **HDD exit pit construction:** Above-ambient TSS concentrations may be present throughout the entire water column because sediments were released at the water surface but are predicted to return to ambient conditions within six hours.

- **Sand bedform dredging and dumping:** Above-ambient TSS concentrations originating from the potential dredging equipment are intermittent along the route and coincide with the representative dredge locations (due to drag arm disturbances at the seafloor) and representative dumping locations. Above-ambient TSS concentrations substantially dissipate within two to three hours and fully dissipate within either four to

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[21] Open trenching at the Horseneck Beach Landfall Site in Massachusetts is unforeseen. In the event that consultations with state and local agencies result in the identification of an alternative Massachusetts landfall site, open trenching could be required.

[22] As described in Appendix II-P, the modeling for HDD exit pit construction focused on backfilling since it may result in greater water quality effects than excavation under the conservative assumption that dredged material is released at the water surface.

six hours (for the Lease Area, Massachusetts OECC, and Eastern Point Beach Approach model scenarios) or six to 12 hours (for the Niantic Beach Approach and the Connecticut OECC model scenarios).

Model results also provided estimates of the extent, area, and range of thicknesses of deposited sediment during construction (see Appendix II-P). Model results for export cable and inter-array cable installation, HDD exit pit construction, and sand bedform dredging and dumping provided the following estimates:

- **Export and inter-array cable installation:** The model predicted a depositional thickness between 1 mm (0.04 in) and 10 mm (0.4 in).

- **HDD exit pit construction:** The model predicted a depositional thickness of less than 5 mm (0.2 in) for the Massachusetts Landfall Site HDD Exit Pit Construction model scenario and less than 100 mm (4 in) for the Connecticut Landfall Site HDD Exit Pit Construction model scenario, although it is noted that only a small area (0.02 km^2 [5 acres]) near the Connecticut HDD exit pit is predicted to have greater than 20 mm (0.8 in) of deposition.

- **Sand bedform dredging and dumping:** The model predicted the cumulative sediment deposition from the representative sand bedform dredging simulations within the Lease Area, Massachusetts OECC, and Connecticut OECC to be less than 5 mm (0.2 in) and to remain close to the drag arm disturbances (i.e., within 0.09 km of the disturbance location) and within the OECC. The deposition associated with overflow and dumping exceeded a thickness of 100 mm (4 in) but was predicted to remain around the dump locations (i.e., within 0.1 km [0.06 mi] to 0.43 km [0.27 mi] depending on the simulation), with a thickness of 1 to 5 mm (0.04 to 0.2 in) occurring in isolated and patchy locations depending on the location of the prevailing currents at the time of release.

During operations, localized scour and resuspension of sediments could potentially occur around each foundation. However, due to the low current speeds in the Lease Area, there is low sediment mobility and transport. As further described in Section 2.2 of the Marine Site Investigation Report (see Appendix II-B), mean current speeds within the Lease Area vary with depth and are greatest near the 21 m (68.9 ft) mark, at approximately 0.2 m/second (s) (0.4 knots) on average. Currents decrease slightly near the air-water interface and also decrease to approximately 0.10 m/s (0.2 knots) or less near the bottom. As discussed in Sections 3.3.4 and 3.4.2 of COP Volume I, scour protection may be installed at the base of each foundation as a conservative measure to minimize scour development and ensure the structural integrity of the foundations over their operational life. Given the relatively low current speeds and the expected use of scour protection, significant resuspension of sediments near foundations during operations is not expected.

3.2.2.2 Ground Disturbance

Vineyard Northeast will include onshore transmission systems in Massachusetts and Connecticut. Each onshore transmission system will ultimately include one landfall site, one onshore export cable route, one onshore substation site, and one grid interconnection cable route, which may pass through or near mapped water resource areas (see Figures 3.2-4 and 3.2-5). Localized ground disturbance will occur from construction, O&M, and decommissioning of the landfall sites, onshore cable routes, and new onshore substations. To minimize disturbance, the Proponent has located onshore cable routes primarily underground within public roadway layouts or within existing utility rights-of-way (ROWs).[23] Although the Proponent intends to prioritize industrial/commercial sites that have been previously disturbed, land clearing and grading may be needed prior to excavation and trenching for site preparation for the substation sites. Ground disturbance associated with Vineyard Northeast will be temporary and disturbed areas will be restored.

Impacts to water quality will be minimized or avoided because the onshore cable routes are primarily located within existing public roadway layouts or utility ROWs, and construction involves standard inert materials such as concrete, polyvinyl chloride conduit, and solid dielectric cable. Proper erosion and sedimentation controls will be maintained for Vineyard Northeast.

3.2.2.3 Discharges

The Proponent will require all vessels to comply with regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills. All vessels will comply with the United States Coast Guard (USCG) ballast water management requirements at 33 CFR Part 151 and 46 CFR Part 162 as well as USCG bilge water regulations in 33 CFR Part 151, among other applicable federal regulations and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements. Vessels covered under the EPA National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP) are also subject to the effluent limits contained in the VGP.

For Vineyard Northeast, some routine releases of liquid wastes are allowed to be discharged from vessels to marine waters in both the Lease Area and OECCs during construction, O&M, and decommissioning. These discharges include domestic water, uncontaminated bilge and ballast water, deck drainage, treated grout hose flush water, and uncontaminated fresh or seawater used for vessel air conditioning. These discharges may result in temporary and localized impacts. BOEM (2014) determined the following related to potential water quality impacts from routine vessel discharges: "In the WEA, coastal and oceanic circulation and the

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[23] In limited areas, the onshore cable routes may depart from public roadway layouts or utility ROWs, particularly at complex crossings (e.g., crossings of busy roadways, railroads, wetlands, and waterbodies).

large volume of water would disperse, dilute, and biodegrade vessel discharges relatively quickly, and the water quality impact would be minor." Other waste generation such as sewage, solid waste or chemicals, solvents, oils, and greases from equipment, vessels, or facilities will be carefully handled, stored, treated, and/or disposed of or recycled in accordance with applicable regulations and would not generate an impact.

The ESP(s) include several complex mechanical and electrical systems that require oil and chemical products and will likely include an oil/water separator. See Section 6.3 in COP Volume I for a list of potential oils and chemical products used on the ESP(s). The procedures outlined in the OSRP will be followed, including spill prevention measures as well as provisions for communication, notification, coordination, containment, removal, and mitigation of a spill.

For HVDC ESP(s), the Proponent expects that seawater will be withdrawn through pipes that are attached to the foundation and pumped to heat exchangers located in the topside. Before entering the heat exchangers, the seawater will likely be passed through filters. After leaving the heat exchangers, the warmed seawater will be discharged below the water's surface through pipes that are attached to the foundation. See Table 3.4-2 of COP Volume I for the maximum anticipated withdrawal rate and temperature increase of the HVDC cooling water. The Proponent plans to conduct an impingement and entrainment analysis, as well as an assessment of any potential thermal impacts, as part of the NPDES permitting process for the cooling water intake structure.

Anti-biofouling additives (e.g., sodium hypochlorite) may be injected near the intake of the HVDC ESP seawater cooling system to prevent marine growth within the system. The anti-biofouling additives (if used) may not be completely removed prior to discharge. However, any discharged additives are expected to rapidly dissipate given the large mass of surrounding ocean. The nature of the seawater cooling system discharge will be more fully described and analyzed in the NPDES permit application. Water quality monitoring and controls would be implemented, if deemed necessary, in accordance with the NPDES permit.

Alternatively, the HVDC ESP(s) could potentially use closed-loop water cooling (where no water is withdrawn from or discharged to the sea) if such technology becomes technically and commercially feasible.[24]

HDD operations will use bentonite or other non-hazardous drilling mud beneath the coastal and nearshore habitats that are seaward of the HDD entry point. The contractor will minimize the amount of bentonite near the exit hole and will have controls near the exit hole to minimize and contain any bentonite. In the unlikely event of an inadvertent release, turbidity could occur;

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[24] Although this technology is not currently available in the offshore wind market, the Proponent is aware of a number of firms that are working to develop and test closed loop cooling systems for use in offshore wind HVDC ESPs.

however, the impacts would be temporary and localized. The temporary receiving pit will be filled back in with the same material once the offshore export cable has been brought to land, thereby restoring the ocean bottom to pre-installation conditions.

Where practicable, onshore vehicle fueling and all major equipment maintenance will be performed offsite at commercial service stations or a contractor's yard. Larger, less mobile equipment (e.g., excavators, paving equipment) will be refueled as necessary onsite. Any such field refueling will be performed in accordance with applicable on-site construction refueling regulations. The fuel transfer operation will be conducted by a competent person knowledgeable about the equipment, the location, and with the use of the work zone spill kit. Proper spill containment gear and absorption materials will be maintained for immediate use in the event of any inadvertent spills or leaks thereby minimizing the risk of potential leaks. During construction, equipment shall be inspected for incidental leaks (e.g., hydraulic fluid, diesel fuel, gasoline, anti-freeze, etc.) prior to site access and at the beginning of each work shift. Spill prevention procedures for onshore refueling of construction equipment will be finalized during consultations with the appropriate state, regional, and local authorities.

The onshore substation equipment will be mounted on concrete foundations with secondary oil containment designed in accordance with industry and local utility standards. A stormwater management system at the onshore substation sites will include low-impact development (LID) strategies (e.g., grass water quality swales to capture and convey site runoff, deep sump catch basin[s] to pretreat surface runoff, etc.), which are designed to capture, treat, and recharge stormwater runoff. The Proponent will develop a Spill Prevention, Control, and Countermeasure (SPCC) Plan for each onshore substation site as part of the state permitting process, which will describe onshore spill prevention and response procedures.

3.2.2.4 Presence of Structures

In addition to the potential for scour formation and resuspension of sediment discussed in Section 3.2.2.1, the development of an offshore wind farm may impact atmospheric and oceanographic processes as currents and winds in the associated area can be altered by the presence of foundations and the extraction of wind energy.

As wind turbines generate power by withdrawing kinetic energy from the atmosphere, this process of wind energy extraction creates atmospheric wakes defined by the downstream reduction of the mean wind speed and enhanced turbulence along with the wind speed deficit. In a cluster of wind turbines, the individual wakes can merge downstream into a single wake structure, which is dependent on wind direction and the layout of the wind turbine (Frandsen 1992). Magnitudes of this wind speed reduction, which influence the formation of waves, are a function of the mean wind speeds and the wind farm drag by the wind turbines. This reduction in wind speed translates to less wind stress at the sea surface boundary. As wind stress influences residual currents and mixing of the surface mixed layer (Kantha and Clayson 2015), it can impact the upper ocean dynamics. The magnitude of this additional mixing needs to be fully quantified to better understand if it affects the shelf system and stratifications, and if the mixing may even positively impact the marine ecosystem (Dorrell et al. 2022). Since turbulent processes near the sea surface boundary control heat, momentum, and constituent fluxes between atmosphere and ocean, a reduction of shear-driven turbulent mixing can potentially lead to a change in the upper ocean heat content and associated surface heating or cooling.

Several studies have assessed the local effect of European offshore wind projects on wake, turbidity, stratification, and fisheries impacts (e.g., van Berkel et al. 2020). Most of the studies have involved numerical modeling of the hydrodynamic processes, and only a few studies provide observations or field studies of actual offshore wind projects to validate the numerical models. Only minor influences from the offshore wind projects in comparison with natural processes are shown by several of these European studies, with short term and localized effects of individual foundations expected in the flow field (Floeter et al. 2017; Simpson et al. 1982). Conversely, some studies have shown contradictory results on topics such as whether an offshore wind project leads to decreases or increases in turbidity (van der Molen et al. 2014; Grashorn and Stanev 2016; Rivier et al. 2016). In the US, the effects of offshore wind developments on hydrodynamics at a regional scale are still in the research phase due to the early stage of offshore wind development. Several numerical modeling studies and field observations have assessed the impacts of offshore wind farm developments on the regional oceanographic conditions, and consequently on fish larvae and marine species such as whales; however, most of those studies have focused on different geographic areas. In the vicinity of the Vineyard Northeast area, BOEM commissioned modeling studies (e.g., Chen et al. 2016; Johnson et al. 2021) to assess the changes in hydrodynamic conditions as well as larval transport resulting from the introduction of offshore wind farms in the Massachusetts Wind Energy Area (MA WEA) and Rhode Island/Massachusetts (RI/MA) WEA. Among the BOEM commissioned studies, Chen et al. (2016) focused on examining the role of wind turbine facilities in modifying the oceanic processing during extreme storm conditions and Johnson et al. (2021) assessed the impact of deployment of wind turbines by applying seasonal conditions in the simulation.

The modeling experiments by Chen et al. (2016) assessed the potential influence of the deployment of wind turbines on larval transport during storm events, such as Hurricane Bob (in August 1991), due to the change in the physical environments. This study involved particle-tracking experiments in which fish larvae were treated as individual passive particle tracers and released outside and within the offshore wind farm area. The results suggested that, during extreme weather events, the presence of wind turbines may not have a significant influence on the southward larval transport from the upstream Georges Bank and Nantucket Shoals areas to the MAB, although it can create a relatively large larval dispersion across the shelf.

Based on their hydrodynamic modeling study, Johnson et al. (2021) suggested different offshore windfarm layouts (or build-out scenarios) can have varying effects on current speed and eventually cause variation in the change of the larval settlement density inside and around the lease area. In normal conditions, the impact of offshore wind farms on oceanographic conditions and circulation is dependent on different parameters such as geographic location and bathymetry; number of wind turbines and their layout; wind velocity over the lease area; current flow and stratification of water column; and the type of habitat and larvae being affected. Thus, the findings of studies in different water bodies and designs cannot be generalized to other geographic regions and layouts.

For example, studies of wind turbines in the North Sea have found that there is a potential to significantly impact the large-scale stratification of the water column by cumulative effects of turbines, which can subsequently change the ecosystem dynamics (Christiansen et al. 2022; Carpenter et al. 2016). However, the North Sea is a shallow region and US wind farms have different design parameters with much (two to three times) higher spacing than the typical wind turbine spacing in European projects. Thus, it is still speculative whether the impact of offshore wind farms in the MA WEA and RI/MA WEA will be the same, and as such, fewer local effects on hydrodynamics are anticipated from Vineyard Northeast as compared to European offshore wind projects.

Johnson et al. (2021) reported the introduction of wind turbines in the US Northeast could cause a relative deepening in the thermocline, as well as retention of colder water during the summer months; though this difference in the effects of temperature, stratification did not significantly change the larval transport. Also, the change in the larval settlement density (e.g., number of individual larvae per unit area settling to the seafloor) can be dependent upon the species of larvae. For instance, the study did not directly assess the impacts on copepod *Calanus* spp. As there is no field survey or observation prior and post turbine installation yet available in the US, the study results are yet to be validated, investigated, and peer-reviewed.

Water quality impacts associated with wind development can not only be interpreted as having potential conservation concerns, but these structures can be considered beneficial to the marine environment by providing habitat to local marine communities. For example, wind turbine foundations can also serve as artificial reefs by attracting marine species and facilitating increased productivity (Wilhelmsson et al. 2006). Therefore, it is difficult to conclude if the introduction of wind turbines can influence the feeding habitat of marine species through the fluctuation of thermocline.

The aforementioned studies mostly analyzed the cumulative impacts of offshore wind farms in a region, and it is not clear how a small number of turbines might contribute to the change in environmental conditions and ecosystem dynamics. Therefore, further research is required to assess the impact of adding or removing small numbers of turbines from an offshore wind farm. Some of these studies are focused on the regions outside New England waters, and the ones focusing on New England have not been validated due to the lack of observation in the presence of wind turbines and wind farms. Thus, the impacts of offshore wind farms in the region are not yet able to be predicted. The presence of large-scale mixing and shift in the ocean dynamics and ecology due to climate change will define a new norm for the shelf ecosystem, with potential benefits and risks from infrastructure-induced mixing of stratified shelf seas that should be studied and better understood (Dorrell et al, 2022). In addition, more research is needed that scales up the results of studies focusing on a single turbine or an array of turbines, to an entire shelf sea region with multiple farms (Dorrell et al, 2022). Regional hydrodynamic models coupled with ecosystem modeling must be used and be validated against direct measurements before-and-after windfarm installation to assess the direct and indirect impacts of turbines. The hydrodynamic alteration and environmental impacts need to be studied with a focus on this particular geographical region and need to be calibrated and validated using local and regional observations in order to guide sustainable development.

3.2.2.5 Summary of Avoidance, Minimization, and Mitigation Measures

For Vineyard Northeast, water quality impacts related to suspended sediments from cable installation, dredging, and other construction activities (such as HDD or placement of scour protection) are expected to be short term and localized. The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to water quality during Vineyard Northeast are summarized below:

- In most instances, underground trenchless crossing methods (e.g., HDD) are expected to be used where the onshore cable routes traverse unique features such as wetlands and waterbodies to avoid impacts to those features.
- The Proponent will require all vessels to comply with regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills.
- Where practicable, onshore vehicle fueling and all major equipment maintenance will be performed offsite at commercial service stations or a contractor's yard. Field refueling will be performed in accordance with applicable on-site construction refueling regulations. Proper spill containment gear and absorption materials will be maintained for immediate use in the event of any inadvertent spills or leaks. Procedures for onshore refueling of construction equipment will be finalized during consultations with the appropriate state, regional, and local authorities.
- Onshore cable routes are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs,[25] and construction involves standard inert materials such as concrete and polyvinyl chloride conduit, which will avoid or minimize impacts to any mapped water resource areas along the routes.
- During construction of Vineyard Northeast, proper erosion and sedimentation controls will be employed.

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[25] In limited areas, the onshore cable routes may depart from public roadway layouts or utility ROWs, particularly at complex crossings (e.g., crossings of busy roadways, railroads, wetlands, and waterbodies).

- The Proponent will develop a SPCC Plan for each onshore substation site.
- The Proponent has also developed a draft Oil Spill Response Plan for Vineyard Northeast, which is included in Appendix I-F.

3.3 Geology

This section addresses the potential impacts of geological site conditions on Vineyard Northeast's offshore facilities in the Offshore Development Area. An overview of the affected environment is proved first, followed by a discussion of the impact producing factors (IPFs) and the proposed measures to avoid, minimize, and mitigate potential effects of the geological site conditions on the proposed offshore facilities during the construction, operation, and decommissioning of Vineyard Northeast.

The Marine Site Investigation Report (MSIR), included as Appendix II-B, provides detailed results of the survey program and geological conditions for Vineyard Northeast.

3.3.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities.

This section summarizes the physical site conditions (primarily seafloor and shallow subsurface geology) within the Lease Area and within and around the Massachusetts OECC and Connecticut OECC. The analysis and interpretation of the Offshore Development Area is based off reconnaissance survey data collected in 2019 and comprehensive survey data collected in 2022 within the Lease Area, the Massachusetts OECC, and the Connecticut OECC, including historical supporting datasets and the following resources:

- 2009 Multichannel seismic reflection (MCS) air gun seismic data collected on the OCS (Siegel et al. 2012)
- 2018 compilation of a continuous bathymetry and topography terrain model for coastal Massachusetts (Andrews et al. 2018)
- High-resolution quality-controlled seafloor elevation from National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS) Hydrographic Survey Bathymetric Attributed Grids (BAGs) in United States (US) coastal waters.
- Connecticut Department of Energy and Environmental Protection (CT DEEP) Long Island Sound Blue Plan
- Massachusetts Ocean Management Plan (OMP)

- NOAA National Data Buoy Center
- NOAA Center for Operational Oceanographic Products and Services (CO-OPS) Tidal Current Predictions
- United States Geological Survey (USGS) East-Coast Sediment Texture Database
- USGS and University of Colorado: usSEABED Offshore Surficial-Sediment Database

3.3.1.1 Lease Area OCS-A 0522

The Lease Area is situated about 46 kilometers (km) (29 miles [mi]) south of Nantucket, Massachusetts in the Atlantic Ocean in approximately 32–64 m (105–210 ft) water depths (see Figure 3.3-1). The Lease Area consists of relatively flat seafloor with few bedforms present. Conditions in the Lease Area have been identified using a combination of marine geophysical, geotechnical, and environmental survey techniques during the 2019 and 2022 field programs. Interpretation of seafloor sediments was ground truthed with benthic grab samples, underwater video imagery, and the surface material collected from the vibracores, while interpretation of the shallow and deep subsurface was completed using vibracores, seabed cone penetration tests (CPTs), deep borings, and downhole CPTs.

Table 3.3-1 provides a summary of geologic site conditions in the Lease Area.

Table 3.3-1 Geologic Conditions in the Lease Area

Results	Summary
[redacted]	[redacted]
[redacted]	[redacted]

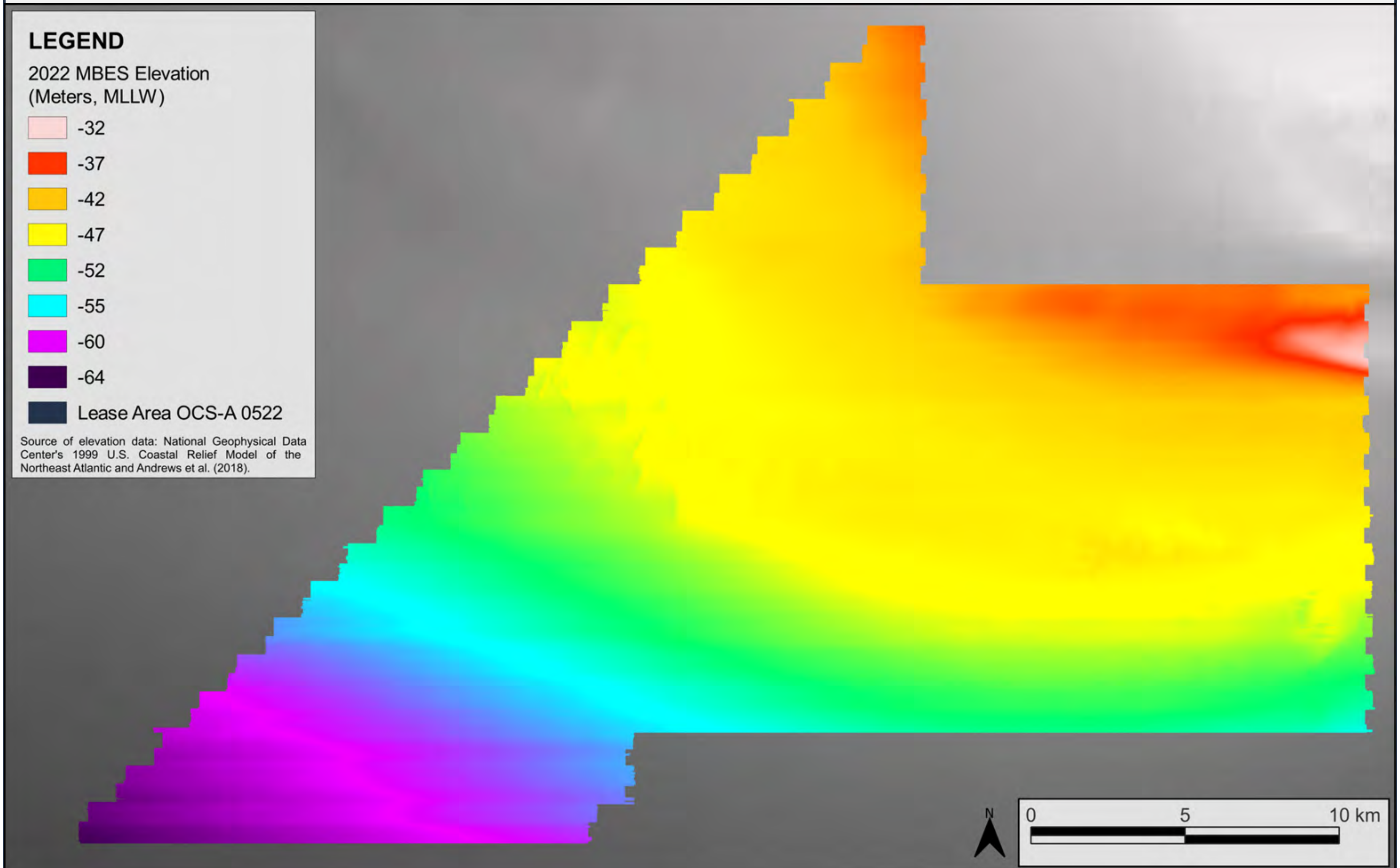

Figure 3.3-1
Water Depths in the Lease Area

VINEYARD NORTHEAST
VINEYARD OFFSHORE

3.3.1.2 Massachusetts OECC

The Massachusetts OECC connects the Lease Area to the Horseneck Beach Landfall Site in Westport, Massachusetts. The Massachusetts OECC will also connect to a booster station in the northwestern aliquot[26] of Lease Area OCS-A 0534. The Massachusetts OECC traverses approximately 126 km (68 nautical miles [NM]) of Massachusetts' state- and federally-regulated waters in approximately 0–42 m (0–138 ft) water depths (see Figure 3.3-2). Conditions in the Massachusetts OECC have been identified using a combination of marine geophysical, geotechnical, and environmental survey techniques during the 2022 field program.

Interpretation of seafloor sediments was ground truthed with benthic grab samples, underwater video imagery, and the surface material collected from the vibracores, while interpretation of the shallow subsurface was completed using vibracores and seabed CPTs.

Table 3.3-2 provides a summary of geologic site conditions in the Massachusetts OECC.

Table 3.3-2 Geologic Conditions in the Massachusetts OECC

Results	Summary
[redacted]	[redacted]
[redacted]	[redacted]

[26] An aliquot is 1/64th of a BOEM Outer Continental Shelf (OCS) Lease Block.

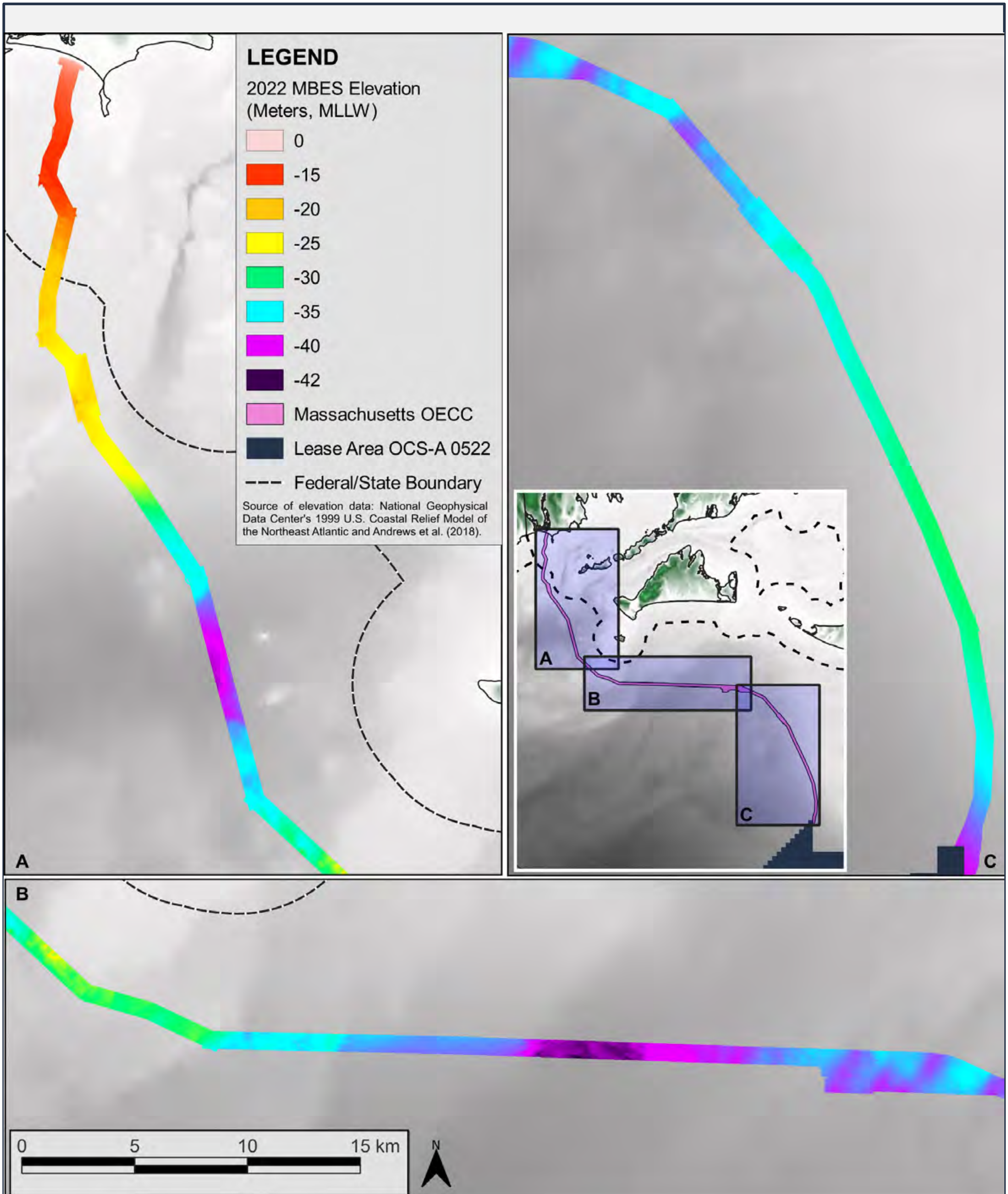

Figure 3.3-2

Water Depths in the Massachusetts OECC

VINEYARD NORTHEAST

VINEYARD OFFSHORE

3.3.1.3 Connecticut OECC

The Connecticut OECC connects the Lease Area to three potential landfall sites near New London, Connecticut: the Niantic Beach Landfall Site, the Ocean Beach Landfall Site, and the Eastern Point Beach Landfall Site. The OECC, depending on the approach, traverses approximately 171–179 km (92–96 NM) of Connecticut's state- and federally-regulated waters in depths of approximately 0–105 m (0–345 ft) water depths (see Figure 3.3-3). Conditions in the Connecticut OECC have been identified using a combination of marine geophysical, geotechnical, and environmental survey techniques during the 2022 field program. Interpretation of seafloor sediments was ground truthed with benthic grab samples, underwater video imagery, and the surface material collected from the vibracores, while interpretation of the shallow subsurface was completed using vibracores and seabed CPTs.

Table 3.3-3 Geologic Conditions in the Connecticut OECC

Results	Summary
[redacted]	• [redacted] • [redacted] • [redacted] • [redacted] • [redacted] • [redacted] • [redacted]

Table 3.3-3 Geologic Conditions in the Connecticut OECC (Continued)

Results	Summary
[redacted]	[redacted]

3.3.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

Geological conditions affect the design of the Vineyard Northeast offshore facilities, including wind turbine generators (WTGs) and foundations, electrical service platforms (ESPs) and foundations, booster station and foundation, and offshore export, inter-array, and inter-link cables. Table 3.3-4 summarizes the geological features and hazards in the Offshore Development Area, potential impacts to Vineyard Northeast, and the specific mitigation measures for each of the identified geological hazards.

The cables will be buried beneath the stable seafloor at a target depth of 1.5 to 2.5 m (5 to 8 ft),[27] which is more than twice the burial depth required to protect the cables from fishing activities and generally provides a maximum of 1 in 100,000 year probability of anchor strike,[28] which is considered a negligible risk.

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27 Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

28 Based on a preliminary CBRA (see Appendix II-T), in portions of the Ocean Beach Approach and Niantic Beach Approach of the Connecticut OECC, a greater target burial depth of approximately 3 m (10 ft) is needed to achieve a 1 in 100,000 year probability of anchor strike.

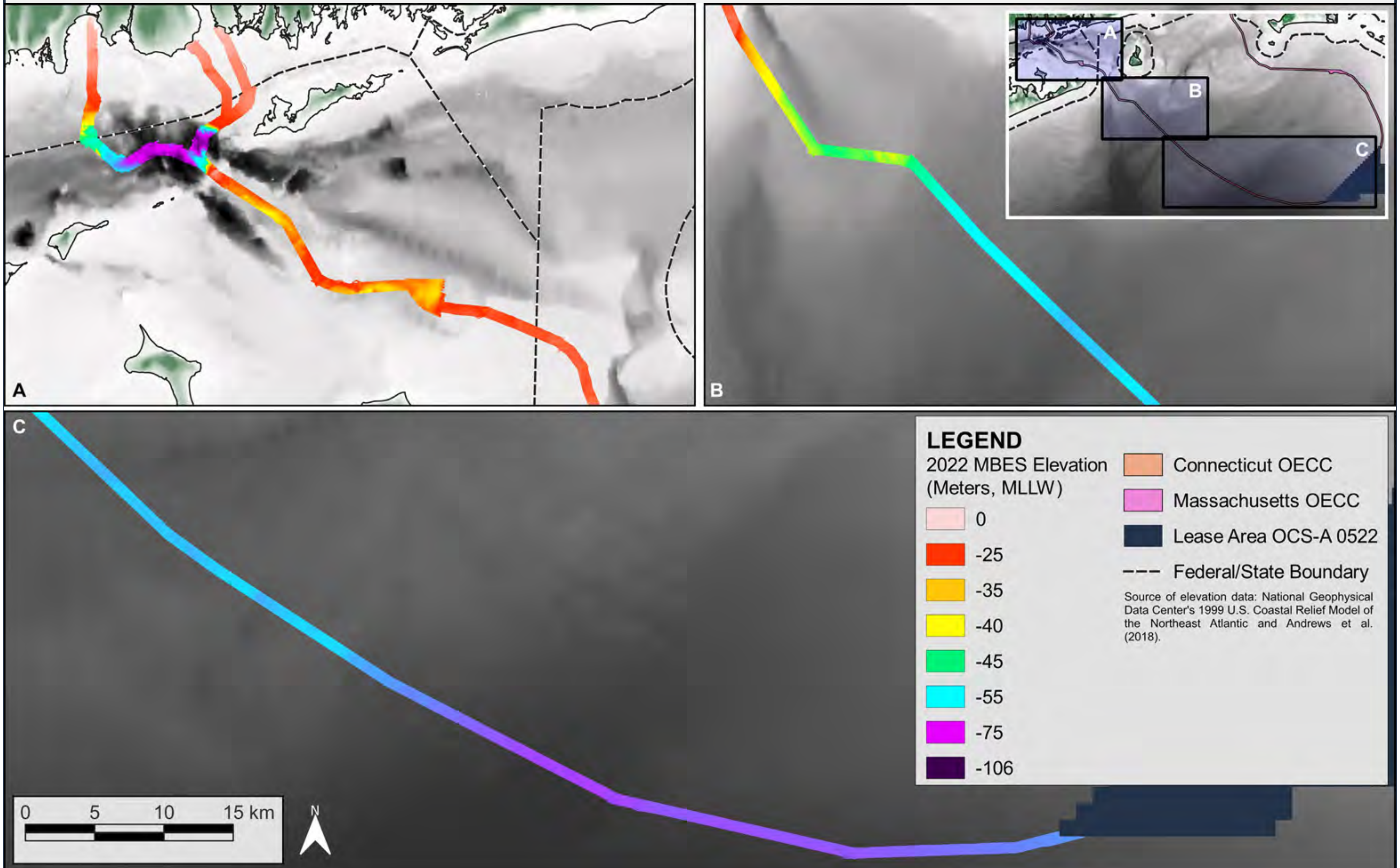

Figure 3.3-3

Water Depths in the Connecticut OECC

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]		[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]		[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]		[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]		[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]

Table 3.3-4 Geological Impact and Hazard Assessment for Offshore Facilities (Continued)

Feature/Hazard Description	Impact Evaluation, Potential	Mitigation Measures
[redacted]	[redacted]	
[redacted]	[redacted]	
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

WTG, booster station, and ESP foundations will be positioned within a limited tolerance area to avoid any suspected adverse conditions interpreted from the geophysical and geotechnical data. Data on the deep sediment units, stratigraphy, and structures below the seafloor is acquired and examined to inform the Proponent of these site conditions. Single and multi-channel seismic profiles, downhole CPTs, and borings document the subsurface environment to at least expected foundation depths and in most places to 10 m (32.8 ft) beyond. If necessary, foundation locations can then be strategically placed to avoid potential locally unsuitable subsurface features or designed to mitigate the hazards. Similarly, export and inter-array cables will be micro-sited, within the limits of the cables' bending radius, to avoid any adverse environmental and hazardous conditions on the seafloor and in the shallow subsurface where possible.

In summary, all Vineyard Northeast components will be designed for site-specific geological conditions. Known natural and anthropogenic hazards will be avoided to the extent practicable. The Proponent will develop one or more Facility Design Reports (FDRs) and Fabrication and Installation Reports (FIRs) for the proposed offshore facilities. The FDRs will contain the specific details of the offshore facilities' design, including structural drawings, justification for referenced design standards, design and load calculations, and summaries of the environmental, engineering, and geotechnical data used as the basis for the designs. The FIRs will describe how each structure will be fabricated, transported, installed, and commissioned. The FDRs and FIRs will be reviewed by a third-party Certified Verification Agent that certifies the offshore facilities are designed to withstand site-specific environmental and functional load conditions for the duration of the facilities' intended service life. As further described in Section 4 of Volume I, the Proponent will regularly monitor the offshore facilities via above and below-water inspections and surveys throughout the operational period. Underwater surveys could include the use of survey vessels, remotely operated vehicles (ROVs), remotely operated towed vehicles (ROTVs), autonomous offshore vehicles/vessels, and/or divers. Geophysical survey equipment may include, but is not limited to, side scan sonar, multibeam echosounders, magnetometers/gradiometers, and sub-bottom/seismic profilers.

4 Biological Resources

4.1 Terrestrial Habitat and Wildlife (Including Inland Birds)

This section addresses the potential impacts of Vineyard Northeast on terrestrial habitat and wildlife (including inland birds) in the Onshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to terrestrial wildlife species during the construction, operation, and decommissioning of Vineyard Northeast.

This section discusses terrestrial wildlife resources along the onshore cable routes, at the onshore substation sites, and at the terrestrial portion of the landfall sites. Coastal and marine birds are discussed in Section 4.2, bats are discussed in Section 4.3, and coastal habitats at the marine portion of the landfall sites are discussed in Section 4.4. Potential impacts to water quality from onshore construction are discussed in Section 3.2.

4.1.1 Description of Affected Environment

The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities.

4.1.1.1 Massachusetts Onshore Development Area Terrestrial Habitats

Landfall Site

All offshore export cables installed within the Massachusetts Offshore Export Cable Corridor (OECC) would transition onshore at the Horseneck Beach Landfall Site. The Horseneck Beach Landfall Site is located within a portion of a paved parking area within Horseneck Beach State Reservation in Westport, Bristol County, Massachusetts. The landfall site is near the entrance to Buzzards Bay, east of the Westport River. Nearby land uses include the public beach, campground, and open space within the State Reservation.

Points of Interconnection

In Massachusetts, power will be delivered to one of the following potential POIs:

- **Pottersville POI:** The 115 kV Pottersville Substation in Somerset, Massachusetts is operated by National Grid.
- **Brayton Point POI:** National Grid has proposed to construct and operate a new 345 kV substation near Brayton Point in Somerset, Massachusetts.

- **Bell Rock POI:** The 115 kV Bell Rock Substation in Fall River, Massachusetts is operated by National Grid.

Onshore export cables will connect the landfall site to a new onshore substation site and grid interconnection cables will connect the onshore substation site to the POI. Modifications may be required at the selected POI to accommodate Vineyard Northeast's interconnection. The design and schedule of this work will be determined by the results of interconnection studies. Any required system upgrades at the POI would be constructed by the existing substation's owner/operator. Based on negotiations with the substation's owner/operator, the Proponent may install onshore cables[29] (i.e., perform ground disturbing activities) within the property line of the existing substation.

Onshore Cable Routes

From the Horseneck Beach Landfall Site, the onshore cables will follow one of the onshore cable routes shown on Figure 4.1-1 to reach the Pottersville POI, the Brayton Point POI, or the Bell Rock POI. Likely onshore cable routes are described below;[30] however, Vineyard Northeast may ultimately use any combination of route segments shown on Figure 4.1-1 to reach any of the three potential POIs.[31] Figure 4.1-1 illustrates the routes and the surrounding land cover.

- **Horseneck Beach Eastern Onshore Cable Route:** The approximately 30 kilometer (km) (19 mile [mi]) long route begins at the landfall site, crosses the Westport River, and proceeds generally north through the Town of Westport and City of Fall River to reach the Bell Rock POI. The route primarily follows town roads and portions of state highways, including Route 88, Route 6, and Blossom Road. Habitat adjacent to the route is predominantly developed land (~51%) and forested area (~31%).

- **Horseneck Beach Western Onshore Cable Route:** This route is primarily located west of, and largely parallels, the Horseneck Beach Eastern Onshore Cable Route. The Horseneck Beach Western Onshore Cable Route is approximately 35 km (22 mi) long and travels north from the landfall site, across the Westport River, and through the Town of Westport and City of Fall River to reach the Bell Rock POI. The route primarily follows

29 At the Brayton Point POI and the Bell Rock POI, the Proponent's grid interconnection cables are expected to be installed within an underground duct bank. Onshore cables at the Pottersville POI may be installed within an underground duct bank or as overhead transmission lines (see Section 3.8.3.3 of COP Volume I).

30 The lengths of the Massachusetts onshore cable routes include conservatism to account for the uncertainty regarding the location of the onshore substation site within the [redacted] Onshore Substation Site Envelopes (see Section 3.9.1 of COP Volume I).

31 For example, any of the variants to the Horseneck Beach Western Onshore Cable Route could be used in conjunction with the southern portion of the Horseneck Beach Eastern Onshore Cable Route.

town roads (such as Main Road and Sandford Road) and utility rights-of-way (ROWs) through a mix of agricultural land, low to moderate density residential areas, and commercial areas. Habitat adjacent to the route is predominantly developed land (~49%) and forested land (~30%). As further described in Section 3.8 of Construction and Operations Plan (COP) Volume I, this route also includes five variants, which begin near the intersection of Route 6 and Old Bedford Road and cross the Taunton River to reach the Pottersville or Brayton Point POIs. The maximum length of any one variant is approximately 39 km (24 mi). The five variants follow bike paths, city/town roads, and state roads, primarily through industrial, commercial, and moderate to high density residential areas. The habitat adjacent to the Horseneck Beach Western Onshore Cable Route with variants is predominantly developed (77%) and forested areas (13%). See Appendix II-C for more detail.

The onshore cables are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs via open trenching. In most instances, underground trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) (see Figure 4.1-2), such as where the onshore cables cross the Westport River and the Taunton River. However, the northern crossing of the Taunton River [redacted] may require a segment of overhead transmission lines if further field data collection and detailed engineering confirms that an underground trenchless crossing at that location is technically or commercially infeasible.[32]

Onshore Substation Site

In Massachusetts, the onshore substation site will be located within one of the following areas shown on Figure 4.1-1:

- [redacted]
- [redacted]

[32] As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

[redacted]

[redacted]

Although the Proponent may select an onshore substation site parcel that contains state-mapped wetlands, the footprint of the onshore substation site would be sited to avoid wetlands.

Terrestrial Habitats

The Northeast Habitat Map, a collaborative dataset put together by the Nature Conservancy, Nature Serve, North Atlantic Landscape Conservation Cooperative, Northeast Climate Science Center, Nature Conservancy of Canada, Atlantic Canada Conservation Data, and Eastern Conservation Science, identifies habitat along areas of proposed Vineyard Northeast activities. In Massachusetts, the onshore facilities are located primarily in developed areas. However, nearby habitats include North Atlantic coastal plain hardwood forest, North-Central Appalachian acidic swamp, and shrubland.

Onshore cable routes travel through Priority and Estimated Habitats mapped by the Massachusetts Division of Fish and Wildlife Natural Heritage and Endangered Species Program (NHESP), immediately north of the Horseneck Beach Landfall Site (see Figure 4.1-3). However, onshore cable routes are primarily co-located within public roadway layouts or existing utility ROWs (i.e., within previously disturbed areas) to minimize disturbance to terrestrial wildlife and habitat. No Priority and Estimated Habitats are mapped in the area of the Pottersville POI or Brayton Point POI. Priority and Estimated Habitat is mapped where the Bell Rock POI is sited; however, this is a previously disturbed and developed site owned by National Grid.

The Brayton Point POI, [redacted] are located partially within the Federal Emergency Management Act (FEMA) 100-year floodplain. The Brayton Point POI is located in an area identified as having vernal pools and mapped Massachusetts Department of Environmental Protection (MassDEP) wetlands; wetlands are also mapped within the Bell Rock POI [redacted] The onshore facilities will be designed to meet all applicable floodplain requirements. Although the Proponent may select an onshore substation site parcel that contains state-mapped wetlands, the footprint of the onshore substation site would be sited to avoid wetlands.

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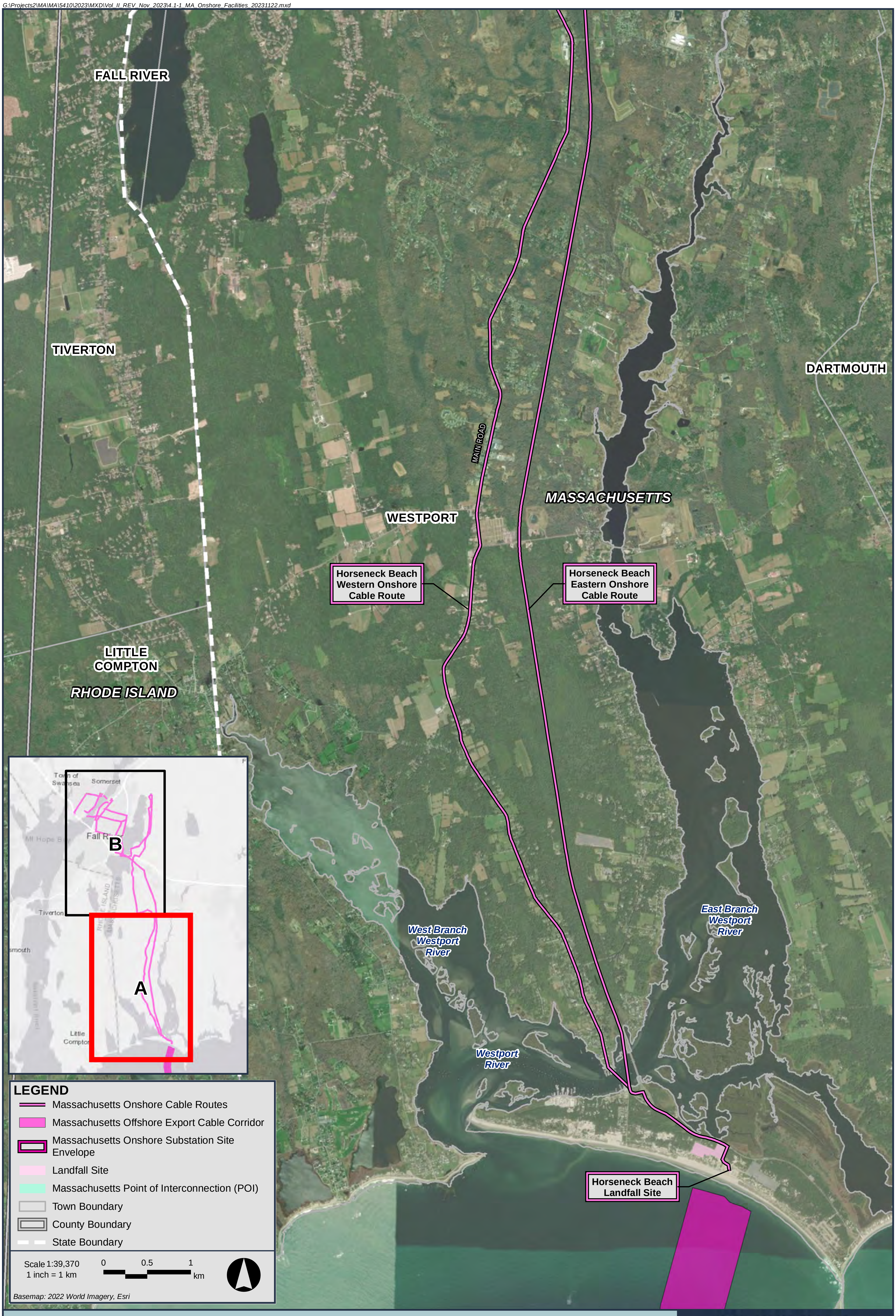

Figure 4.1-1A
Massachusetts Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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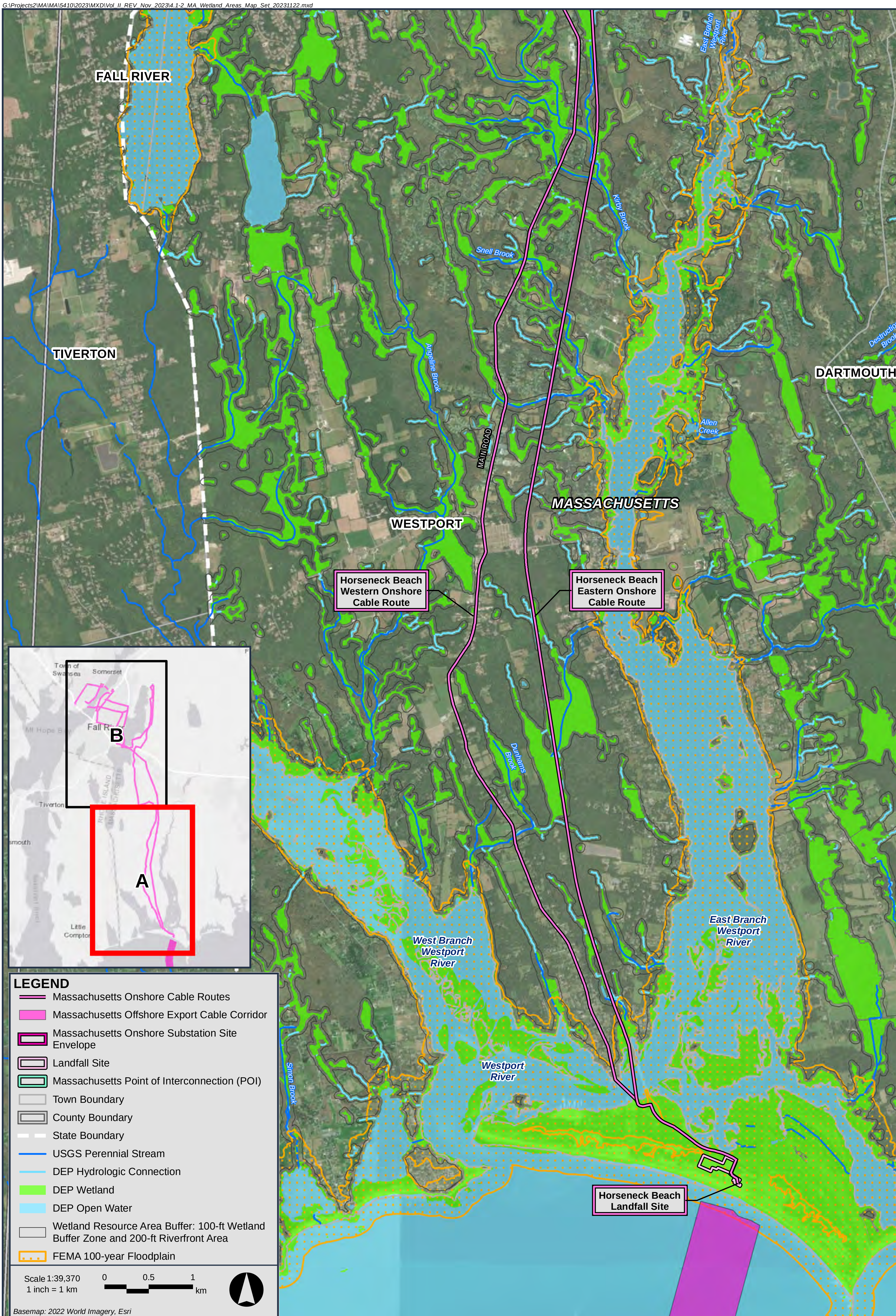

Figure 4.1-2A
Massachusetts Wetlands and Waterbodies Proximal to Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

[redacted]

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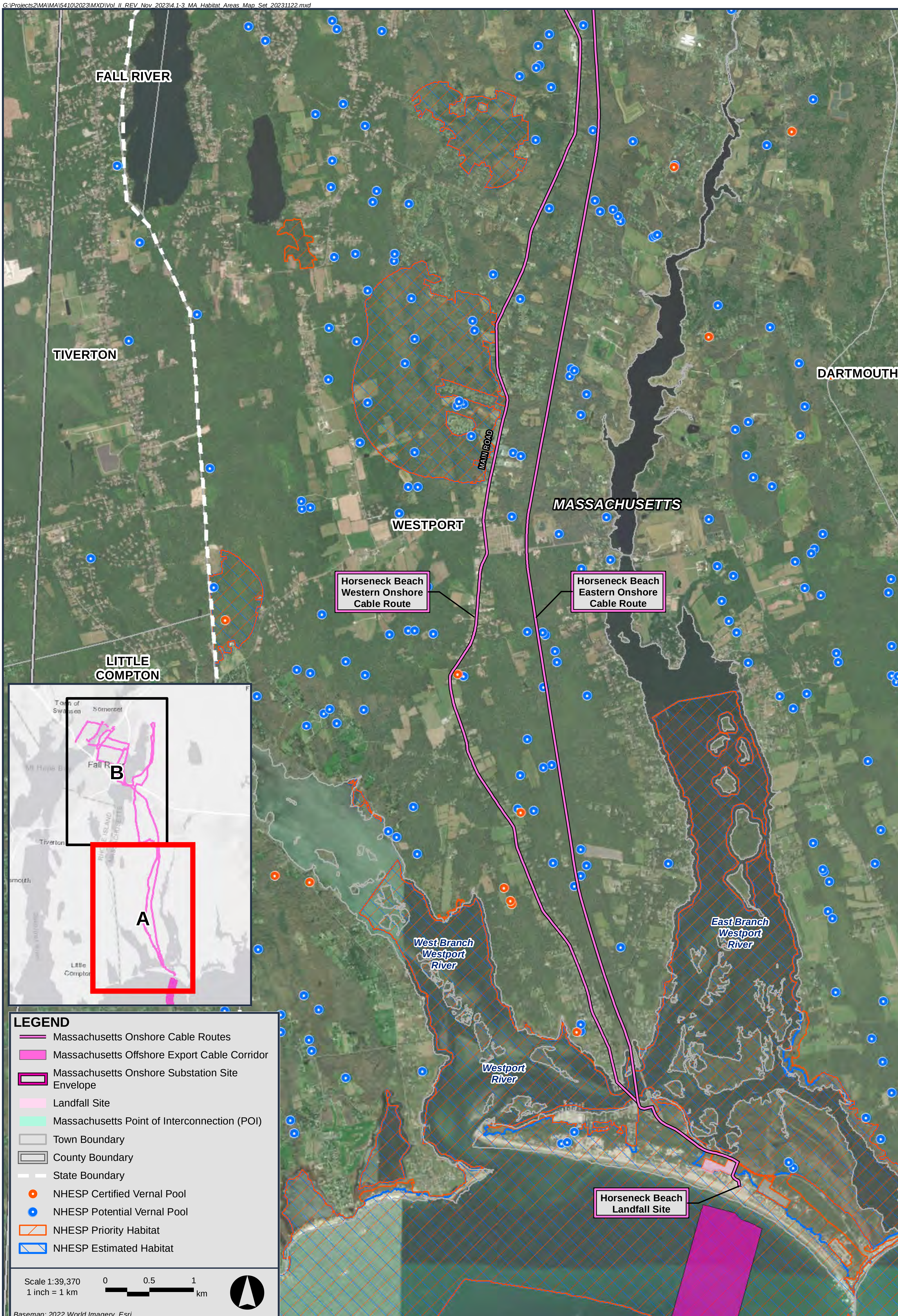

Figure 4.1-3A

Massachusetts Rare Species Habitats Proximal to Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

[redacted]

4.1.1.2 Connecticut Onshore Development Area Terrestrial Habitats

Landfall Sites

Offshore export cables installed within the Connecticut OECC would transition onshore at one of the following landfall sites, as shown on Figure 4.1-4:

- **Ocean Beach Landfall Site:** The Ocean Beach Landfall Site is located in a portion of a paved parking area within Ocean Beach Park in New London, Connecticut. Ocean Beach Park is a public recreation facility owned by the City of New London that includes a beach, among other recreational amenities (Ocean Beach Park 2017). The landfall site is located near the mouth of the Thames River. Nearby land uses include primarily private residences.

- **Eastern Point Beach Landfall Site:** The Eastern Point Beach Landfall Site is located in a portion of a paved parking area on Eastern Point in Groton, Connecticut. The beach, which is located near the mouth of the Thames River, is managed by the City of Groton's Parks and Recreation Department (City of Groton 2022). Nearby land uses include the public beach and associated recreational facilities and open space, as well as private residences to the north and east.

- **Niantic Beach Landfall Site:** The Niantic Beach Landfall Site is located in a paved parking area at Niantic Beach in East Lyme, Connecticut. The landfall site is near the mouth of the Niantic River. The town-managed beach includes a boardwalk and bathhouse (Town of East Lyme Connecticut 2022). The beach is abutted by Route 156 and train tracks.

Point of Interconnection

In Connecticut, power from Vineyard Northeast will be delivered to the electric grid at the following POI:

- **Montville POI:** The 345 kV Montville Substation in Montville, Connecticut is operated by Eversource Energy.

Any required system upgrades at the POI would be constructed by the existing substation's owner/operator. Based on negotiations with the substation's owner/operator, the Proponent may install onshore cables[33] (i.e., perform ground disturbing activities) within the property line of the existing substation.

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[33] At the Montville POI, the Proponent's grid interconnection cables are expected to be installed within an underground duct bank.

[redacted]

Onshore Cable Routes

Between the Connecticut landfall sites and the Montville POI, onshore cables will be installed within one of the following potential onshore cable routes identified on Figure 4.1-4.

- **Ocean Beach Onshore Cable Route:** This route begins at the Ocean Beach Landfall Site and travels generally north approximately 21 km (13 mi) through New London, Waterford, and Montville, Connecticut, to reach the POI. The route mostly follows town and state roads, including Ocean Avenue, Route 213, Clark Lane, Jefferson Avenue, Vauxhall Street, Williams Street, Old Norwich Road, and Route 32. The route passes adjacent to a mix of low to high density residential areas, commercial areas, and forests/parkland, but the predominate habitat is developed land (91%). See Appendix II-C for more detail.

- **Eastern Point Beach Onshore Cable Route:** This approximately 23 km (14 mi) route begins at the Eastern Point Beach Landfall Site and travels generally north through the towns of Groton and Ledyard, Connecticut, before crossing the Thames River into Montville, Connecticut, to reach the POI. The route primarily follows utility ROWs, but also follows town and state roads, such as Route 349 and Benham Road. Habitat adjacent to the route is largely forested (54%), although moderate density residential areas and commercial areas are located along portions of the route (37%). See Appendix II-C for additional details.

- **Niantic Beach Onshore Cable Route:** This approximately 20 km (13 mi) route begins at the Niantic Beach Landfall Site in East Lyme, Connecticut, and travels northeast along Route 156 before joining the Ocean Beach Onshore Cable Route near the intersection of US Highway 1 and Clark Lane. From Clark Lane northward to the POI, the Niantic Beach and Ocean Beach Onshore Cable Routes are identical. Habitat adjacent to the route is predominantly developed (86%) and forested areas (10%), including a mix of low to moderate density residential areas, commercial areas, and forests/parkland (see Appendix II-C).

The onshore cables are expected to be installed entirely underground primarily within public roadway layouts or within existing utility ROWs via open trenching. While the onshore cable routes intersect mapped wetlands and waterbody resources (see Figure 4.1-5), trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) such as at the Thames River crossing.

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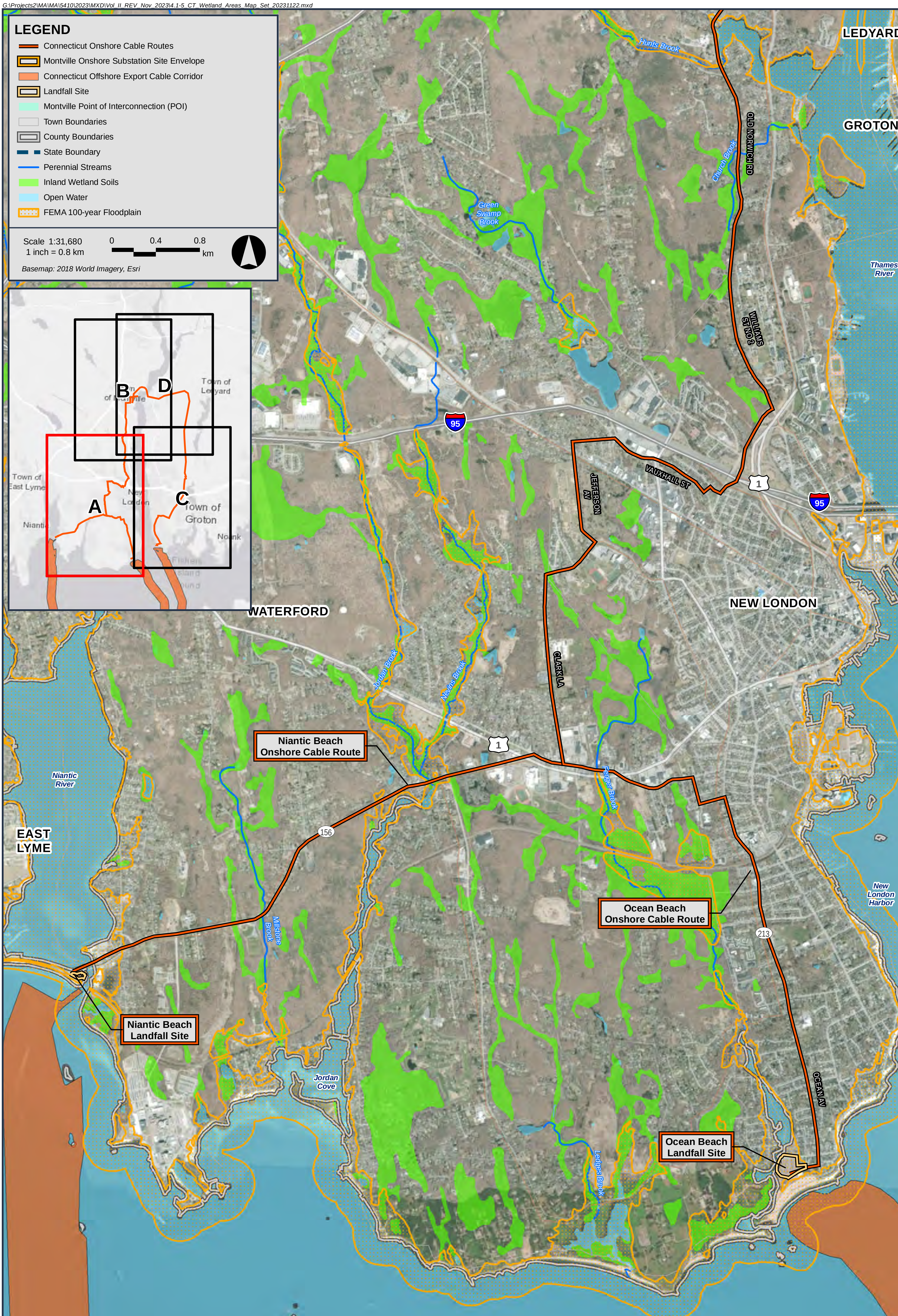

Figure 4.1-5A

Connecticut Wetlands and Waterbodies Proximal to Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

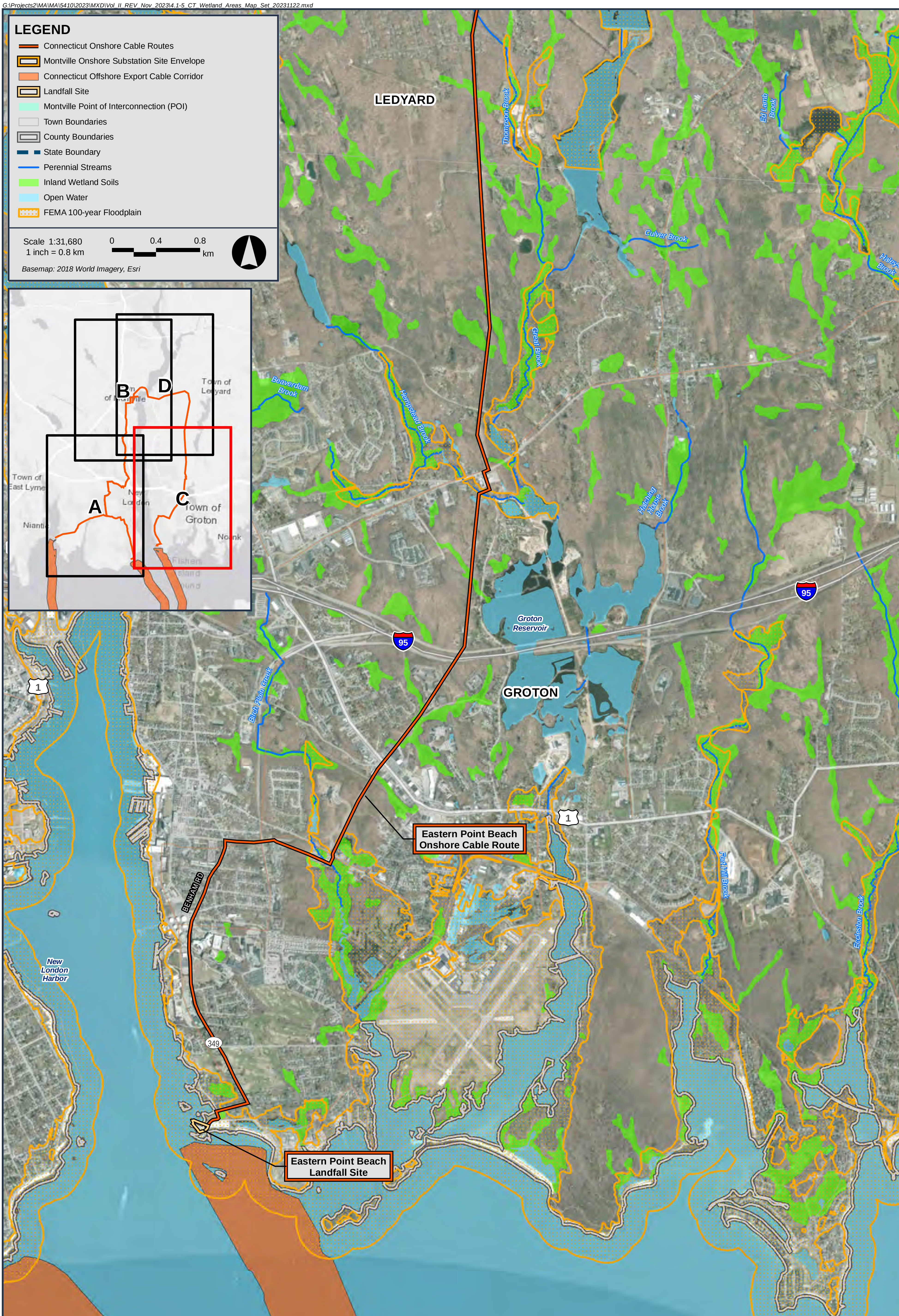

Figure 4.1-5C
Connecticut Wetlands and Waterbodies Proximal to Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Onshore Substation Site

In Connecticut, the onshore substation site will be located [redacted]

Terrestrial Habitat

According to the Northeast Habitat Map, the Onshore Development Area in Connecticut is identified as largely developed and includes both shrubland and North Atlantic coastal plain hardwood forest. North Atlantic coastal plain hardwood forest is typically dominated by oaks and mixed with pine. North-Central Appalachian acidic swamp is described as a conifer or mixed conifer-hardwood swamp, primarily made up of poorly drained acidic soils. Hemlock, red maple, and/or black gum are typical trees found in these areas.

The Connecticut Department of Energy and Environmental Protection (CT DEEP) maps critical habitats and maintains a Natural Diversity Data Base (NDDB). The NDDB maps show approximate locations of endangered, threatened, and special concern species, and important natural communities in Connecticut. The locations shown on the NDDB maps are based on information collected over the years by CT DEEP staff, scientists, and others. In some cases, an occurrence is from a historic record. The maps are intended to be a tool to show potential impacts to state listed species. Both the Ocean Beach Landfall Site and Niantic Beach Landfall Site are located outside, but near, areas mapped as critical habitats. The Eastern Point Beach Landfall Site, [redacted] and limited portions of each of the three potential Connecticut onshore cable routes are located within mapped NDDB locations. However, at the landfall sites, the offshore export cables are expected to transition onshore using horizontal directional drilling (HDD) into existing paved parking lots to avoid or minimize impacts to the beach, intertidal zone, and nearshore areas. Furthermore, all three onshore cable routes are primarily co-located within public roadway layouts or existing utility ROWs (i.e., within previously disturbed areas) to minimize disturbance to terrestrial wildlife and habitat (see Figure 4.1-6).

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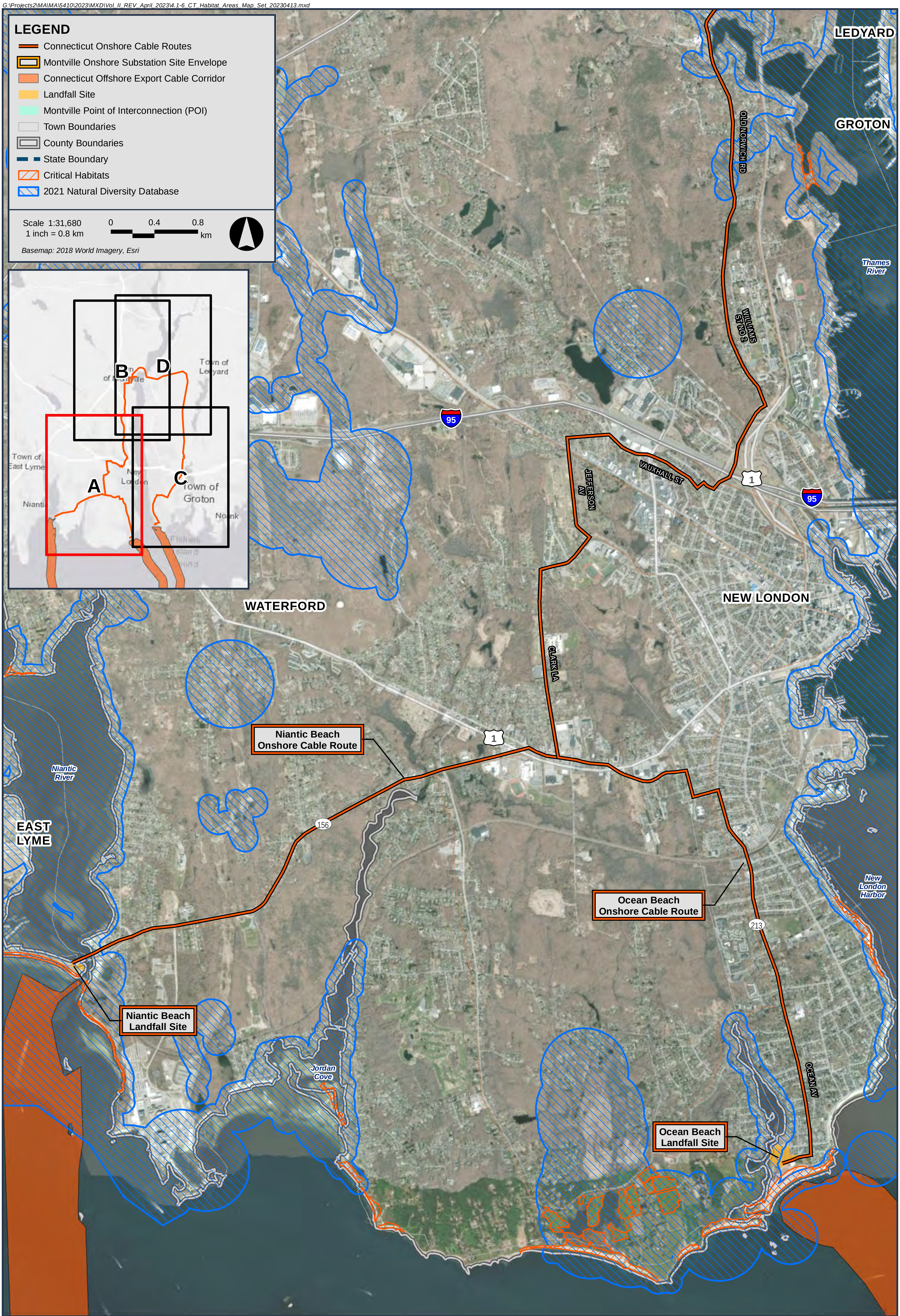

Figure 4.1-6A
Connecticut Rare Species Habitats Proximal to Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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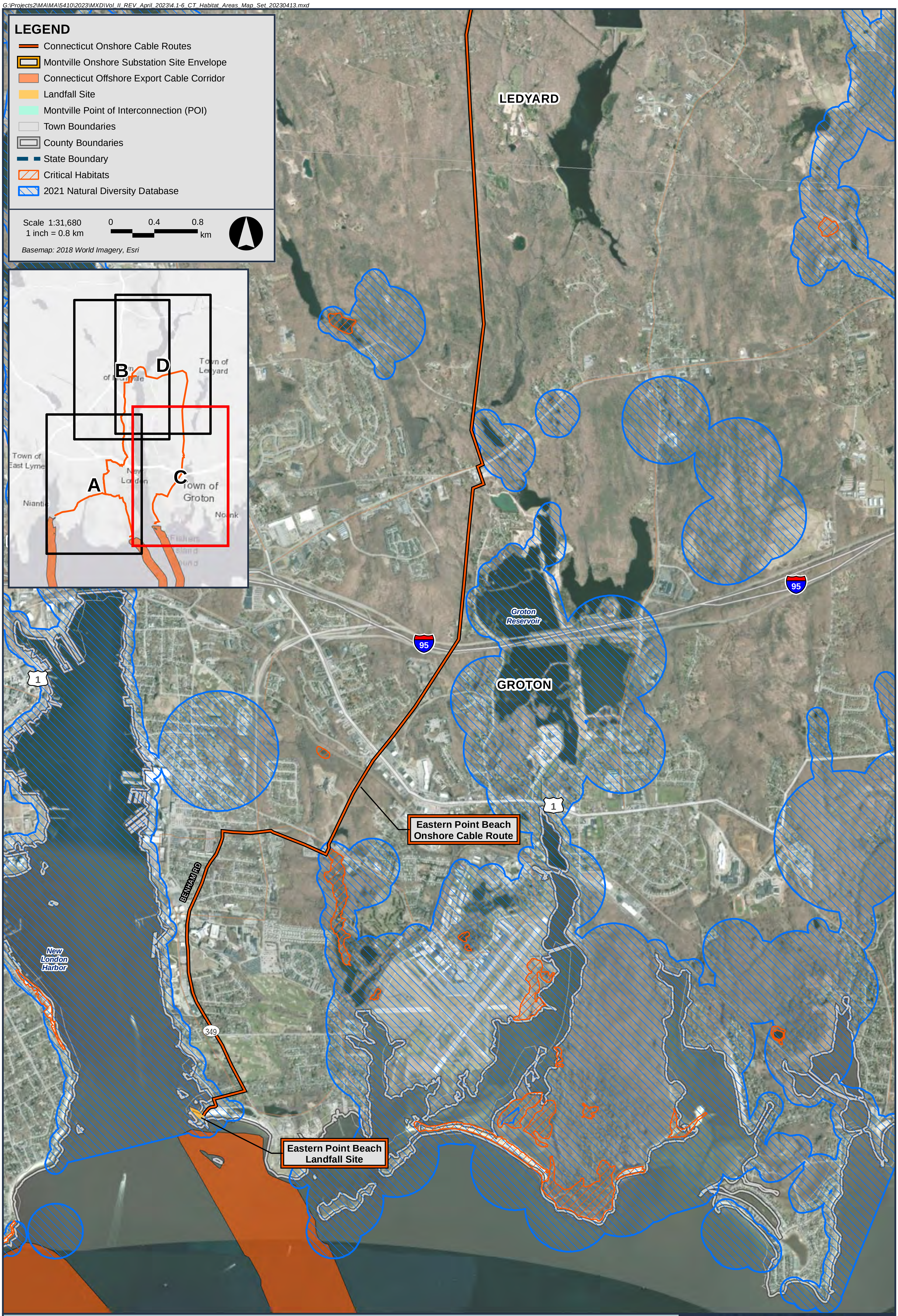

Figure 4.1-6C
Connecticut Rare Species Habitats Proximal to Onshore Facilities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

4.1.1.3 Terrestrial Fauna Including Inland Birds

Species known to commonly occur in both states and within the habitats adjacent to the onshore cable routes as well as the onshore substation site envelopes are listed in Table 4.1-1.

Table 4.1-1 Commonly Occurring Species in the Onshore Development Area

Common Name	Scientific Name
Mammals[1]	
white-tailed deer	*Odocoileus virginianus*
coyote	*Canis latrans*
red fox	*Vulpes vulpes*
Virginia opossum	*Didelphis virginiana*
woodchuck	*Marmota monax*
striped skunk	*Mephitis mephitis*
common raccoon	*Procyon lotor*
white-footed mouse	*Peromyscus maniculatus*
masked shrew	*Sorex cinereus*
Southern flying squirrel (swamp and forest)	*Glaucomys volans*
Reptiles and Amphibians[2]	
northern redback salamander	*Plethodon cinereus*
mole salamander	*Ambystoma*
American toad	*Bufo americanus*
spring peeper	*Hyla crucifer*
wood frog	*Rana sylvatica*
leopard frog	*Rana pipiens*
green frog	*Rana clamitans*
snapping turtle	*Chelydra serpentina*
spotted turtle (swamp and forest)	*Clemmys guttata*
garter snake	*Thamnophis sirtalis*
black racer	*Coluber constricta*

Notes:

1. DeGraaf and Yamasaki 2001
2. MA DMF 2021

Massachusetts Onshore Development Area

There are 244 bird species that may be present at or near the Massachusetts Onshore Development Area (see Appendix II-C). Coastal and marine areas will primarily include seabirds, waterfowl, sea ducks, shorebirds, and songbirds; freshwater areas will include waterbirds, shorebirds, wading birds, and songbirds; and terrestrial areas will include raptors and songbirds. There are three federally listed species that may use coastal areas, the piping plover (*Charadrius melodus*), red knot (*Calidris canutus rufa*), and roseate tern (*Sterna d.*

dougllaii), and 15 Massachusetts listed species or Species of Special Concern[34] that may be present in the Onshore Development Area (see Table 4.1-2). Based on eBird observations between 2012 and 2022, 11 state-listed bird species, 19 birds of conservation concern, and two federally listed species (roseate tern and piping plover) were observed at the Horseneck Beach Landfall Site. Both least tern (special concern) and piping plover (federally threatened) nest on the beach (MA DMF 2021). The federally threatened red knot was not observed in the immediate area of the Horseneck Beach Landfall Site, but was observed in the general Onshore Development Area.

The three federally listed species are all present in coastal Massachusetts for part of the year; red knots pass through during both spring (April–May) and fall (August–October) migrations, while piping plovers and roseate terns are also present during spring and fall migrations, with some individuals remaining in the state throughout the breeding season (May–August). The rufa red knot subspecies breeds in the Arctic and winters at sites as far south as Tierra del Fuego, Argentina. During both migrations, red knots use key staging and stopover areas to rest and feed, where they utilize habitats including sandy coastal beaches, at or near tidal inlets, or the mouths of bays and estuaries, salt marshes, tidal mudflats, and sandy/gravel beaches, where they feed on clams, crustaceans, and invertebrates. The highest numbers of red knots are detected in Massachusetts during fall migration, but since 2017 there have been no eBird records at Horseneck Beach. There is no identified or proposed critical habitat for red knots at the Horseneck Beach Landfall Site (see Appendix II-C).

Piping plovers nest on coastal beaches and feed on exposed wet sand and in adjacent habitat by probing for invertebrates at or just below the surface. They use beaches adjacent to foraging areas for roosting and preening. Most piping plovers arrive in Massachusetts in March and leave by October. The Horseneck Beach Landfall Site overlaps with Priority Habitat areas mapped by NHESP. Horseneck Beach State Reservation historically has supported breeding piping plovers, which have been carefully managed by the Massachusetts Department of Conservation and Recreation. In 2020, the beach had 11 nesting pairs and 14 fledglings (MA DMF 2021).

The closest roseate tern breeding colony, Penikese Island, is 11 km (~7 mi) to the southeast of Horseneck Beach (Buzzards Bay National Estuary Program 2022). Birds from this small colony may forage in the shallow waters off of Horseneck Beach and potentially use the beach to rest. Roseate terns return to colonies in the Buzzards Bay area in late-April to mid-May and initiate breeding in May–June. During breeding, they use shallow coastal waters to forage, primarily for American sand lance (*Ammodytes americanus*), generally at upwellings or tidal fronts within 25 km (~15 mi) of the colony (Gochfeld and Burger 2020). eBird records indicate that over the last five years only a small number of roseate terns were observed off the beach (see Appendix

[34] See: https://www.mass.gov/info-details/list-of-endangered-threatened-and-special-concern-species

II-C). Roseate terns tend to initiate their fall movements in August and September, initially staging in the Cape Cod area before heading farther south, generally leaving the area by late-September (Gochfeld and Burger 2020). Prior to any construction activities, Vineyard Northeast will consult with MassWildlife to determine if there are any listed species known to be present in or adjacent to the Massachusetts Onshore Development Area, and to determine if any survey efforts are needed.

Table 4.1-2 includes federal and state listed birds observed by eBird users in the general Massachusetts Onshore Development Area, their conservation statuses, and whether the United States Fish and Wildlife Service's (USFWS's) Information for Planning and Consultation (IPaC) database indicates their presence in the Massachusetts Onshore Development Area.[35] See Appendix II-C for a full species list.

Table 4.1-2 eBird Observations of federal and state listed birds in the Massachusetts Onshore Development Area

Common Name	Latin Name	Federal Status	State Status	IPaC
Grebes				
Pied-billed Grebe	*Podilymbus podiceps*	None	Endangered	
Nightjars				
Eastern Whip-poor-will	*Antrostomus vociferus*	None	Special Concern	•
Shorebirds				
Piping Plover	*Charadrius melodus*	Threatened	Threatened	•
Red Knot	*Calidris canutus rufa*	Threatened	Threatened	•
Terns				
Roseate Tern	*Sterna dougllaii dougllaii*	Endangered	Endangered	•
Least Tern	*Sternula antillarum*	None	Special Concern	
Common Tern	*Sterna hirundo*	None	Special Concern	
Loons				
Common Loon	*Gavia immer*	None	Special Concern	•
Herons, Egrets, and Bitterns				
American Bittern	*Botaurus lentiginosus*	None	Endangered	
Raptors				
Northern Harrier	*Circus hudsonius*	None	Threatened	
Bald Eagle	*Haliaeetus leucocephalus*	Bald and Golden Eagle Protection Act	Special Concern	•
Peregrine Falcon	*Falco peregrinus*	None	Special Concern	
Songbirds				
Saltmarsh Sparrow	*Ammospiza caudacuta*	None	Special Concern	
Eastern Meadowlark	*Sturnella magna*	None	Special Concern	•
Northern Parula	*Setophaga americana*	None	Threatened	

35 See: https://ipac.ecosphere.fws.gov/

Connecticut Onshore Development Area

There are 222 bird species that may be present at or near the Connecticut Onshore Development Area (see Appendix II-C). Coastal and marine areas will primarily include seabirds, waterfowl, sea ducks, shorebirds, and songbirds; freshwater areas will include waterbirds, shorebirds, wading birds, and songbirds; and terrestrial areas will include raptors and songbirds. There are three federally listed species that may use coastal areas—the piping plover, red knot, and roseate tern—and 17 Connecticut listed species may be present in the Onshore Development Area (see Table 4.1-3).

The three federally listed species are all present in coastal Connecticut for part of the year—red knots pass through during both spring (April–May) and fall (August–October) migrations, while piping plovers and roseate terns are also present during spring and fall migrations, with some individuals remaining in the state throughout the breeding season (May–August). The highest numbers of red knots are detected in coastal Connecticut during May, August, and September, but there is no identified or proposed critical habitat for red knots at the potential Connecticut landfall sites, and over the last five years, there have been no red knot eBird records at any of the landfall sites (see Appendix II-C). Piping plovers arrive in Connecticut in March and leave by September; in 2020, there were 58 pairs that had 58 fledglings (CT CEQ 2020). The potential Connecticut landfall sites overlap with Critical Habitat areas mapped by the CT DEEP. While the beach habitat around the landfall sites could potentially be used by piping plovers, eBird records indicate limited use of the area (see Appendix II-C). Great Gull Island, an important roseate tern colony, is 12–14 km (7.5–8.7 mi) from the landfall sites. As described above, roseate terns forage in coastal areas and tracking data suggests that they can use the area (Loring et al. 2019), but the landfall sites are unlikely to be important foraging areas due to their generally developed nature. Prior to any construction activities, Vineyard Northeast will consult with CT DEEP to determine if there are any listed species known to be present in or adjacent to Connecticut Onshore Development Area, and to determine if any survey efforts are needed.

Table 4.1-3 includes federal and state listed birds observed by eBird users in the general Connecticut Onshore Development Area, their conservation status, and whether the USFWS's IPaC database indicates their presence in the Connecticut Onshore Development Area.[36] See Appendix II-C for a full species list.

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[36] See: https://ipac.ecosphere.fws.gov/

Table 4.1-3 eBird Observations of federal and state listed birds in the Connecticut Onshore Development Area

Common Name	Latin Name	Federal	State	IPaC
Nightjars				
Common Nighthawk	*Chordeiles minor*	None	Endangered	
Shorebirds				
Piping Plover	*Charadrius melodus*	Threatened	Threatened	
Red Knot	*Calidris canutus rufa*	Threatened	Special Concern	
Terns				
Least Tern	*Sternula antillarum*	None	Threatened	
Roseate Tern	*Sterna dougallii dougallii*	Endangered	Endangered	•
Common Tern	*Sterna hirundo*	None	Special Concern	
Loons				
Common Loon	*Gavia immer*	None	Special Concern	•
Herons, Egrets, and Bitterns				
Snowy Egret	*Egretta thula*	None	Threatened	
Little Blue Heron	*Egretta caerulea*	None	Special Concern	
Raptors				
Northern Harrier	*Circus hudsonius*	None	Endangered	
American Kestrel	*Falco sparverius*	None	Special Concern	
Peregrine Falcon	*Falco peregrinus*	None	Threatened	
Passerines				
Horned Lark	*Eremophila alpestris*	None	Endangered	
Saltmarsh Sparrow	*Ammospiza caudacuta*	None	Special Concern	
Savannah Sparrow (Ipswich Sparrow)	*Passerculus sandwichensis*	None	Special Concern	
Swamp Sparrow (Coastal Plain Swamp Sparrow)	*Melospiza georgiana*	None	Special Concern	
Bobolink	*Dolichonyx oryzivorus*	None	Special Concern	•
Horned Lark	*Eremophila alpestris*	None	Endangered	
Saltmarsh Sparrow	*Ammospiza caudacuta*	None	Special Concern	
Savannah Sparrow (Ipswich Sparrow)	*Passerculus sandwichensis*	None	Special Concern	
Swamp Sparrow (Coastal Plain Swamp Sparrow)	*Melospiza georgiana*	None	Special Concern	
Bobolink	*Dolichonyx oryzivorus*	None	Special Concern	•

4.1.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect terrestrial habitat and wildlife (including inland birds) during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.1-4.

Table 4.1-4 Impact Producing Factors for Terrestrial Habitat and Wildlife

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Onshore Construction and Maintenance Activities	•	•	•
Ground Disturbance and Habitat Modification	•	•	•
Noise	•	•	•
Artificial Light	•	•	•

Potential effects to terrestrial habitat and wildlife were assessed using the maximum design scenario for Vineyard Northeast's onshore facilities as described in Section 1.5.

4.1.2.1 Onshore Construction and Maintenance Activities

Onshore construction and maintenance activities may cause temporary impacts to terrestrial habitats and wildlife. Temporary air emissions may occur from support vehicles and equipment during construction, maintenance, and decommissioning activities. Such emissions are expected to be similar to other onshore construction projects. Potential air emissions from Vineyard Northeast activities are further described in Section 3.1.

The effects of ground disturbance, noise, and artificial light are discussed further in Sections 4.1.2.2, 4.1.2.3, and 4.1.2.4, respectively.

4.1.2.2 Ground Disturbance and Habitat Modification

Vineyard Northeast will include onshore transmission systems in Massachusetts and Connecticut. Each onshore transmission system will ultimately include one landfall site, one onshore export cable route, one onshore substation site, and one grid interconnection cable route. Localized ground disturbance will occur from construction, O&M, and possibly from decommissioning of the landfall sites, onshore cable routes, and new onshore substations. The Proponent has located onshore cable routes primarily within public roadway layouts or existing utility ROWs (i.e., within previously disturbed areas) to minimize disturbance to terrestrial wildlife and habitat. The Proponent also intends to select onshore substation sites that are in industrial/commercial areas that have been previously disturbed, although land clearing and grading may be needed depending on the sites ultimately selected. Ground disturbance associated with Vineyard Northeast will be temporary and disturbed areas (outside the onshore substations' security fencing) will be restored. Construction will be conducted in accordance with soil erosion and sedimentation control plans.

Landfall Sites and Onshore Cable Routes

As further detailed in Section 3.7.3 of COP Volume I, at each landfall site the offshore export cables are expected to transition onshore using HDD. HDD at the landfall sites will require a staging area, which would be located in a parking lot or previously disturbed area. Further details regarding dimensions and anticipated temporary disturbances associated with the approach pit, exit pit, and staging areas are provided in Section 3.7.3 of COP Volume I. Although not anticipated, if detailed engineering for the Connecticut landfall sites determines that HDD is technically infeasible, offshore open trenching may be used to bring the offshore export cables onshore. While not anticipated, if open trenching is utilized, a temporary, three-sided cofferdam will be installed, and a trench for the cable conduits will be excavated within the cofferdam.

In Massachusetts, the use of HDD at the Horseneck Beach Landfall Site will avoid direct impacts to piping plover and least tern nesting beach habitat. Disturbance of upland bird habitat will also be avoided because the cables will emerge within an existing parking lot (see Appendix II-C; see Figure 4.1-1). Given the presence of nesting plovers and terns at Horseneck Beach, Vineyard Northeast will consult with MassWildlife to determine if any additional conservation measures are needed. In Connecticut, the landfall sites are generally in previously disturbed areas with sections of riprap and concrete structures adjacent to the beach areas, which likely limit beach nesting bird habitat. Prior to construction activities, Vineyard Northeast will consult with CT DEEP to determine if there are any beach nesting birds in the vicinity of the landfall sites. Onshore construction at the landfall sites in both Massachusetts and Connecticut is planned to occur outside of the period from Memorial Day to Labor Day, further avoiding potential impacts.

The Proponent will work with municipalities to develop the construction schedule and hours in accordance with local ordinances. Certain activities cannot stop once they are initiated, such as conduit pull-in for the HDD work, which may extend work in some circumstances. Disturbed ground and/or infrastructure will be restored following completion.

High voltage direct current (HVDC) or high voltage alternating current (HVAC) onshore export cables will transmit power from the landfall sites to the onshore substation sites. HVAC grid interconnection cables will transmit power from the onshore substation sites to the POIs. The onshore cables are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs.[37] The underground onshore cables may be installed

[37] In limited areas, the onshore cable routes may depart from public roadway layouts or utility ROWs, particularly at complex crossings.

within a duct bank or installed within directly buried conduit(s). The duct bank would consist of plastic conduits (e.g., high-density polyethylene [HDPE] or polyvinyl chloride [PVC]) encased in concrete (i.e., cast in-place concrete). For HVDC cables, the power cables may be installed in separate conduits or within the same conduit (particularly at underground trenchless crossings). Additional conduits may be accommodated within the duct bank for fiber optic cables and grounding. For HVAC cables, each onshore cable and fiber optic cable is expected to be installed within its own conduit. Spare conduits and grounding may also be accommodated within the duct bank.

Both HVDC and HVAC onshore cables typically require splices approximately every 150-610 meters (m) (500–2,000 feet [ft]) or more. At each splice location, one or more splice vaults will be installed. The splice vaults are typically two-piece (top and bottom) pre-formed concrete chambers with openings at both ends to admit the onshore cables. The duct bank and splice vaults are expected to be installed in open trenches using conventional construction equipment (e.g., hydraulic excavator, loader, dump trucks, flatbed trucks, crew vehicles, cement delivery trucks, and paving equipment). The trench dimensions will vary along the onshore cable route (depending on the duct bank layout) but are expected to measure up to approximately 3.4 m (11 ft) in depth, 6.7 m (22 ft) in width at the bottom, and 8.5 m (28 ft) in width at the top. In locations where splice vaults are necessary, the excavated area will be larger (up to approximately 13 m [43 ft] wide, 15 m [50 ft] long, and 6 m [20 ft] deep). Since the splice vaults may be installed anywhere along the onshore cable routes, the maximum extent of disturbance along the entire route is based on the dimensions of the area excavated for splice vaults.

Open trenching is expected to primarily occur within paved areas or within 3 m (10 ft) of pavement. Any pavement will be removed before excavating and shoring the trenches. Minimal tree trimming and/or tree clearing may be needed where the routes follow existing roadway layouts, depending on the final duct bank alignment.[38] Tree trimming, tree clearing, and/or grading may be required to facilitate onshore cable installation where the onshore cable routes follow existing utility ROWs, in limited areas where the routes depart from the public roadway layout (particularly near complex crossings), at trenchless crossing staging areas (see Section 3.8.3.3 of COP Volume I), and at the POIs. The work, however, will be confined to as narrow a corridor as possible. Excavated material will be hauled away in trucks daily and recycled or disposed of in accordance with state regulations. All work will be performed in accordance with local, state, and federal safety standards, as well as any company-specific requirements.

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[38] Subject to further engineering and consultations with local and state agencies (e.g., Massachusetts Department of Transportation [MassDOT]).

In most instances, underground trenchless crossing methods are expected to be used where the onshore cable routes traverse unique features such as busy roadways, railroads, wetlands, and waterbodies to avoid impacts to those features. However, the northern crossing of the Taunton River [redacted] (see Figure 4.1-1) may require a segment of overhead transmission lines.[39] At this time, it is envisioned that up to two lattice-type towers would be located [redacted] and up to two lattice-type towers would be located [redacted] and/or Pottersville POI to support the overhead transmission lines. Power lines can cause bird mortality (Loss et al. 2014) through collision or electrocution (Bevanger 1994). To minimize risks, the transmission lines will be built, to the extent practicable, following the Avian Power Line Interaction Committee (APLIC) standard design guidance (https://www.aplic.org/). Additional details regarding onshore cable installation and specialty cable crossing techniques are described in Section 3.8.3 of COP Volume I.

The Proponent's contractor will identify construction staging areas (i.e., equipment laydown and storage areas) proximate to the onshore cable routes. With exception of staging areas for trenchless crossings (see Section 3.8.3.3 of COP Volume I), the Proponent anticipates that construction staging areas will either be in paved areas or at locations already utilized for similar activities and are therefore not expected to cause new ground disturbance.

Vineyard Northeast infrastructure is proposed to be installed primarily underground and any temporarily disturbed areas will be restored. Since there will be little to no habitat disturbance in the Onshore Development Area and there are substantial developed areas directly adjacent to most construction areas, few, if any, impacts to wildlife and wildlife habitat (including inland birds and bird habitats) are expected. Specific to Massachusetts, although onshore cable routes travel through Priority and Estimated Habitats mapped by NHESP, onshore cable routes are primarily co-located within public roadway layouts or existing utility ROWs (i.e., within previously disturbed areas) to minimize disturbance to terrestrial wildlife and habitat; thus, no or minimal impacts are anticipated. Prior to construction activities, the Proponent will consult with the state wildlife agencies to determine if any listed species are known to be present.

During O&M, periodic maintenance may be required. If onshore cable repairs are required, the cables would typically be accessed through manholes installed at the splice vaults and transition vaults, thereby avoiding and minimizing land disturbance.

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[39] As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

Onshore Substation Sites

Vineyard Northeast will include two onshore substations (one in Massachusetts and one in Connecticut). Since the Proponent has not yet secured site control for the onshore substation sites, the Proponent has identified several "onshore substation site envelopes." The onshore substation sites will be located within the onshore substation site envelopes described in further detail in Sections 3.9.1 and 3.9.2 of COP Volume I.

Construction of each onshore substation will include site preparation, installation of the substation equipment and cables, commissioning, and site clean-up and restoration. Temporary fencing and a security gate will be installed around the perimeter of the construction area and temporary erosion control measures will be deployed. Up to approximately 0.06 km^2 (15 acres) of tree clearing and ground disturbance from grading, excavation, and trenching is anticipated for each onshore substation site. Through the permitting process, the Proponent will consult with agencies to develop appropriate time of year restrictions for tree clearing, if needed. This limited loss of forested habitat during onshore substation construction is unlikely to have population level impacts on wildlife, including inland birds. Prior to construction activities, Vineyard Northeast will consult with the state wildlife agencies to determine if any listed species are known to be present, and if surveys are needed.

Once onshore substation construction is completed, a permanent fence will be installed and the disturbed area immediately adjacent and outside of the fence will be restored and revegetated (if required). Visual screening and sound attenuation walls may be installed, if needed. Native species will be utilized for restoration and vegetative buffers, which will provide some wildlife and inland bird habitat. The Proponent will coordinate with local municipalities regarding local ordinances.

Periodic maintenance will likely occur within the fenced perimeter of the onshore substation site. During decommissioning, potential impacts are expected to be similar to construction and appropriate environmental protection measures, such as installing erosion and sedimentation controls, will be employed.

4.1.2.3 Noise

Noise from equipment during construction, O&M, or decommissioning may disturb or temporarily displace nearby wildlife, including inland birds. It is anticipated that any wildlife affected will return once construction activities are complete, as is typically observed. Construction will largely take place in areas that are already impacted by traffic noise and occasional construction. Therefore, impacts are expected to be short-term and localized and are not anticipated to have impacts on wildlife populations.

4.1.2.4 Artificial Light

During construction, temporary lighting may be required at work areas, which could cause limited disturbance of wildlife, including inland birds. Lighting during O&M is expected to be minimal and will primarily occur at the onshore substations, which will have outdoor lights installed. The majority of lights will only be used on an as-needed basis (e.g., if equipment inspection is needed at night) and when necessary for work crew safety. For security reasons, a few lights at the onshore substations will typically be illuminated on dusk–to-dawn sensors and a few lights will likely be controlled by motion-sensors. Outdoor lighting at the onshore substation sites will typically be equipped with light shields to prevent light from encroaching into adjacent areas, which would minimize the effects of artificial light on wildlife, including inland birds.

In summary, the majority of artificial lighting will be used in localized areas for specific scenarios and will be lit for short time periods, which will limit disturbance to terrestrial wildlife. Whenever practicable, the Proponent will down-shield lighting or use down-lighting to minimize the effects of artificial light on terrestrial fauna. The Proponent will work with municipalities to ensure any lights installed comply with local ordinances.

4.1.2.5 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to terrestrial habitat and wildlife (including inland birds) during Vineyard Northeast are summarized below:

- The onshore cable routes will be installed primarily in public roadway layouts and utility ROWs to avoid undisturbed habitat. The Proponent also intends to select onshore substation sites that are in industrial/commercial areas that have been previously disturbed, although land clearing and grading may be needed depending on the sites ultimately selected.

- HDD is expected to be used at all landfall sites to avoid or minimize disturbance; however, open trenching may be used at the Connecticut landfall sites if HDD is technically infeasible.

- In most instances, underground trenchless crossing methods (e.g., HDD) are expected to be used where the onshore cable routes traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) to avoid impacts to those features.

- The onshore cables are expected to be installed primarily underground. Where overhead transmission may be required, to minimize risks, the transmission lines will be built, to the extent practicable, following the APLIC standard design guidance.

- Ground disturbances will be temporary and disturbed areas will be restored.

- Whenever practicable, the Proponent will down-shield lighting or use down-lighting to minimize the effects of artificial light on terrestrial fauna.

- Visual screening and sound attenuation walls may be installed, if needed. Native species will be utilized for restoration and vegetative buffers, which will provide some wildlife and inland bird habitat.

- Best management practices for erosion and sedimentation control measures will be utilized during construction.

- The Proponent will consult with state and local agencies regarding the timing of onshore construction activities. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.

4.2 Coastal and Marine Birds

This section addresses the potential impacts of Vineyard Northeast on coastal and marine birds in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to coastal and marine birds during the construction, operation, and decommissioning of Vineyard Northeast. A detailed analysis is provided in Appendix II-C.

The potential impacts of Vineyard Northeast on inland birds in the Onshore Development Area, including at the terrestrial portion of the landfall sites, are discussed in Section 4.1.

4.2.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities.

The affected environment was assessed by considering the exposure (likelihood of occurrence) of birds to the Lease Area. Exposure was assessed for each species and each taxonomic group, where "exposure" is defined as the extent of overlap between a species' seasonal or annual distribution and the Lease Area. The results presented in the affected environment provide a summary of species that may occur in the Lease Area, with their specific exposure scores discussed in the impacts section. Detailed methods and results are provided in Appendix II-C.

The primary information sources used in the assessment came from the following:

- Thirty-two Vineyard Northeast-specific digital aerial surveys, conducted from June 2019 to July 2021, provide data on tern use of the Lease Area, marine bird seasonal density estimates, and, combined with the Massachusetts Clean Energy Center (MassCEC) aerial survey data, integrated taxonomic group distribution models.

- MassCEC aerial surveys that cover the Massachusetts Wind Energy Area (MA WEA) (Veit et al. 2016) and provide the local context.

- Marine-life Data and Analysis Team (MDAT) version 2 marine bird relative density and distribution models (hereafter MDAT models; Curtice et al. 2019) which provide the regional context. Models based on Northwest Atlantic Seabird Catalog observations from 1978-2016

- Other data information sources, including individual tracking studies and records in the Northwest Atlantic Seabird Catalog. The Catalog consists of observations from 1938-2019.

4.2.1.1 Lease Area OCS-A 0522

Lease Area OCS-A 0522 is in the MA WEA, which was identified by the Bureau of Ocean Energy Management (BOEM) through a multi-step process over a period of approximately six years (BOEM [date unknown]). Between November 2009 and May 2012, BOEM developed the MA WEA through extensive collaboration and consultation with the Massachusetts Renewable Energy Task Force, federal agencies, federally recognized Native American tribes, the general public, and other stakeholders (including fishermen). The original area considered was ~7,628 square kilometer (km^2)(~1,884,920 acres) (see 75 FR 82055), but, based on public comments, it was ultimately reduced in size by approximately 60%. Specifically, BOEM excluded an area of high fisheries value to reduce potential conflict with commercial and recreational fishing activities, as well as an area of high sea duck concentration on Nantucket Shoals (77 FR 5820; BOEM 2012).

The Lease Area is located immediately to the south and west of Nantucket Shoals, which forms the boundary between the Gulf of Maine and the New England continental shelf, and is at the confluence of cold water of the Labrador Current and warm water of the Gulf Stream (Bowman et al. 2022). These shallow waters have high primary and secondary productivity, tidal fronts, rotary currents, and upwelling (White & Veit 2020). The Shoals support a high abundance of benthic mollusks and amphipods, providing important foraging areas for sea ducks (Bowman et al. 2022) and other marine birds (Veit et al. 2016). The Lease Area is largely outside the core concentration areas of marine birds, including sea ducks, as is seen in the MDAT models (see Figure 4.2-1) and in the MassCEC/digital aerial survey integrated models (see Figure 4.2-2).

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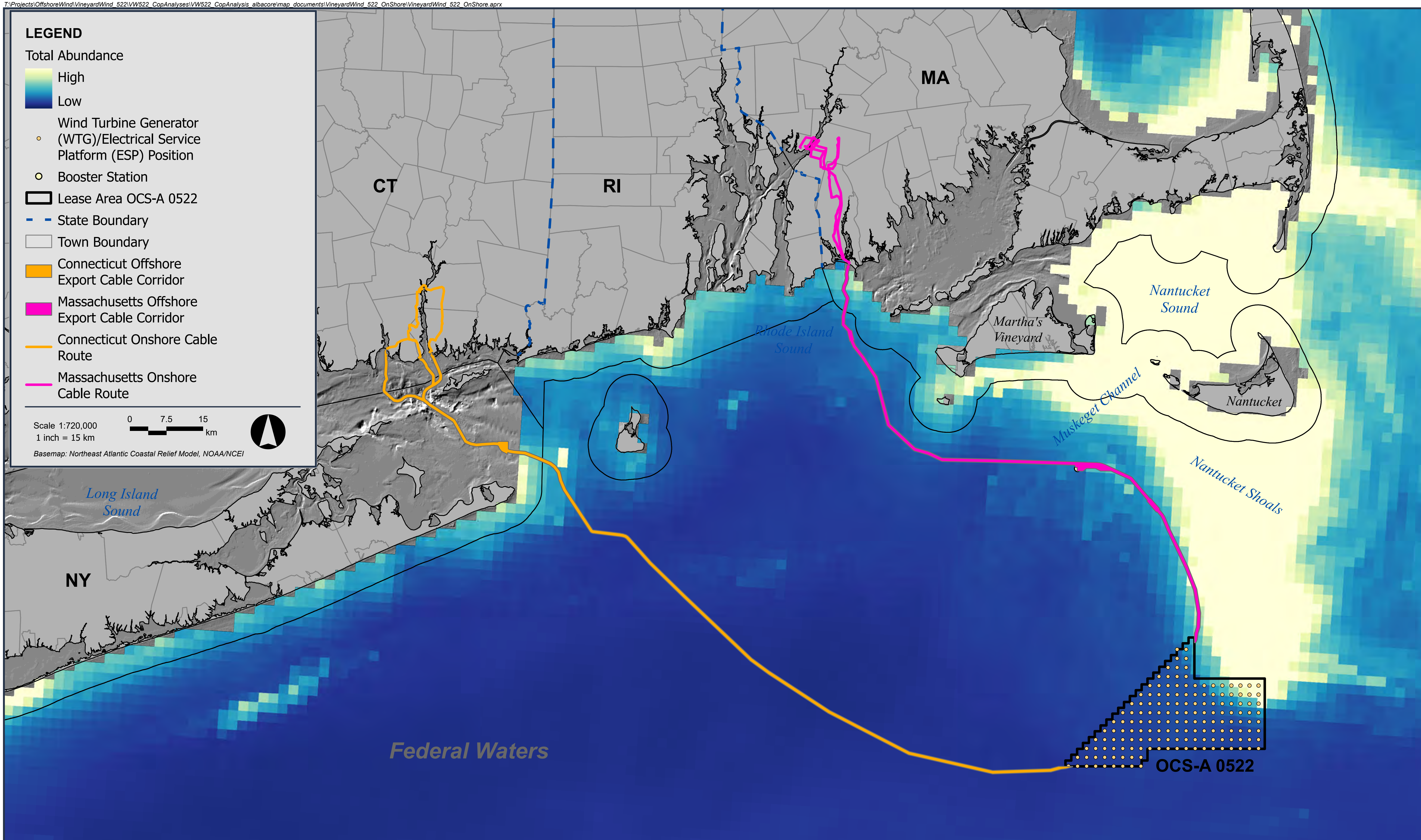

Figure 4.2-1

Bird Abundance Estimates from the MDAT Models

VINEYARD NORTHEAST

VINEYARD OFFSHORE

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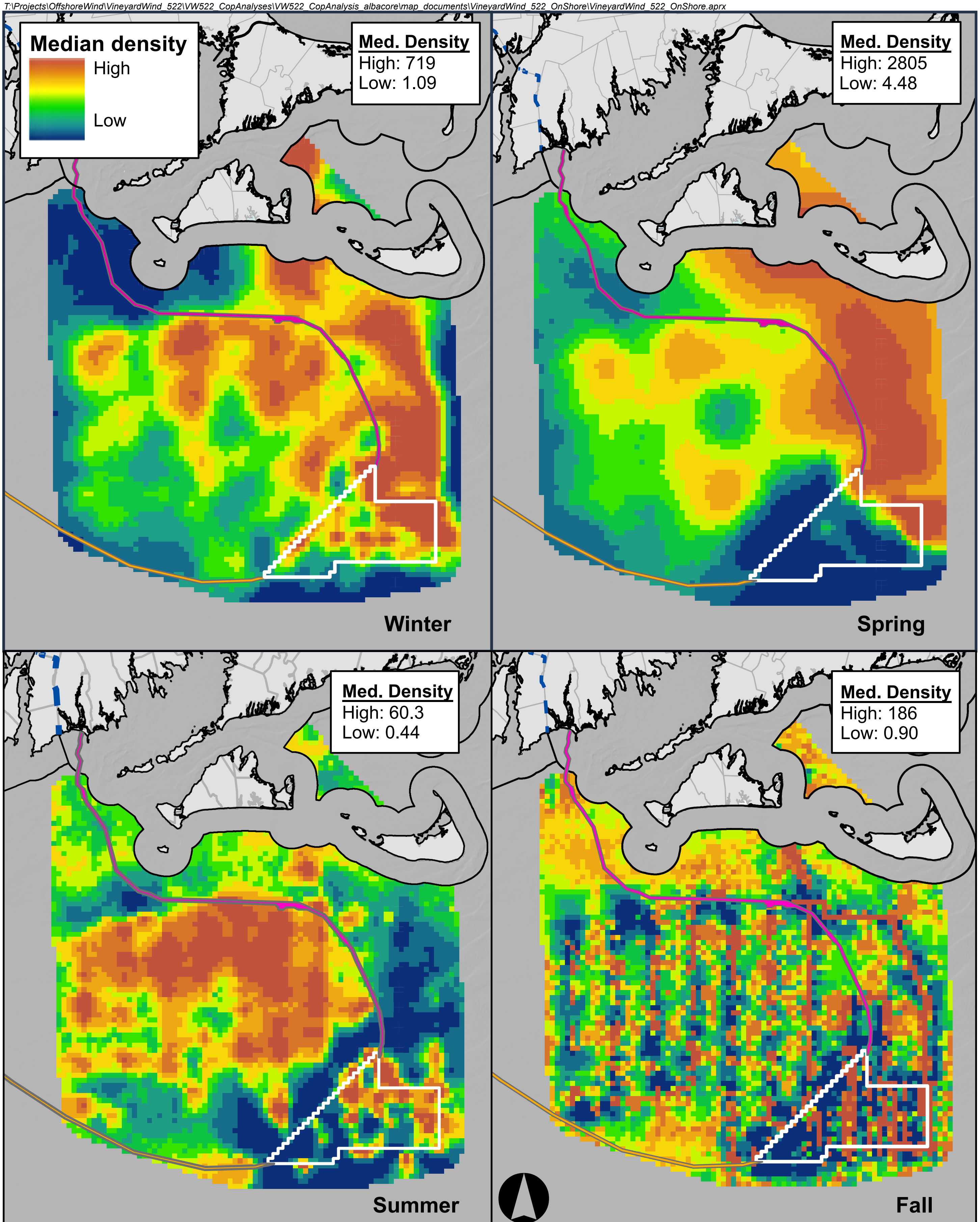

Figure 4.2-2
Joint Density Estimates for All Species in Lease Area OCS-A 0522

0 10 20 40 Miles
0 10 20 40 60 Km
CS: NAD 1983 UTM Zone 19N

VINEYARD NORTHEAST
VINEYARD OFFSHORE

A total of 44 bird species were detected in the Lease Area during the MassCEC surveys and the site-specific digital aerial surveys (see Table 4.2-1). These include waterfowl, sea ducks, shorebirds, skuas, jaegers, auks, gulls, terns, loons, storm-petrels, shearwaters, petrels, northern gannet (*Morus bassanus*), wading birds, and osprey (*Pandion haliaetus*). In addition, migratory birds may pass through the Lease Area, including coastal waterbirds, falcons, and songbirds. There are three species listed under the Endangered Species Act and one candidate species that may also pass through the vicinity of the Lease Area: piping plover (*Charadrius m. melodus*), red knot (*Calidris canutus rufa*), roseate tern (*Sterna dougallii*), and the candidate species black-capped petrel (*Pterodroma hasitata*). A detailed exposure assessment is provided in Appendix II-C and is summarized in the impact section below.

Table 4.2-1 Avian Species Recorded in Each Season

Species[1]	Scientific Name	Winter	Spring	Summer	Fall	IPaC
Ducks, Geese, and Swans						
Brant	*Branta bernicla*				•	
Canada Goose	*Branta canadensis*	•				
Sea Ducks						
Black Scoter	*Melanitta nigra*	•	•		•	•
Common Eider	*Somateria mollissima*	•	•		•	•
King Eider	*Somateria spectabilis*	•				
Long-tailed Duck	*Clangula hyemalis*	•	•		•	•
Red-breasted Merganser	*Mergus serrator*	•	•			
Surf Scoter	*Melanitta perspicillata*	•	•		•	•
White-winged Scoter	*Melanitta fusca*	•	•		•	•
Shorebirds						
Greater Yellowlegs	*Tringa melanoleuca*				•	
Phalaropes						
Red Phalarope	*Phalaropus fulicaria*	•	•		•	
Skuas and Jaegers						
Great Skua	*Stercorarius skua*				•	
Long-tailed Jaeger	*Stercorarius longicaudus*				•	
Parasitic Jaeger	*Stercorarius parasiticus*				•	
Pomarine Jaeger	*Stercorarius pomarinus*				•	•
South Polar Skua	*Stercorarius maccormicki*				•	
Auks						
Atlantic Puffin	*Fratercula arctica*	•	•	•	•	•
Common Murre	*Uria aalge*	•	•			•
Dovekie	*Alle alle*	•	•			•
Razorbill	*Alca torda*	•	•		•	•

Table 4.2-1 Avian Species Recorded in Each Season (Continued)

Species[1]	Scientific Name	Winter	Spring	Summer	Fall	IPaC
Small Gulls						
Bonaparte's Gull	*Larus philadelphia*	•	•		•	
Medium Gulls						
Black-legged Kittiwake	*Rissa tridactyla*	•	•		•	•
Laughing Gull	*Larus atricilla*	•		•	•	
Ring-billed Gull	*Larus delawarensis*		•			
Large Gulls						
Great Black-backed Gull	*Larus marinus*	•	•	•	•	
Herring Gull	*Larus argentatus*	•	•	•	•	
Lesser Black-backed Gull	*Larus fuscus*		•		•	
Medium Terns						
Common Tern	*Sterna hirundo*		•	•	•	
Forster's Tern	*Sterna forsteri*				•	
Roseate Tern	*Sterna dougallii*		•	•		•
Royal Tern	*Sterna maxima*			•		
Loons						
Common Loon	*Gavia immer*	•	•	•	•	•
Red-throated Loon	*Gavia stellata*	•	•		•	•
Storm-Petrels						
Wilson's Storm-Petrel	*Oceanites oceanicus*	•	•	•		•
Shearwaters and Petrels						
Black-capped Petrel	*Pterodroma hasitata*			•		
Cory's Shearwater	*Calonectris diomedea*	•		•	•	•
Great Shearwater	*Puffinus gravis*			•	•	•
Manx Shearwater	*Puffinus puffinus*			•	•	•
Northern Fulmar	*Fulmarus glacialis*	•	•	•	•	
Sooty Shearwater	*Puffinus griseus*		•	•	•	
Gannet						
Northern Gannet	*Morus bassanus*	•	•	•	•	
Cormorants						
Double-crested Cormorant	*Phalacrocorax auritus*				•	
Heron and Egrets						
Great Blue Heron	*Ardea herodias*	•			•	
Raptors						
Osprey	*Pandion haliaetus*		•			

Note:

1. Species detected in the MassCEC aerial surveys and the site-specific digital aerial surveys, and cross-referenced with United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) database (http://ecos.fws.gov/ipac/).

4.2.1.2 Massachusetts OECC and Connecticut OECC

The Proponent initially identified several OECCs to connect the Lease Area to potential landfall sites in Massachusetts and Connecticut. As described further in Section 2.8 of COP Volume I, the Proponent modified and refined the OECCs through numerous consultations with federal and state agencies, as well as fishermen, and, based on their feedback, consolidated the offshore export cables with other developers' proposed cable routes to the extent feasible. Overall, the species that may be present along the Massachusetts OECC and Connecticut OECC will be similar to those in the Lease Area (see Table 4.2-1).

The Massachusetts OECC travels from the northernmost corner of the Lease Area along the northeast boundary of the MA WEA and Rhode Island/Massachusetts (RI/MA) WEA, south of Nomans Land, and across Buzzards Bay towards the Horseneck Beach Landfall Site in Westport. The initial route was adjusted to be farther offshore to avoid sea duck and other marine bird habitat associated with Nantucket Shoals, and by staying predominantly in federal offshore waters, largely avoids high marine bird abundance areas (see Figure 4.2-1). The Massachusetts OECC now only has a small overlap with sea duck core use areas, which is limited to the winter and spring seasons (see Appendix II-C). As the Massachusetts OECC travels inshore and the depth decreases, the marine bird community will shift from a mix of pelagic (e.g., shearwaters and auks) and coastal species (e.g., terns and cormorants) to predominately coastal species, and overall abundance and species richness would be expected to increase.

Common tern (*Sterna hirundo*) nesting colonies are present along the west coast of Buzzards Bay, as well as on the islands east of Buzzards Bay (Mostello 2015); however, the Massachusetts OECC is predominantly offshore of the colonies. The closest island to the Massachusetts OECC is ~8.5 kilometers (km) (13.8 miles [mi]). Common terns arrive at coastal locations in Massachusetts in April–May, with the largest populations occurring on Cape Cod and in Buzzards Bay. Common terns depart from breeding colonies in July–August (Mostello 2015).

The Connecticut OECC travels from the southwestern tip of Lease Area OCS-A 0522 along the southwestern edge of the MA WEA, and then heads between Block Island and the tip of Long Island, towards potential landfall sites near New London, Connecticut. The Connecticut OECC travels offshore in deeper waters, which will be dominated by pelagic species. As the water depth decreases near Long Island and Block Island, the community will shift to more coastal species (see Figure 4.2-1). The portion of the Connecticut OECC off the eastern tip of Long Island partially passes through core use areas of sea ducks (primarily black scoter) in the winter and spring (see Appendix II-C). The Connecticut OECC passes within 3.5 km (2.2 mi) of Great Gulls Island, which is a significant regional common tern and roseate tern colony and is recognized as a global priority Important Bird Area (National Audubon Society 2008). While any impacts to tern foraging opportunities would be temporary and localized, Vineyard Northeast will consult with applicable federal and state agencies on measures to avoid and minimize impacts in this area prior to installation.

4.2.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect coastal and marine birds during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.2-2. IPFs are similar in each development phase but will be temporary and localized during both construction and decommissioning.

Table 4.2-2 Impact Producing Factors for Coastal and Marine Birds

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Presence of Structures: Collision and Displacement	•	•	•
Suspended Sediments and Deposition	•		
Noise	•	•	•
Vessel Activity	•	•	•
Artificial Light	•	•	•

Potential effects to coastal and marine birds were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

4.2.2.1 Presence of Structures: Collision and Displacement

The wind turbine generators (WTGs) and other Vineyard Northeast structures can create a displacement and/or collision hazard for birds. Potential impacts of structures were evaluated by considering how vulnerable species will be exposed (likelihood of occurrence) to IPFs. To be at risk of an impact, a species must be both exposed to a wind farm ***and*** be vulnerable to either displacement or collision (Goodale and Stenhouse 2016). Vulnerability is defined as behavioral factors (e.g., flight, height, and avoidance) that increase the likelihood that a bird will either collide with a WTG or be displaced from the Lease Area (Goodale and Stenhouse 2016).

For non-marine migratory species, vulnerability was evaluated based on existing assessments (e.g., Furness et al. 2013), and documented behavioral response to offshore wind farms in the literature. For marine birds, a ranking of relative vulnerability to the operation of Vineyard Northeast was developed for displacement and collision. The ranking was done for the maximum dimensions (tip height and rotor diameter) and the minimum tip clearance (also known as air gap) of the WTGs under consideration. Details on the methods are provided in Appendix II-C. A summary of the exposure and vulnerability results are provided below by each major taxonomic group. Please see Appendix II-C for specific exposure, vulnerability, and risk scores.

Coastal Birds

- *Coastal Waterbirds:* Given that these species spend most of their life in freshwater aquatic and associated terrestrial habitats, that few were observed during digital aerial surveys, that they were not identified in the IPaC data, and that there is little or no evidence of offshore migration in the literature or in the MassCEC aerial survey data, these species are expected to have little to no exposure to the Lease Area.

- *Shorebirds:* Shorebird exposure will be primarily limited to migration. The digital aerial surveys detected a few small flocks of shorebirds in the summer, fall, and winter. If exposed to the Lease Area, shorebird collision vulnerability is likely low because these birds often migrate at heights well above the rotor swept zone (RSZ) and fly during fair weather conditions.

    - *Piping Plover:* The Atlantic population of piping plovers is listed as threatened under the Endangered Species Act (ESA), with an estimated 2,289 nesting pairs in the U.S. as of 2021 (USFWS 2022). Piping plovers were not observed during the digital aerial surveys. Tracking studies estimated that nine tracked piping plovers (tagged in Massachusetts) passed through lease areas in Massachusetts to the west of Lease Area OCS-A 0522 (Loring et al. 2019), but did not estimate exposure events for Lease Area OCS-A 0522, and modeled track lines did not cross the Lease Area. Piping plover exposure to the Lease Area would hypothetically only occur during migration and there is no breeding or foraging habitat for the species in the Lease Area. If plovers were exposed to the Lease Area, they would not be expected to be vulnerable to displacement because the offshore environment is not used as foraging habitat. Collision vulnerability is expected to be minimal to low because, during migration, these birds tend to fly above the WTGs. These findings are supported by the results of a collision risk model carried out by BOEM for piping plovers potentially passing through the Vineyard Wind 1 Wind Development Area (WDA), which estimated the annual number of fatalities as zero and found that any extra energy expenditure resulting from the avoidance of an offshore wind farm would be minimal (BOEM 2019).

    - *Red Knot*: The *rufa* subspecies of the red knot is listed as threatened under the ESA, primarily because the Atlantic flyway population has decreased by ~70% to less than 30,000 individuals (Baker et al. 2020, Burger et al. 2011, USFWS 2015). The Northwest Atlantic Seabird Catalog has no records of red knots in the Lease Area, and none were observed during the daytime digital aerial surveys, although knots generally fly at night. During migration most adult *rufa* fly offshore over the Atlantic from Canadian or U.S. staging areas to South America (Baker et al. 2020); this is the period in which they could potentially move through the Lease Area (BOEM 2014). In a telemetry study, two birds tagged in Massachusetts (n=99) were detected as potentially crossing a lease area to the west of Lease Area OCS-A 0522 (Loring et al. 2018). If red knots were exposed to the Lease Area, they would not be expected to be vulnerable to displacement because the offshore environment is not used as foraging habitat. Collision vulnerability is expected to be low because knots tend to fly above the WTGs, although they may fly lower in poor weather conditions. These findings are supported by the results of a collision risk model carried out by BOEM for red knots potentially passing through the Vineyard Wind 1 WDA, which estimated the annual number of fatalities as zero and found that any extra energy expenditure resulting from the avoidance of an offshore wind farm would be insignificant (BOEM 2019).

- *Wading Birds:* No wading birds were detected in the Lease Area during digital aerial or MassCEC surveys. Recent results of great blue herons tracked with satellite transmitters indicates that these birds tend to fly inshore of the Lease Area, but that some individuals have the potential to pass through the Lease Area. If herons were exposed to the Lease Area, they would not be expected to be vulnerable to displacement because the offshore environment is not used as foraging habitat. While wading birds have the potential to fly though the RSZ, collision vulnerability is expected to be low; there are few records of these birds colliding with terrestrial wind turbines.

- *Raptors:* Overall, use of the Lease Area by most raptors is minimal during breeding or winter seasons and will be limited to falcons, and possibly ospreys during migration. Individual tracking data and species accounts indicate that falcons fly within the vicinity of the Lease Area, but that most ospreys stay closer to the islands (only one was observed in the Lease Area during the digital aerial surveys). If exposed to the Lease Area, falcons may have some vulnerability to collision, but collisions with offshore WTGs have not been documented. The general morphology of both bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) dissuades regular use of offshore habitats and none were detected during the surveys.

- *Songbirds:* During digital aerial surveys, a few individual songbirds were observed in the fall (September and October). Given that songbirds do not generally use the offshore marine system as habitat, exposure will be limited to the migratory period. If songbirds were exposed to the Lease Area, they would not be expected to be vulnerable to displacement because the offshore environment is not used as foraging habitat. Collision vulnerability is expected to be low to medium as songbirds have been documented colliding with terrestrial WTGs, but these collisions are considered to have a small effect on most songbird populations (Erickson et al. 2014).

Marine Birds

- *Sea ducks*: The northeastern corner of the Lease Area overlaps with a Key Habitat Site identified by the Sea Duck Joint Venture (Bowman et al. 2022). The western side of Nantucket Shoals is a well-recognized important area for wintering sea ducks (Silverman et al. 2013; Meattey et al. 2019), particularly for long-tailed ducks (*Clangula hyemalis*; White et al. 2009), and other marine bird species (Veit et al. 2016). Long-tailed ducks and other sea ducks winter on the Nantucket Shoals in large aggregations from November to April (Silverman et al. 2012). Tracking data indicates that core use areas for the surf scoter (*Melanitta perspicillata*), black scoter (*Melanitta americana*), and long-tailed duck (*Melanitta deglandi*) are all generally inshore of the Lease Area, and that only core use areas for the white-winged scoter overlap with northeastern portion of the Lease Area. Satellite-tracked movements of these birds highlighted several within-winter movements throughout the southern New England coastal area, suggesting the possibility that white-winged scoters could cross the Lease Area during these movements (Meattey et al. 2019). During digital aerial surveys, sea ducks were detected from December–May, and scoters and long-tailed ducks were among the most abundant species in the Lease Area during the winter months. Sea duck distribution in the winter and spring seasons was strongly biased to the northeast of the Lease Area towards Nantucket Shoals, and this is supported by similar patterns observed in tracking data, MassCEC surveys, and the MDAT models.

Sea ducks are generally not considered vulnerable to collision (Furness et al. 2013) because they primarily fly below the RSZ and have strong avoidance behavior. Sea ducks are considered vulnerable to displacement (Furness et al. 2013), which can lead to effective habitat loss (Petersen and Fox 2007; Percival 2010; Langston 2013). However, avoidance of individual wind arrays is not expected to significantly increase energy expenditure (Masden et al. 2009). In one well-known European study, displacement of common scoters (*Melanitta nigra*) appeared to wane over time as birds eventually returned to a wind farm several years after construction, apparently adapting to new foraging opportunities as food resources, behavioral responses, and/or other factors changed (Petersen and Fox 2007; Leonhard et al. 2013). A follow up study some years later suggested that the displacement of sea ducks was in fact more lasting, however (Petersen et al. 2014). Although difficult to reconcile, these previous studies were conducted in European wind farms involving considerably smaller turbines (~2 megawatts [MW]), which were spaced much closer together (500 meters [m]; 1,640 feet [ft]) than those being considered by Vineyard Northeast, and so may not accurately reflect the behavior of sea ducks around future offshore wind farms constructed off the United States (US) coast, including Vineyard Northeast.

- *Phalaropes:* Phalaropes (the most marine-focused species among the shorebirds) were detected in the Lease Area during the winter, summer, and fall. Their distribution varied by season, however, with high numbers detected in the early winter. While little is known regarding how phalaropes will respond to offshore wind turbines, they likely have low collision vulnerability since they generally fly below the RSZ, but may have some vulnerability to displacement.

- *Auks:* During digital aerial surveys, auks were among the most abundant species observed in the fall, winter, and spring. In the Lease Area, auk distributions varied by season and lacked a specific spatial trend. The available information indicated exposure for most auks will be limited, except for razorbill (*Alca torda*), which will have higher exposure in the winter and spring. Auks are expected to have limited behavioral vulnerability to collision, because they fly low and have strong avoidance rates. However, auks are expected to be vulnerable to displacement, due to their sensitivity to disturbance and documented avoidance of offshore wind farms (Dierschke et al. 2016, Furness et al. 2013, Wade et al. 2016).

- *Skuas, Jaegers, and Gulls*: Skuas and jaegers were rarely observed during surveys. During digital aerial surveys, the herring gull (*Larus argentatus*) and great black-backed gull (*Larus marinus*) were among the most common gulls and were observed nearly year-round, but had relatively lower densities. Bonaparte's gull (*Chroicocephalus philadelphia*) was most common during spring and fall migration and black-legged kittiwake (*Rissa tridactyla*), among the gulls, had the highest densities in the fall and winter and were most common in November and December. Gulls have some vulnerability to displacement, but rank at the top of collision vulnerability assessments because they can fly within the RSZ (Johnston et al. 2014), have a documented attraction to WTGs (Vanermen et al. 2015), and have been documented to collide with WTGs (Skov et al. 2018).

- *Terns*: During the digital aerial surveys, terns had relatively low densities and were observed in the spring, summer, and fall. The digital aerial surveys were conducted twice a month in April, May, August, and September, to increase effort when terns might be flying through the Lease Area during migration. Overall, the survey data indicated limited use of the Lease Area by any tern species. As a group, terns are expected to have low behavioral vulnerability to collision because, for the WTGs under consideration, common terns were estimated to only fly in the RSZ only 1.78% of the time. Terns are predicted to have some vulnerability to displacement because terns have been shown to have a 76% lower abundance inside offshore wind farms and were estimated to start avoidance behaviors at a distance of 1.5 km (0.93 mi; Welcker & Nehls 2016).

    - *Roseate Tern:* The northwest Atlantic Ocean population of roseate terns has been federally listed as endangered since 1987. Overall, the regional and site-specific information indicate limited use of the Lease Area by roseate terns during spring, summer, and fall (terns are not present in the winter). The MDAT abundance models suggest that roseate tern occupancy and abundance in the Lease Area is likely to be much lower than in Nantucket Sound in all seasons examined—spring, summer, and fall (Curtice et al. 2019)—and during the breeding and post-breeding periods, very few, if any, roseate terns are predicted to occur within the Lease Area (BOEM 2014, Curtice et al. 2019). During digital aerial surveys, two roseate terns were observed immediately south of the Lease Area (one in May of 2020, and one in June of 2021). Little information is available specifically about roseate tern vulnerability, but it is expected to be similar to common terns, discussed above.

- *Shearwaters, petrels, and storm-petrels:* During digital aerial surveys, storm-petrels and shearwaters were among the most abundant species from June–November. The northern fulmar (Fulmarus glacialis) had a different temporal pattern, and was most abundant through the fall, winter, and spring. One black-capped petrel was observed during digital aerial surveys, but none were detected during the MassCEC aerial surveys, and other information sources (i.e., tracking studies) indicate that the birds are unlikely to pass through the Lease Area. Shearwaters, storm-petrels, and petrels are expected to have low behavioral vulnerability to collision and some vulnerability to displacement, but interactions with offshore wind farms has not been well studied in this species group.

- *Gannet and Cormorants:* During digital aerial surveys, the northern gannet was observed in the Lease Area in all months except July, and was among the most common species November–January and in April and May. Northern gannets are expected to have low behavioral vulnerability to collision, with some vulnerability to displacement, because many studies indicate that they avoid wind developments (Cook et al. 2012; Dierschke et al. 2016; Garthe et al. 2017; Hartman et al. 2012; Krijgsveld et al. 2011). During digital aerial surveys, cormorants were observed only in March and were among the least common species. The double-crested cormorant (*Phalacrocorax auritus*) is expected to have some behavioral vulnerability to collision because they can fly within the RSZ, but low vulnerability to displacement.

In summary, during construction, operations, and decommissioning, coastal birds are expected to be ephemerally exposed during migration, and marine birds are expected to be exposed during all seasons. Of the coastal birds, shorebirds, wading birds, peregrine falcons, and songbirds are expected to generally have low exposure to the Lease Area, which will be limited to short migration periods. Eagles are not expected in the Lease Area due to the distance from shore. The location of the Vineyard Northeast WTGs far offshore largely avoids exposure to coastal birds.

Depending on the species, marine birds are expected to have a range of behavioral vulnerability with sea ducks, auks, terns, and loons, having higher vulnerability to displacement, and gulls and cormorants having higher vulnerability to collision. Of the marine birds, razorbill, black-legged kittiwake, and Cory's shearwater (*Calonectris diomedea*) had higher exposure than other species. The northeast section of the Lease Area closest to Nantucket Shoals is used by sea ducks in the winter and spring but is at the edge of the birds' core use area that is concentrated on Shoals to the east. While studies on sea ducks indicate a strong avoidance response to WTGs spaced relatively close together, there is uncertainty on sea duck avoidance response to the WTGs proposed by Vineyard Northeast that will be spaced 1.85 km (1 nautical mile [NM]). At a certain distance of spacing, sea ducks may fly between the WTGs rather than avoid the entire array. The Proponent will develop a framework for a post-construction monitoring program for birds to increase the understanding of how sea ducks will respond to widely spaced turbines. Additionally, to the extent practical and in accordance with health and safety requirements, the Proponent will evaluate the feasibility of installing bird deterrents at WTGs that have been identified as having high use by birds. Additionally, the Proponent will document any dead or injured birds found on vessels and structures during construction, O&M, and decommissioning.

Exposure of federally listed species is expected to be limited and would largely be restricted to migration. Roseate terns are expected to have limited exposure, low vulnerability to collision, and some vulnerability to displacement. Piping plovers and red knots are also expected to have limited exposure, and vulnerability. These species may be exposed during migration periods, though flight heights during migration are thought to be generally well above the RSZ. There was one detection of a black-capped petrel in digital aerial surveys, but this species likely flies below the RSZ most of the time, and generally remains well offshore along the shelf edge.

4.2.2.2 Suspended Sediments and Deposition

Offshore export cable installation will generate minimal suspended sediments that will be temporary and localized. For foraging marine birds, the suspended sediments could temporarily inhibit detecting prey in the bottom few meters of the water column and could locally displace prey. However, water quality is expected to return to prior conditions within a few hours (see Sections 3.2 for more details). Therefore, any effects are expected to be temporary, and, if displaced by cable installation activities, birds will likely only need to fly a short distance to alternate foraging locations to find prey. While there may be short-term disturbance of resident birds during offshore wind farm construction (Fox and Petersen 2019), many bird that are initially disturbed by cable installation will likely return to the area after construction activities are completed. Overall, bird exposure to construction IPFs will be ephemeral and limited because the Lease Area is located far offshore. In summary, suspended sediments and deposition are unlikely to pose population level risk for any species because the IPF will be temporary and localized.

4.2.2.3 Noise

Noise from pile driving may cause birds to avoid the construction area and can disturb the local prey base. When pile driving occurs close to tern colonies (within 2 km; 1.24 mi), pile driving noise may disperse the local abundance of prey fish (e.g., herring). The decreased abundance of prey can reduce seabird foraging success and may cause reduced reproductive success for multiple years (Perrow et al. 2011). However, the footprint of any displacement (should it occur) is small for each piling event compared to available habitat, and the Lease Area is far from the nearest tern colony. Any short-term reduction in the prey base would be expected to recover completely once construction was completed. The Biological Assessment for Vineyard Wind 1 found that impacts from pile driving and noise related to construction would be "insignificant and discountable" (BOEM 2019). In summary, noise is unlikely to pose population level risk for any species because the IPF will be largely limited to construction and will be temporary and localized.

4.2.2.4 Vessel Activity

During construction, coastal and marine birds may encounter installation vessels within the Lease Area or along the OECC, but such exposure, in any given location, will be limited to a finite temporal and ephemeral period. While birds may encounter construction equipment during migration and may land on vessels, mortality from collision is unlikely.

During O&M, regular vessel trips to the Lease Area are expected as part of planned maintenance or periodic repairs for the WTGs, electrical service platform(s) (ESP[s]), and booster station (if used). Helicopters may also be used. Less frequent vessel trips may also be required for any needed maintenance of the offshore export cables.

There has been very little research on the effects on birds during the construction and maintenance of offshore wind farms, though marine bird species vary in their reactions to operational WTGs and the associated vessel and helicopter traffic that may be required during maintenance and repair activities. Increased vessel traffic has the potential to affect distributions of birds foraging in the immediate area (Fox et al. 2006; Furness et al. 2013).

Gulls and cormorants may be attracted to and perch on construction equipment. In contrast, some marine birds (e.g., sea ducks and loons) may be disturbed by vessels, equipment, and activities, which may lead to temporary displacement from cable installation and wind farm construction areas (MMS 2007). However, sea ducks have been shown to return to areas with repeated boat traffic (Ramírez-garofalo 2020), and vessel traffic is unlikely to cause long-term habitat loss. In summary, vessel traffic is unlikely to pose population level risk for any species.

4.2.2.5 Artificial Light

Artificial light on vessels, construction equipment, and WTGs, can attract birds and increase collision risk, discussed above. For songbirds, movement during low visibility periods creates the highest collision risk conditions; at an offshore research station with substantial lighting, songbird mortalities have been documented during poor weather conditions (Hüppop et al. 2006a). Evidence of nocturnal soaring, perching, and feeding under lighted structures in terrestrial and offshore settings has been noted in peregrine falcons (Cochran 1985; Johnson et al. 2011; Kettel et al. 2016; Voous 1961), and these behaviors increase the exposure risk in this species.

Marine birds are known to be attracted to offshore vessels and structures, especially when brightly lit (Montevecchi 2006; Wiese et al. 2001). Shearwaters and petrels forage on vertically migrating bioluminescent prey and are instinctively attracted to light sources of any kind (Imber 1975). This may be particularly true during periods of poor visibility, when collision risk is likely to be highest. However, there is little information on avian behavior in the marine environment during such periods, as surveys are generally limited to periods of good weather during daylight hours.

While potential for colliding with lit structures in the marine environment may increase if there is substantial lighting (e.g., Hüppop et al. 2006), Vineyard Northeast will minimize lighting by using best management practices and an Aircraft Detection Lighting System (ADLS) or similar system that automatically activates all aviation obstruction lights when aircraft approach the structures, subject to BOEM approval. The use of an ADLS would substantially reduce the amount of time that the aviation obstruction lights are illuminated to approximately 1.25 hours/year (see Appendix II-I). In summary, lighting is unlikely to pose population level risk for any species because Vineyard Northeast will reduce lighting to the extent practicable, which will alleviate any increased risk of collision.

4.2.2.6 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate, potential effects to coastal and marine birds during Vineyard Northeast are summarized below:

- The location of the Vineyard Northeast WTGs far offshore largely avoids exposure to coastal birds.
- The Proponent will minimize lighting to the extent practicable by using best management practices and adhering to federal regulations and BOEM guidance.
- The Proponent will use an ADLS or similar system that automatically activates all aviation obstruction lights when aircraft approach the Lease Area, subject to BOEM approval.
- The Proponent will develop a framework for a post-construction monitoring program for birds to increase the understanding of how sea ducks will respond to widely spaced turbines.
- The Proponent will document any dead or injured birds found on vessels and structures during construction, O&M, and decommissioning.
- To the extent practical and in accordance with health and safety requirements, the Proponent will evaluate the feasibility of installing bird deterrents at WTGs that have been identified as having high use by birds.

4.3 Bats

This section addresses the potential impacts of Vineyard Northeast on bats in the Onshore Development Area and Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to bats during the construction, operation, and decommissioning of Vineyard Northeast.

4.3.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities.

The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities.

The methods used to assess the affected environment include scientific literature review, bat natural history, and state-specific resources on known maternity roosts and hibernacula of listed bat species.

4.3.1.1 Overview of Bat Species in Massachusetts and Connecticut

Historically, nine species of bats are known to occur in Massachusetts and Connecticut, five of which are listed as endangered under the Massachusetts Endangered Species Act (Massachusetts Natural Heritage and Endangered Species Program [MA NHESP] 2022) and are included on Connecticut's List of Endangered, Threatened and Special Concern Species (Connecticut Department of Energy and Environmental Protection [CT DEEP] 2015). The Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) are also listed as federally endangered under the Endangered Species Act (ESA), and the tricolored bat (*Perimyotis subflavus*) is proposed for federal listing. The Indiana bat is thought to be extirpated from Massachusetts and its presence has not been recorded since 1939 (Luensmann 2005; MA NHESP 2022). Table 4.3-1 summarizes bat species present in Massachusetts and Connecticut along with their conservation status.

Bat species can be categorized into two major groups based on their wintering strategy: cave-hibernating bats and migratory tree bats. Both groups are nocturnal insectivores that use a variety of forested and open habitats for foraging during the summer. Cave-hibernating bats generally exhibit lower activity in the offshore environment than migratory tree bats (Sjollema et al. 2014). These species hibernate regionally in caves, mines, and other structures, and feed primarily on insects in terrestrial and freshwater habitats. Their movements occur primarily during the fall. The presence of the fungal disease white-nose syndrome (WNS) in hibernacula has caused high mortality of cave-hibernating bats and led to the northern long-eared bat being listed under the ESA. Migratory tree bats, rather than hibernating in the winter months, fly to southern parts of the United States (US). Eastern red bats (Lasiurus borealis) may exhibit shoreline migration (Cryan 2003; Hatch et al. 2013; True et al. 2021). Targeted surveys, for example, have observed this species up to 41.8 kilometers (km) (26 miles [mi]) off the coast of New Jersey, Delaware, and Virginia (Hatch et al. 2013).

Bat species present in Massachusetts and Connecticut have the potential to utilize the Onshore Development Area and Offshore Development Area, although cave bats are unlikely to use the offshore environment. Exposure of bats to the specific activities and facilities within the Lease Area is assessed below. The northern long-eared bat is discussed separately in this section because it is a federally listed species.

Table 4.3-1 Bat Species Present in Massachusetts and Connecticut, Type, and Conservation Status[1]

Common Name	Scientific Name	Type[3]	MA State Status	CT State Status	Federal Status
Eastern small-footed bat	*Myotis leibii*	Cave-hibernating bat	E	E, SGCN	-
Little brown bat	*Myotis lucifugus*	Cave-hibernating bat	E	E, SGCN	-
Northern long-eared bat	*Myotis septentrionalis*	Cave-hibernating bat	E	E, SGCN	E
Indiana bat[2]	*Myotis sodalis*	Cave-hibernating bat	E	E, SGCN	E
Tricolored bat	*Perimyotis subflavus*	Cave-hibernating bat	E	E, SGCN	*P*
Big brown bat	*Eptesicus fuscus*	Cave-hibernating bat	-	SGCN	-
Eastern red bat	*Lasiurus borealis*	Migratory Tree Bat	-	SC, SGCN	-
Hoary bat	*Lasiurus cinereus*	Migratory Tree Bat	-	SC, SGCN	-
Silver-haired bat	*Lasionycteris noctivagans*	Migratory Tree Bat	-	SC, SGCN	-

Notes:
1. E = Endangered; T = Threatened; SGCN = Species of Greatest Conservation Need; SC = Special Concern; *P* = Proposed for Federal Listing.
2. Winter and summer records are not located east of the Connecticut River Valley in Massachusetts, Vermont, and New Hampshire border and Connecticut (USFWS 2007).
3. "Type" refers to two major life history strategies among bats in eastern North America; cave-hibernating bats roost in large numbers in caves during the winter, while migratory tree bats do not aggregate in caves and are known to migrate considerable distances.

Federally Listed Species

As shown in Table 4.3-1, two federally listed bat species have the potential to be present in Massachusetts and Connecticut—the northern long-eared bat and the Indiana bat—and one species proposed for listing, the tricolored bat. The northern long-eared bat is found in eastern Massachusetts (where the onshore facilities will be located) whereas the range of the Indiana bat does not include the eastern part of the state; historical records only demonstrate its presence in western Massachusetts (Barbour and Davis 1969). While both species are potentially present in Connecticut, they are rare. In an acoustic assessment of bat species presence at one golf course and ten state parks throughout Connecticut, Indiana bats were detected in Tolland, Litchfield, Windham, and Fairfield Counties (Wisniewski 2018). No Indiana bats were detected in New London County where the onshore facilities will be located, and no northern long-eared bats were detected anywhere in the state. Historically, northern-long eared bat hibernacula have been identified in Connecticut, but not in New London County (CT DEEP 2019).

There were no records of Indiana bats in the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) database for the Onshore Development Area (in either Massachusetts or Connecticut), but IPaC results indicate the potential for northern-long eared bat presence. Thus, this assessment will focus solely on the potential exposure of northern long-eared bat and tricolored bat to Vineyard Northeast activities.

Northern Long-Eared Bat

The northern long-eared bat is an insectivorous bat that hibernates in caves, mines, and other locations (e.g., possibly talus slopes) in winter and spends the remainder of the year in forested habitats. During the summer, northern long-eared bats roost under tree bark and in cavities and crevices of live and dead trees (Sasse and Perkins 1996; Foster and Kurta 1999; Owen et al. 2001; Perry and Thill 2007). Anthropogenic structures will also occasionally be used for roosting (Amelon and Burhans 2006; Timpone et al. 2010). Most foraging activity takes place between the understory and forest canopy, typically up to 3 meters (m) (10 feet [ft]) off the ground (Brack and Whitaker 2001). Foraging occurs within a few kilometers of roost sites (Broders et al. 2006; Henderson and Broders 2008; Lacki et al. 2009; Timpone et al. 2010), and roosts are relocated every two to three days (Foster and Kurta 1999; Owen et al. 2001; Carter and Feldhamer 2005; Timpone et al. 2010). The species' range includes most of the eastern and mid-western US and southern Canada. Due to impacts from WNS, the species has declined by 90–100% in most locations where the disease has occurred, and declines are expected to continue as the disease spreads throughout the remainder of the species' range (USFWS 2016). WNS was detected in Massachusetts in 2007 (MassWildlife 2020) and in Connecticut in 2008 (CT DEEP 2022). The impact of WNS on the northern long-eared bat resulted in the species being listed as threatened under the ESA in 2015. Due to continued severe population declines from WNS, the species was reclassified as endangered in November 2022 (Federal Register 2022).

The northern long-eared bat is active from March to November (Menzel et al. 2002; Brooks and Ford 2005). At summer roosting locations, the northern long-eared bat forms maternity colonies (aggregations of females and juveniles) where females give birth to young in mid-June. Roosting tree-selection varies and the size of tree and canopy cover changes with reproductive stage (USFWS 2016). The bats are born flightless and remain so until mid-July (Carter and Feldhamer 2005). Adult females and flying juveniles remain in maternity colonies until mid-August, at which time the colonies begin to break up and bats begin migrating to their hibernation sites (Menzel et al. 2002). Bats forage around the hibernation site and mating occurs prior to entering hibernation in a period known as fall swarm (Broders and Forbes 2004; Brooks and Ford 2005). Throughout the summer months and during breeding, northern long-eared bats have small home ranges of less than 0.1 km^2 (25 acres; Silvis et al. 2016 in Dowling et al. 2017). Migratory movements, however, can be up to 275 km (170 mi; Griffin 1945 in Dowling et al. 2017).

Despite severe population declines, northern long-eared bats are documented in 11 of 14 counties in Massachusetts (MA NHESP 2022), including Dukes County and Nantucket County (Dowling et al. 2017). However, no known northern long-eared bat maternity roost trees or hibernacula are located near the onshore substation sites in either state (CT DEEP 2019; MA NHESP 2022). The closest known roost trees in Massachusetts are at or near Cape Cod Joint Base and Cape Cod National Seashore, which are approximately 48 km (30 mi) from the Massachusetts Onshore Development Area. Known hibernacula in Connecticut have been identified in the towns of Salisbury, Winchester, East Granby, Morris, New Milford, Bridgewater, Roxbury, Greenwich, and North Branford. There are no known hibernacula in the Connecticut municipalities where landfall sites, onshore cable routes, or onshore substation are proposed (these include New London, Groton, East Lyme, Ledyard, Montville, and Waterford). The closest known hibernacula in North Branford, Connecticut is approximately 50 km (31 mi) west of the Town of Montville. As of 2019, no maternity roost trees had been confirmed in the state (CT DEEP 2019). Occupancy modeling from the North American Bat Monitoring Program (NABat) suggests a low probability of northern long-eared bat summer occupancy across most the eastern portions of both Connecticut and Massachusetts (Udell et al. 2022).

Tricolored Bat

The tricolored bat, another insectivorous cave-hibernating bat, is common in eastern North America, ranging from Central America to southern Canada (Hoofer et al. 2006). During summer, tricolored bats roost both in buildings and in foliage. Females may roost alone or in colonies, while males are mostly solitary (Leivers et al. 2019; Poissant et al. 2010; Veilleux et al. 2003). Tricolored bats are not known to migrate long distances prior to hibernation, but stable isotope analysis suggests instances of latitudinal migration of greater distances than traditionally thought (Fraser et al. 2012). After engaging in swarming behavior in autumn, hibernation occurs in caves, abandoned mines, and human-made structures (Slider & Kurta 2011).

Tricolored bats are one of the species most affected by WNS, with hibernacula counts at caves in WNS-positive regions showing reductions of >90% from previous counts (Cheng et al. 2021; Perea et al. 2022). Presence of WNS in hibernacula has been confirmed across an estimated 59% of the total distribution (Cheng et al. 2021), and population declines have been documented throughout most of the range (Hoyt et al. 2021). As a result of these range-wide declines, the USFWS has drafted a proposal to list tricolored bats as endangered under the ESA (USFWS 2022). The USFWS's Species Status Assessment Report for the tricolored bat predicts that even in the absence of further WNS spread and wind energy development, the population viability for the species is likely to experience rapid decline over the next decade (USFWS 2021).

Tricolored bats were once the third most abundant bat in Massachusetts caves, but WNS-related mortality has reduced these numbers by at least 90% (MA NHESP 2015). Tricolored bats have been documented in 9 of 14 Massachusetts counties, though hibernacula have only been documented in the western portion of the state (Berkshire, Franklin, and Hampden counties). Occupancy modeling from NABat suggests a low probability of tricolored bat summer occupancy across most of Massachusetts, with slightly higher probability in Connecticut (Udell et al., 2022).

4.3.1.2 Offshore Development Area

This section assesses the potential exposure (likelihood of occurrence) of cave-hibernating and migratory tree bats to the Offshore Development Area, which consists of the Lease Area, the Massachusetts OECC, and the Connecticut OECC. The assessment of potential exposure to bats during construction includes activities within the Lease Area and OECC. For operations and maintenance (O&M), however, the assessment only includes the wind turbine generators (WTGs) within the Lease Area, since O&M activities within the OECC are not expected to affect bats and stationary objects (such as electrical service platforms [ESPs]) are not generally considered a collision risk for bats (Bureau of Ocean Energy Management [BOEM] 2014) because they are able to detect these objects with echolocation (Johnson et al. 2004; Horn et al. 2008). See Table 4.3-2 for definitions of exposure.

Table 4.3-2 Definitions of Exposure Levels

Exposure Level	Definition
minimal	Based upon the literature, little to no evidence of use of the offshore environment for breeding, wintering, or staging and minimal predicted use during migration.
low	Based upon the literature, little evidence of use of the offshore environment during any season and a low proportion of the population is exposed.
medium	Based upon the literature, moderate evidence of use of the offshore environment during any season and a moderate proportion of the population is exposed.
high	Based upon the literature, strong evidence of use of the offshore environment and the offshore environment is primary habitat during any season and a high proportion of the population is exposed.

While there remain data gaps on offshore bat movements, available data indicate that bat activity levels are generally lower offshore than onshore or nearshore (Hein et al. 2021). Acoustic detections at nearshore and onshore sites on the North Sea were up to 24 times higher compared to offshore locations (Brabant et al. 2021). Bats have been documented in the marine environment in the U.S. (Grady & Olson 2006, Cryan & Brown 2007, Johnson et al. 2011, Hatch et al. 2013, Pelletier et al. 2013, Dowling & O'Dell 2018, Stantec 2016), and in Europe (Boshamer and Bekker 2008; Ahlén et al. 2009; Lagerveld et al. 2015). All recorded instances of North American bats flying over open ocean have occurred in the Atlantic region between Nova Scotia and North Carolina, with visual observations occurring between 2.6 and 817.3 km (2–508 mi) from the nearest land (Solick and Newman 2021). Bats have been observed to temporarily roost on structures on nearshore islands, such as lighthouses (Dowling et al. 2017), and there is evidence of bats, particularly eastern red bats, migrating offshore in the Atlantic (Hatch et al. 2013). In a mid-Atlantic bat acoustic study conducted during the spring and fall of 2009 and 2010 (86 nights), the maximum distance that bats were detected from shore was 21.9 km (13.6 mi), and the mean distance was 8.4 km (5.2 mi; Sjollema et al. 2014). In Maine, bats were detected on islands up to 41.6 km (26 mi) from the mainland (Peterson et al. 2014). In the mid-Atlantic acoustic study, eastern red bats comprised 78% of all bat detections offshore (166 bat detections during 898 monitoring hours) and bat activity decreased as wind speed increased (Sjollema et al. 2014). Acoustic bat detectors deployed aboard research vessels at sea have detected bat activity up to 130 km (81 mi) from shore (Stantec 2016). For context, at its closest point, the Lease Area is approximately 46 km (29 mi) from Nantucket.

Several studies have highlighted the relationship between bat activity and weather conditions. In general, bat activity has been found to occur primarily during nights with warmer temperatures and low wind speeds (Fiedler 2004; Reynolds 2006; Cryan et al. 2014; Stantec 2016; Gorresen et al. 2020). Smith & McWilliams (2016) developed predictive models of regional nightly bat activity using continuous acoustic monitoring at several locations in coastal Rhode Island. Bat activity was found to steadily decrease with decreasing temperatures, and departures from seasonally normal temperatures increasingly inhibited bat activity later in the season (September–October). Although Smith and McWilliams (2016) found no association with wind speed and activity of migratory bats (primarily eastern red bats and silver-haired bats), they demonstrate a strong relationship with "wind profit," a variable indicating combinations of wind speeds and directions that would likely induce coastal flight paths.

Cave-hibernating bats hibernate regionally in caves, mines, and other structures, and feed primarily on insects in terrestrial and fresh-water habitats. These species generally exhibit lower activity in the offshore environment than the migratory tree bats (Sjollema et al. 2014), with movements primarily during the fall (Peterson et al. 2014; Stantec 2016). While at least one ship record indicates that these species can fly farther from shore—Thompson et al. (2015) documented Myotis bats (unknown spp.) landing and roosting on their ship 110 km (68 mi) from the nearest land—acoustic studies generally indicate lower use of the offshore environment by cave-hibernating bats (as compared to tree-roosting species). In a mid-Atlantic study, the maximum distance Myotis species were detected offshore was 11.5 km (7 mi; Sjollema et al. 2014). A nano-tracking study on Martha's Vineyard recorded little brown bat (Myotis lucifugus; n = 3) movements off the island in late August and early September, with one individual flying from Martha's Vineyard to Cape Cod (Dowling et al. 2017). Big brown bats (Eptesicus fuscus; n = 2) were also detected migrating from Martha's Vineyard later in the year (October–November; Dowling et al. 2017). These findings are supported by an acoustic study conducted on islands and buoys of the Gulf of Maine that indicate the greatest percentage of migration activity for cave-hibernating bats takes place between July and October (Peterson et al. 2014). As shown by these studies, the use of coastline as a migratory pathway by cave-hibernating bats is likely limited to their fall migration period. Furthermore, acoustic studies indicate lower use of the offshore environment by cave-hibernating bats as compared to tree-roosting species (Lagerveld et al. 2017). Overall, use of the Lease Area by cave-hibernating bats is likely limited to few individuals during migration. This is supported by BOEM's analysis of Vineyard Wind 1, which found that cave-hibernating bats do not typically occur offshore (BOEM 2021).

Tree bats generally migrate to southwestern and southern parts of the U.S. to overwinter (Cryan 2003; Cryan et al. 2014; Wieringa et al. 2021) and have been documented in the offshore environment (Hatch et al. 2013; True et al. 2021). Eastern red bats were detected in the mid-Atlantic up to 41.8 km (26 mi) offshore by high resolution digital video aerial surveys (Hatch et al. 2013). These bats were all observed in September off Delaware and Maryland. Eastern red bats have been detected migrating from Martha's Vineyard late in the fall, and one bat was tracked as far south as Maryland, indicating that individuals of this species can travel at least 450 km (280 mi) over water in a single night (Dowling et al. 2017). These results are supported by historical observations of eastern red bats offshore, as well as acoustic and survey results (Hatch et al. 2013; Peterson et al. 2014; Sjollema et al. 2014). Tree bats exposure to the Lease Area is likely limited to migration period (late summer/early fall) and their use of the Lease Area is expected to be limited because there are no migratory destinations immediately to the south. This is supported by the Supplemental Environmental Impact Statement (SEIS) for

Vineyard Wind 1, in which BOEM determined that offshore use by tree bats is expected to be "very low and limited to spring and fall migration periods" and "under very specific conditions like low wind and high temperatures" (BOEM 2020).

For both cave-hibernating and migrating tree bats, overall exposure to the Lease Area is expected to be minimal to low. As detailed above, acoustic and radio-tracking studies indicate low use of the offshore environment by cave-hibernating bats and such use is likely limited to the fall migration period (Peterson et al. 2014; Dowling et al. 2017). While migratory tree bats are detected more often in the offshore environment, exposure is likely to be limited to the migration period.

Bat exposure to the Massachusetts OECC and Connecticut OECC will be generally similar to the Lease Area, although bat activity is expected to be relatively higher closer to shore. Where the Massachusetts OECC and Connecticut OECC pass through coastal areas, cave-hibernating activity may be higher than farther offshore. While bats are expected to be more common overland, they can use coastal areas and nearshore waters while migrating or foraging. In summary, exposure for bats is expected to be minimal to low.

Federally Listed Species

Northern long-eared bats are not expected to be exposed to the Lease Area. While there is little information on the movements of northern long-eared bat with respect to ocean travel, a tracking study on Martha's Vineyard (n = 8; July to October 2016) did not record any offshore movements by northern long-eared bat (Dowling et al. 2017). If northern long-eared bats were to migrate over water, movements would likely be from Martha's Vineyard to the mainland. The related little brown bat has been found to migrate from Martha's Vineyard to Cape Cod. As such, northern long-eared bats may likewise migrate to mainland hibernacula between August and September. Tracking data suggest that at least some northern-long eared bats overwinter on the island (Dowling et al. 2017). Nevertheless, given that the Lease Area is located far from shore, the exposure of northern long-eared bats is expected to be minimal. These conclusions are consistent with those determined by comprehensive risk assessments conducted for Vineyard Wind 1, which will be located northwest of Vineyard Northeast in Lease Area OCS-A 0501 (BOEM 2018; BOEM 2019).

Tricolored bats are generally thought to travel short distances (<100 km [62 mi]) between summer breeding habitat and winter hibernacula (Smith et al. 2022), and limited data exists on the distances traveled during the summer period (Fraser et al. 2012). Offshore observations of tricolored bats are rare (Solick & Newman 2021), though they have been acoustically detected and visually observed on islands and in coastal habitats (Broders et al. 2003; Stantec, 2016). One tricolored bat was opportunistically observed 103.5 km (64.3 mi) due east of Corolla, North Carolina in August 2018 (Thornton et al. 2023). This observation occurred on a survey vessel operating in the vicinity of a planned offshore wind farm (Coastal Virginia Offshore Wind [CVOW]); however, it was unknown whether the bat had flown or had stowed away on the vessel and transited from port. While there remains uncertainty on tricolored bat occurrence offshore, exposure is expected to be minimal given that the Lease Area is located far from shore, and potential impacts to tricolored bats and northern long-eared bats are unlikely.

4.3.1.3 Massachusetts and Connecticut Onshore Development Area

Forested areas in Massachusetts or Connecticut can serve as important foraging habitat for bats. Preferred foraging habitat, however, varies among species. The type of foraging habitat a bat species selects may be linked to the flight abilities, preferred diet, and echolocation capabilities of each species (Norberg and Rayner 1987). Small, maneuverable species like the northern long-eared bat and the little brown bat can forage in "cluttered" conditions, such as the forest understory or small forest gaps. Larger, faster-flying bats, such as the hoary bat (*Lasiurus cinereus*), often forage above the forest canopy or in forest gaps (Taylor 2006). Some species, such as the little brown bat and the tricolored bat, regularly forage over water sources. The big brown bat, eastern red bat, and hoary bat are also known to use waterways as foraging areas as well as travel corridors.

Forested habitats provide roosting areas for both migratory and non-migratory species. Some species roost solely in the foliage of trees, while others select dead or dying trees where they roost in peeling bark or inside crevices. Some species may select forest interior sites, while others prefer edge habitats. All bat species present in Massachusetts and Connecticut are known to utilize various types of forested areas during summer for foraging and roosting.

Caves and mines are a key habitat for bats. These locations serve as winter hibernacula, fall swarm locations (i.e., areas where mating takes place in the fall months), and summer roosting locations for some individuals. Four main factors are understood to determine whether a cave, mine, or anthropogenic structure (e.g., cellar) is suitable for use as a hibernaculum: (1) low levels of disturbance, (2) suitable temperature, (3) suitable humidity, and (4) suitable airflow (Tuttle and Taylor 1998).

Potential disturbance of bat habitat by the construction and installation of Vineyard Northeast's onshore facilities is primarily limited to small areas around onshore substation sites, POIs, and onshore cable routes, although most of the onshore facilities are in, or adjacent to, disturbed areas (see Section 3 Onshore in Appendix II-C). While any treed or forested areas adjacent to or in the footprint of the onshore facilities may provide limited roosting or foraging habitat for bats, including northern long-eared bats and tricolored bats, the sites do not provide cave habitat and do not possess the necessary features for a hibernaculum. This assessment is confirmed by the Natural Heritage Species Report and online database (MA NHESP 2023), which does not show any known roosting or hibernaculum sites for northern long-eared bats in Westport, Fall River, or Somerset (where the onshore facilities are located) or surrounding area (as of January 2023). The current Connecticut Department of Energy and Environmental Protection map documents summer occurrence in the Town of Montville, but no known hibernacula in the vicinity (CT DEEP 2023).

The onshore cable routes are generally not expected to provide important habitat for bats because they primarily follow previously disturbed corridors. The onshore cable routes are primarily co-located within public roadway layouts or existing utility rights-of-way (ROWs) (i.e., within previously disturbed areas) to minimize disturbance to bat habitat. Approximately 37-90% of the habitat adjacent to the onshore cable routes is developed (depending on route option), with the remaining habitat primarily either forested areas or wetlands (see Appendix II-C). Similarly, the landfall sites are all in paved parking areas and are not expected to provide important habitat for bats. In summary, bat exposure to onshore activities is expected to be minimal to low.

Federally Listed Species

As discussed above, the assessment of the Onshore Development Area is primarily limited to the onshore substation sites, POIs, and onshore cable routes, which are generally co-located with developed or disturbed habitat. While any treed or forested areas adjacent to or in the footprint of the onshore facilities in both Massachusetts and Connecticut have the potential to serve as roosting or foraging habitat for bats, including northern long-eared bats and tricolored bats, the sites do not provide cave habitat and do not possess the necessary features for a hibernaculum. In summary, exposure is expected to be minimal.

4.3.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect bats during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.3-3. Except for vessel activity during construction, activities in the OECC are not considered an IPF for bats and no impact analysis was conducted. Offshore, bats may otherwise be exposed to the following IPFs: construction and maintenance vessels, the WTGs, and associated lighting. Onshore, the primary IPF is habitat modification (see Table 4.3-3). The decommissioning period IPFs that bats will be exposed to (e.g., boat activity) are expected to be similar to the construction period. Best practices available at the time of decommissioning will be discussed with BOEM and the USFWS to avoid and minimize potential impacts to bats.

Table 4.3-3 Impact Producing Factors for Bats

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Presence of Structures	•	•	•
Ground Disturbance and Habitat Modification	•		•
Artificial Light: Vessel and Structure Light	•	•	•
Vessel Activity	•	•	•
Noise	•		•

Potential effects to bats were assessed using the maximum design scenario for Vineyard Northeast's onshore and offshore facilities as described in Section 1.5.

4.3.2.1 Presence of Structures

Offshore Construction

Bats may be attracted to WTGs, ESP(s), and the booster station (if used) while these structures are under construction (BOEM 2014). Bats at onshore wind facilities have been documented as showing higher attraction and more frequent approaches to stationary WTGs (Cryan et al. 2014), but stationary objects are not generally considered a collision risk for bats because of their use of echolocation (Johnson et al. 2004; Horn et al. 2008; BOEM 2012). Overall, since there is little evidence to suggest that stationary objects pose significant risk to bats, population level risk from offshore construction activities is unlikely. This finding is consistent with BOEM's assessment of the impacts of offshore wind along the Outer Continental Shelf (OCS) (BOEM 2021).

Offshore Operations & Maintenance

The primary IPFs for bats during offshore O&M is collision with WTGs. Exposure of bats to the Lease Area is minimal to low and is expected to only occur during migration. If bats pass through the Lease Area, injury or mortality from collision with WTGs is a potential risk. Bats are not expected to regularly forage in the Lease Area but may be present during fall migration (BOEM 2012; BOEM 2019). As discussed above, the exposure of cave-hibernating bats to the Offshore Development Area would only occur on rare occasions during migration. Therefore, the population level risk to cave-hibernating bats is unlikely. This finding is consistent with BOEM's assessment in the Final Environmental Impact Statement (FEIS) for Vineyard Wind 1, which determined that cave-hibernating bats "do not typically occur" on the OCS and exposure to offshore wind activities on the OCS is "expected to be negligible, if exposure occurs at all" (BOEM 2021).

Migratory tree bats have a higher potential to pass through the Lease Area, but overall, a small number of bats are expected in the Lease Area given its distance from shore (BOEM 2014). While there is evidence of bats visiting WTGs close to shore (4 to 7 km [2.5 to 4.3 mi]) in the Baltic Sea (enclosed by land; Ahlén et al. 2009, Rydell & Wickman 2015), the Lease Area is far offshore (at its closest point, the Lease Area is approximately 46 km (29 mi) from Nantucket) and there are no nearby landing areas to the south (e.g., islands), which might otherwise increase the presence of bats in the Lease Area. Therefore, the population level risk is unlikely. This finding is consistent with BOEM's assessment in the FEIS for Vineyard Wind 1, in which BOEM anticipated "very few individuals would be expected to encounter operating WTGs or other structures associated with future offshore wind development," that the "likelihood of collisions is low," and that there would be "non- measurable negligible impacts" (BOEM 2021).

In summary, bats have minimal to low exposure to the Lease Area because the Lease Area is located far offshore, and bat exposure is likely limited to a few individuals of migrating tree bats in the fall. Risks will be further minimized through mitigation measures. For these reasons, population level risk is unlikely. Nonetheless, the Proponent will document any dead or injured bats found on vessels and structures during construction, O&M, and decommissioning.

4.3.2.2 Ground Disturbance and Habitat Modification

Ground disturbance and habitat modification that have the potential to affect bats are limited to construction of Vineyard Northeast components within the Onshore Development Area. Periodic maintenance will likely occur within the fenced perimeter of the onshore substation site, but these activities are not expected to affect bat habitat and will not be discussed further. During decommissioning, potential impacts are expected to be similar to construction. Activities in the Lease Area will not be discussed in this section.

Onshore Construction

In general, potential impacts to bats onshore are primarily limited to the onshore substation sites, which have the potential to serve as roosting or foraging habitat for bats, including northern long-eared bats and tricolored bats. However, no known northern long-eared bat maternity roost trees or hibernaculum are located in the areas surrounding the Onshore Development Area (CT DEEP 2019; MA NHESP 2022).

Construction of each onshore substation will include site preparation, installation of the substation equipment and cables, commissioning, and site clean-up and restoration. Temporary fencing and a security gate will be installed around the perimeter of the construction area and temporary erosion control measures will be deployed. Up to approximately 0.06 km^2 (15 acres) of tree clearing and ground disturbance from grading, excavation, and trenching is anticipated for each onshore substation site.

The onshore cable routes are expected to be located primarily within public roadway layouts, which will avoid most impacts to bat habitat. Certain onshore cable routes also utilize existing utility ROWs. Depending on the final onshore cable alignment, minimal tree trimming and/or tree clearing may be needed where the onshore routes follow existing roadway layouts.[40] Tree trimming, tree clearing, and/or grading may be required to facilitate onshore cable installation where the onshore cable routes follow existing utility ROWs, in limited areas where the routes depart from the public roadway layout (particularly near complex crossings), at trenchless crossing staging areas, and at the POIs. The work, however, will be confined to as narrow a

[40] Subject to further engineering and consultations with local and state agencies (e.g., Massachusetts Department of Transportation [MassDOT]).

corridor as possible. Overall, the onshore cable routes primarily follow previously disturbed corridors, thereby minimizing any potential impacts to bat habitat. The potential landfall sites do not provide suitable roosting habitat, so land disturbance and habitat alteration are not expected to impact bats.

In most instances, underground trenchless crossing methods are expected to be used where the onshore cable routes traverse unique features such as busy roadways, railroads, wetlands, and waterbodies to avoid impacts to those features. However, the northern crossing of the Taunton River [redacted] (see Figure 3.8-1 in COP Volume I) may require a segment of overhead transmission lines.[41] At this time, it is envisioned that up to two lattice-type towers would be located [redacted] and up to two lattice-type towers would be located [redacted] to support the overhead transmission lines. Additional details regarding onshore cable installation and specialty cable crossing techniques are described in Section 3.8.3 of COP Volume I.

Tree clearing at any of the potential onshore substation sites, along the onshore cable routes, or at the POIs (if needed) could result in permanent loss of potentially suitable summer roosting habitat. However, given the small area being cleared in relation to locally available habitat, habitat loss is unlikely to affect bat populations, including the northern long-eared bat and tricolored bat. This finding is consistent with BOEM's assessment in the Vineyard Wind 1 FEIS (BOEM 2021) and the Biological Assessment (BA) (BOEM 2019). Furthermore, since the Onshore Development Area is co-located with existing development, risks to bat population are unlikely.

During the permitting process, the Proponent will consult with MassWildlife and CT DEEP to request the most current information on known northern long-eared bat and tricolored bat maternity roosts and hibernacula. In consultation with state and federal regulators, the Proponent will adhere to conservation strategies for the northern long-eared bat and tricolored bat, which will likely be similar to those implemented for other endangered bats, such as the Indiana bat. The conservation strategies could include time of year restrictions for tree clearing, if needed, to avoid or minimize impacts to bats and/or conducting bat surveys pursuant to current USFWS protocols to determine whether northern long-eared bats or tricolored bats are present in the areas proposed to be cleared.

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41 As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

4.3.2.3 Artificial Light: Vessel and Structure Light

<u>Offshore Development Area</u>

During construction there will be lighting of vessels and installation equipment, but as discussed above, bats are unlikely to collide with stationary or slow-moving objects and construction lighting is not expected to be an individual IPF for bats. The need for lighting during construction of Vineyard Northeast is expected to be minimal and best practices will be considered, when necessary, to limit lighting where practicable.

To aid marine navigation, the WTGs, ESP(s), booster station (if used), and their foundations will be equipped with marine navigation lighting, marking, and signaling in accordance with United States Coast Guard (USCG) and BOEM guidance. Each structure will include yellow flashing lights that are visible in all directions at a distance of 3.7 to 9.5 km (2 to 5 nautical miles [NM]). The intensity of the lights will depend on the location of the structure within the Lease Area. All WTGs will include an aviation obstruction lighting system in compliance with Federal Aviation Administration (FAA) and/or BOEM guidance. Based on current guidance, the aviation obstruction lighting system will consist of two synchronized red flashing lights placed on the nacelle of each WTG. If the WTGs' total tip height is 213.36 m (699 ft) or higher, there will be at least three additional low intensity flashing red lights on the tower approximately midway between the top of the nacelle and sea level. If the height of the ESP(s) or booster station exceeds 60.96 m (200 ft) above Mean Sea Level (MSL) or any obstruction standard contained in 14 CFR Part 77, they will similarly include an aviation obstruction lighting system in compliance with FAA and/or BOEM guidelines.

Importantly, the Proponent will use an Aircraft Detection Lighting System (ADLS) or similar system that automatically activates all aviation obstruction lights when aircraft approach the structures, subject to BOEM approval. The use of an ADLS would substantially reduce the amount of time that the aviation obstruction lights are illuminated to approximately 1.25 hours/year (see Appendix II-I).

Several studies have investigated the impacts of different lighting methods on attraction and avoidance behaviors in bats. Red aviation lights on top of WTG towers have been considered to be a potential source of interest to bats; however, studies have shown that mortality at land-based towers with aviation lights is similar to or less than mortality at towers without aviation lights (Arnett et al. 2008; Bennett and Hale 2014). Bennett and Hale (2014) reported higher eastern red bat fatalities at unlit WTGs in comparison with those lit with red aviation lights. These studies suggest that the type of lighting that will be used by Vineyard Northeast is not expected to increase potential collisions of bats with WTGs. Bats may be attracted to maintenance vessels servicing WTGs, ESP(s), the booster station (if used), or offshore export cables, particularly if insects are drawn to the lights of the vessels; however, bats are not expected to collide with the vessels.

In summary, lighting is not expected to increase collision risk during construction or operation. The lighting during construction will be temporary and lighting during O&M is expected to be minimal and adhere to federal guidance.

Onshore Development Area

During construction, temporary lighting may be required at work areas. The Onshore Development Area is primarily co-located with existing development. Any lighting required during onshore construction will be temporary and localized to the work area and is not expected to be a significant increase over the existing residential and commercial lighting in the area.

Lighting during O&M is expected to be minimal and will primarily occur at the onshore substations, which will have outdoor lights installed. The majority of lights will only be used on an as-needed basis (e.g., if equipment inspection is needed at night) and when necessary for work crew safety. For security reasons, a few lights at the onshore substations will typically be illuminated on dusk–to-dawn sensors and a few lights will likely be controlled by motion-sensors. Outdoor lighting at the onshore substation sites will typically be equipped with light shields to prevent light from encroaching into adjacent areas. The Proponent will ensure that the lighting scheme complies with local requirements.

While lighting can influence bat foraging strategies and prey availability (Cravens et al. 2018), the limited onshore lighting, both during construction and O&M, is unlikely to affect local bat populations due to the temporary and limited nature of the lighting.

In summary, the majority of artificial lighting will be used in localized areas for specific scenarios and will be in use for short time periods and is unlikely to present a risk to bat populations. Where practicable, Vineyard Northeast will down-shield lighting or use down-lighting to minimize the effects of artificial light on bats.

4.3.2.4 Vessel Activity

Bats may be attracted to construction vessels, particularly if insects are drawn to the lights of the vessels (BOEM 2014), and bats have been recorded occasionally roosting on vessels at sea (Thompson et al. 2015), but stationary or slow-moving objects are not generally considered a collision risk for bats because of their use of echolocation (Johnson et al. 2004; Horn et al. 2008; BOEM 2012). Overall, since there is little evidence to suggest that stationary or slow-moving objects pose significant risk to bats, population level risk from vessel activities is unlikely.

4.3.2.5 Noise

This IPF section addresses sound generated during activities conducted both onshore and offshore, including pile driving and secondary noise sources, and the potential effect on bats.

Offshore Development Area

The primary source of noise impacts to bats is likely by pile-driving activities during construction, but these will be temporary and highly localized (see Appendix II-E). While bats present offshore may respond to noise from turbines and maintenance vessels, any avoidance behavior is unlikely to lead to habitat loss, as the offshore marine environment is unlikely to support important foraging habitat. Studies suggest that bats may be less sensitive to temporary or permanent hearing loss due to exposure to intense sounds (Simmons et al. 2016). The limited exposure of bats to the Lease Area will further reduce any potential impacts of pile driving and O&M activities. In considering the impacts of offshore wind on bats along the OCS, BOEM determined "no individual fitness or population-level impacts would be expected to occur as a result of onshore or offshore noise associated with future offshore wind development" (BOEM 2021). In summary, noise generated at the Offshore Development Area is unlikely to present a risk to bat populations due to its limited duration.

Onshore Development Area

As discussed above, little bat habitat is expected to be disturbed by onshore activities, due to the co-locations with existing development. Studies have suggested anthropogenic noise, including traffic, may decrease foraging success and overall activity in some bat species (Schaub et al. 2008; Siemers and Schaub 2010; Bunkley and Barber 2015). While noise generated during construction could potentially cause avoidance behaviors leading to temporary displacement, this would not be expected to result in significant impacts, as frequent roost switching is common among many bat species (Willis and Brigham 2004; Hann et al. 2017). These activities would also be temporary and highly localized (BOEM 2021). In summary, noise generated at the Onshore Development Area is unlikely to present a risk to bat populations due to its limited duration.

4.3.2.6 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to bats during Vineyard Northeast are summarized below:

Offshore

- The location of the Vineyard Northeast WTGs far offshore avoids exposure of bats.
- The Proponent will reduce lighting to the extent practicable.
- The Proponent will use an ADLS or similar system that automatically activates all aviation obstruction lights when aircraft approach the Lease Area, subject to BOEM approval.
- The Proponent will document any dead or injured bats found on vessels and structures during construction, O&M, and decommissioning.

Onshore

- The onshore cable routes will be installed primarily in public roadway layouts and utility ROWs to avoid undisturbed habitat.
- The onshore cables are expected to be installed primarily underground.
- Ground disturbances will be temporary and disturbed areas will be restored.
- Where practicable, the Proponent will down-shield lighting or use down-lighting to minimize the effects of artificial light on bats.
- The Proponent will consult with state and local agencies regarding the timing of onshore construction activities. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.
- In consultation with state and federal regulators, the Proponent will adhere to conservation strategies for the northern long-eared bat.

4.4 Coastal Habitats

This section addresses the potential impacts of Vineyard Northeast on coastal habitats in the Onshore Development Area and Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to coastal habitats during the construction, operation, and decommissioning of Vineyard Northeast.

Benthic resources are discussed in greater detail in Section 4.5, finfish and invertebrates are discussed in Section 4.6, and terrestrial habitat, wildlife, and wetlands (including a description of species at the landfall sites) are discussed in Section 4.1.

4.4.1 Description of Affected Environment

Coastal habitat is defined as the affected area out to the three nautical mile limit (5.5. kilometer [km]), which includes the landfall sites in Massachusetts and Connecticut and portions of the Massachusetts Offshore Export Cable Corridor (OECC) and Connecticut OECC. This section presents an overview of coastal habitats within the Massachusetts OECC, Connecticut OECC, and marine portion of the landfall sites. More details on the coastal habitats within the Onshore Development Area (including at the terrestrial portion of the landfall sites and along onshore cable routes and associated waterbody crossings within the coastal zone) are included in Section 4.1.

As described further in Section 5 of Appendix II-B (the Marine Site Investigation Report), marine habitat boundaries are identified using survey data, including multibeam bathymetry, backscatter, side scan sonar, underwater video transects, and benthic grab samples.

4.4.1.1 Massachusetts OECC

The Massachusetts OECC travels from the northernmost tip of Lease Area OCS-A 0522 (the "Lease Area") along the northeastern edge of the Massachusetts Wind Energy Area (MA WEA) and Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) and then heads across Buzzards Bay towards a landfall site in Westport, Massachusetts (see Figure 4.4-1). The Massachusetts OECC is typically 720 meters (m) (2,362 feet [ft]) wide. Where the Massachusetts OECC approaches the northern border of Lease Area OCS-A 0501, it widens to approximately 1,891 m (6,204 ft) to enable high voltage alternating current (HVAC) offshore export cables (if used) to connect to a booster station in Lease Area OCS-A 0534 (see Section 3.4 of COP Volume I). The Massachusetts OECC is also wider at expected cable crossings to allow the cables to cross existing cables perpendicularly and to provide flexibility for the installation process, which is more complex at cable crossings.

As described further in Section 2.1.3 of Appendix II-B, surficial site conditions along the route are described using kilometer posts (KPs) along the centerline of the OECC. Seafloor sediment compositions vary along the Massachusetts OECC. Sediment composition along the Massachusetts OECC mainly consists of sand with localized areas of silt/fines and gravel/coarse materials. The coarsest materials are found nearshore and at/around submerged moraines.

4.4.1.2 Connecticut OECC

The Connecticut OECC travels from the southwestern tip of Lease Area OCS-A 0522 along the southwestern edge of the MA WEA and then heads between Block Island and the tip of Long Island towards potential landfall sites near New London, Connecticut (see Figure 4.4-2). As the Connecticut OECC approaches shore, it splits into three variations to connect to three potential landfall sites. The "Eastern Point Beach Approach" of the Connecticut OECC connects to the Eastern Point Beach Landfall Site, the "Ocean Beach Approach" connects to the Ocean Beach Landfall Site, and the "Niantic Beach Approach" connects to the Niantic Beach Landfall Site (see Figure 4.4-2). The Connecticut OECC is typically 720 m (2,362 ft) wide, but is wider at expected cable crossings to enable the cables to cross perpendicularly and to provide flexibility during installation.

As described further in Section 2.1.4.1 of Appendix II-B, surficial sediment conditions vary along the Connecticut OECC. Sediment composition along the Connecticut OECC mainly consists of sand with localized areas of silt/fines and gravel/coarse materials. The coarsest materials are found nearshore, at/around submerged moraines, and in the region known as the Race (Harbor Hill Moraine that connects Orient Point and Fishers Island).

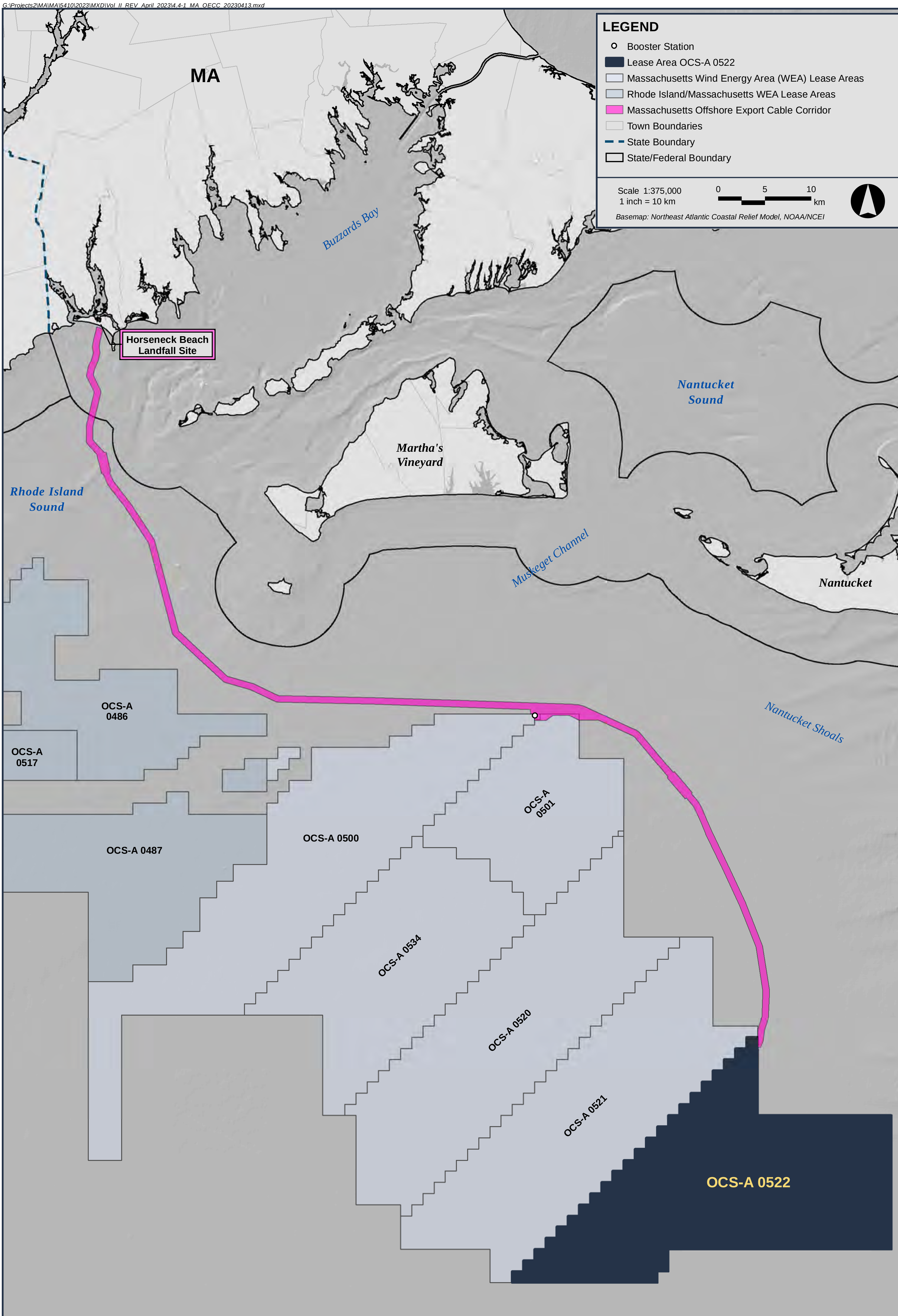

Figure 4.4-1
Massachusetts OECC

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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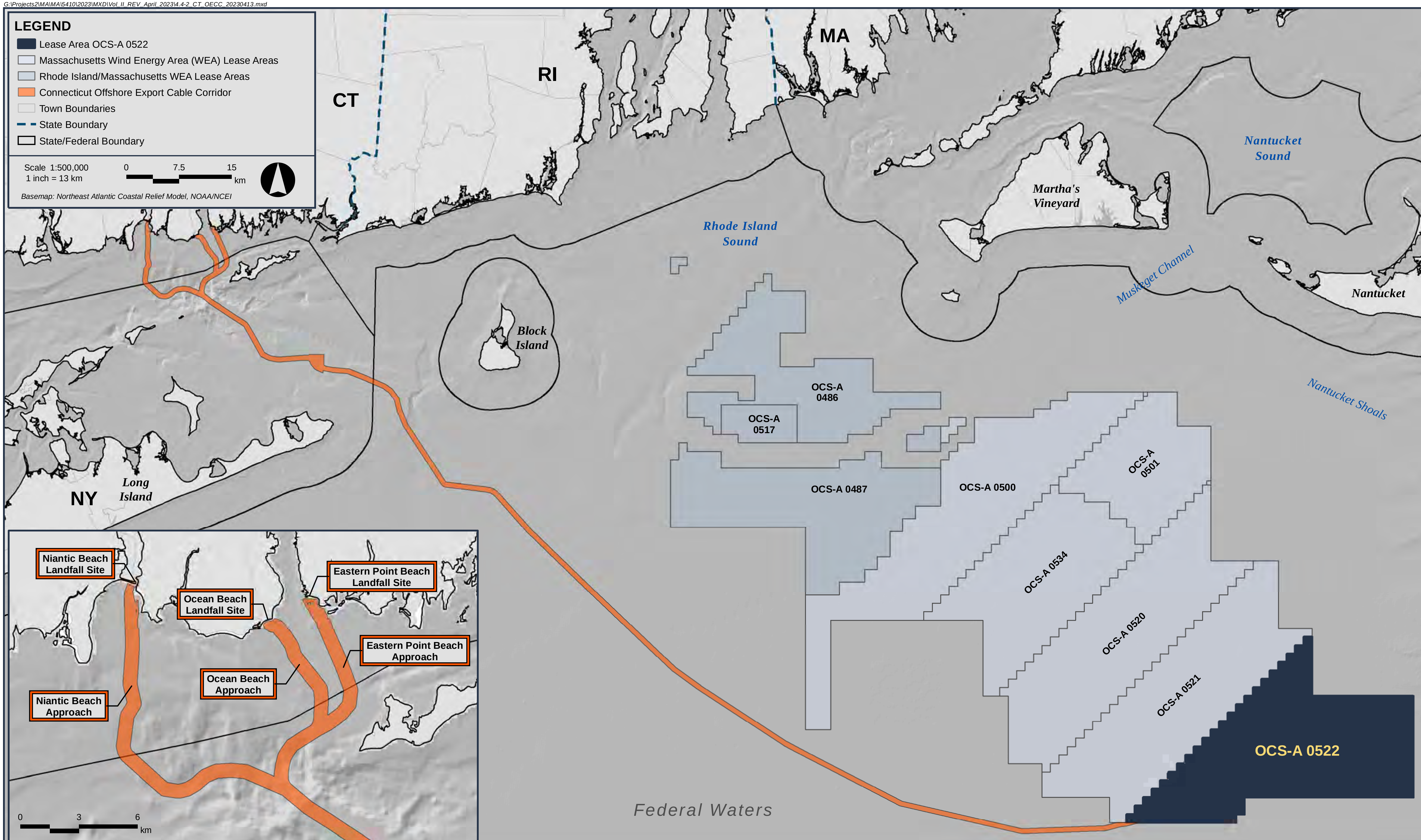

Figure 4.4-2
Connecticut OECC

VINEYARD NORTHEAST
VINEYARD OFFSHORE

4.4.1.3 Massachusetts Landfall Site

Offshore export cables installed within the Massachusetts OECC will transition onshore at the Horseneck Beach Landfall Site (see Figure 4.4-1). The Horseneck Beach Landfall Site is located in a portion of a paved parking area within Horseneck Beach State Reservation, a state-owned facility in Westport, Massachusetts.

The 2021 Massachusetts Ocean Management Plan (Massachusetts Coastal Zone Management [MA CZM] 2021) does not include any mapped eelgrass (*Zostera marina*) at the Horseneck Beach Landfall Site. No eelgrass was identified in any of the video transects or grab samples within the Massachusetts OECC during survey work.

4.4.1.4 Connecticut Landfall Sites

Offshore export cables installed within the Connecticut OECC will transition onshore at one of the following landfall sites shown on Figure 4.4-2:

- **Ocean Beach Landfall Site:** The Ocean Beach Landfall Site is located in a portion of a paved parking area within Ocean Beach Park in New London, Connecticut. Ocean Beach Park is a public recreation facility owned by the City of New London. The landfall site is located near the mouth of the Thames River.

- **Eastern Point Beach Landfall Site:** The Eastern Point Beach Landfall Site is located in a portion of a paved parking area on Eastern Point in Groton, Connecticut. The beach, which is located near the mouth of the Thames River, is managed by the City of Groton's Parks and Recreation Department.

- **Niantic Beach Landfall Site:** The Niantic Beach Landfall Site is located in a paved parking area at Niantic Beach in East Lyme, Connecticut. The landfall site is near the mouth of the Niantic River. The town-managed beach includes a boardwalk and bathhouse.

The Long Island Sound Blue Plan (CT DEEP 2019) includes mapped submerged aquatic vegetation (i.e., eelgrass) near the Connecticut landfall sites. Eelgrass was observed on grab camera and video transect footage at all three Connecticut landfall sites and coincides with mapped areas. Eelgrass was observed to be the densest at the Eastern Point Beach Landfall Site, and eelgrass beds were also detected at the Niantic Beach Landfall Site. Eelgrass was less common at the Ocean Beach Landfall Site, with occasional eelgrass plants in low concentrations identified by video. For further information on eelgrass, see Section 5 of Appendix II-B.

4.4.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect coastal habitats during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.4-1.

Table 4.4-1 Impact Producing Factors for Coastal Habitats

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Seafloor Disturbance and Habitat Modification	•	•	•
Ground Disturbance and Habitat Modification	•	•	•

Potential effects to coastal habitats resources were assessed using the maximum design scenario for Vineyard Northeast's offshore and onshore facilities as described in Section 1.5.

4.4.2.1 Seafloor Disturbance and Habitat Modification

As described further in Section 2.8 of COP Volume I, the Massachusetts OECC and Connecticut OECC were sited to avoid or minimize potential impacts to sensitive habitats and resources to the extent possible. Throughout the OECC routing process, the Proponent consulted with numerous federal and state agencies, including the Bureau of Ocean Energy Management (BOEM), National Marine Fisheries Service (NMFS) (on several occasions), United States Army Corps of Engineers (USACE), United States Coast Guard (USCG), the Department of Homeland Security (DHS), and the Connecticut Department of Energy and Environmental Protection (CT DEEP), as well as stakeholders (including fishermen). Based on feedback obtained through the OECC routing process, the Proponent refined the OECCs and consolidated the offshore export cables with other developers' proposed cables to the extent feasible. Further, the Proponent will avoid identified areas of eelgrass near the Connecticut landfall sites to the extent feasible.

Installation of offshore export cables is described in detail in Section 3.5 of COP Volume I and summarized here. Prior to cable installation, the offshore export cable alignments may require boulder clearance and sand bedform dredging. Following those activities, pre-lay grapnel runs and pre-lay surveys will be performed to confirm that the cable alignments are suitable for installation. The offshore cables will then be buried beneath the stable seafloor at a target depth of 1.5 to 2.5 m (5 to 8 ft)[42] likely using jetting techniques or a mechanical plow.

The Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route. While every effort will be made to achieve sufficient burial, a limited portion of the offshore cables may require cable protection (rocks, rock bags, concrete mattresses, half-shell pipes, or similar) if a sufficient burial depth cannot be achieved. Cable protection may also be used where the cables need to cross other infrastructure (e.g., existing cables, pipelines, etc.), to secure the cable entry protection system in place, or where a cable splice requires protection. The Proponent will evaluate the feasibility of using nature-inclusive cable protection designs, which can include adding an additional layer of larger rock to provide larger crevices, using methods that can be easily relocated with minimal disturbance during cable repairs (e.g., rock bags with lifting points), using mattresses with specially-designed concrete blocks that create additional nooks and crannies, and using mattresses with polyethylene fronds. The maximum potential seafloor disturbance from offshore export cable installation (including pre-installation activities and cable protection) is provided in Table 3.5-1 in COP Volume I (note the values in Table 3.5-1 are for state and federal waters).

The Proponent anticipates that the offshore export cables will include a monitoring system, such as distributed temperature sensing (DTS), online partial discharge (OLPD) monitoring, and/or distributed acoustic sensing (DAS), to continuously monitor the cables' status. If the cables' monitoring system detects an anomalous condition, the Proponent will carefully review the issue and determine whether an ad-hoc cable survey is necessary. Additionally, as further described in Section 4.2.3 of COP Volume I, the offshore cables will be surveyed periodically throughout the operational period. In the unlikely scenario that cable monitoring or surveys detect that a segment of cable no longer meets a sufficient burial depth, additional measures (e.g., cable reburial or application of cable protection) will be undertaken as necessary.

During decommissioning, the offshore cables and any associated cable protection may be retired in place or removed, depending on the outcome of consultations with BOEM and other appropriate regulatory agencies regarding the preferred approach to minimize environmental impacts. If the cables are removed, temporary effects from decommissioning are expected to be similar to those experienced during construction. Long-term modifications of habitat are expected to be reversed when components on the seafloor such as cable protection are removed.

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[42] Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

4.4.2.2 Ground Disturbance and Habitat Modification

Onshore construction and maintenance activities may result in temporary ground disturbance and habitat modification at the landfall sites. The Proponent will work with municipalities to develop the construction schedule and hours in accordance with local ordinances. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day. Certain activities cannot stop once they are initiated, such as conduit pull-in for the horizontal directional drilling (HDD) work, which may extend work in some circumstances. Disturbed ground and/or infrastructure will be restored to existing conditions following completion.

As further detailed in Section 3.7.3 of COP Volume I, at each landfall site, the offshore export cables are expected to transition onshore using HDD. HDD is a trenchless installation method that avoids or minimizes impacts to the beach, intertidal zone, and nearshore areas and achieves a burial significantly deeper than any expected erosion. HDD at the landfall sites will require a staging area to be located in a parking lot or previously disturbed area. Further details regarding dimensions and anticipated temporary disturbances associated with the approach pit, exit pit, and staging areas are located in Section 3.7.3 of COP Volume I. Although not anticipated, if detailed engineering for the Connecticut landfall sites determines that HDD is technically infeasible, offshore open trenching may be used to bring the offshore export cables onshore. While not anticipated, if open trenching is utilized, a temporary, three-sided cofferdam will be installed and a trench for the cable conduits will be excavated within the cofferdam.

HDD operations will use bentonite or other non-hazardous drilling fluid beneath the coastal habitats that are seaward of the HDD entry point. Crews are trained to closely monitor both the position of the drill head and the drilling fluid pressure to reduce the risk of inadvertent releases of pressurized drilling fluid to the surface (i.e., drilling fluid seepage). The Proponent will develop an HDD Inadvertent Release Response Plan, which will describe measures to reduce the risk of an inadvertent release and the immediate corrective actions that will be taken in the unlikely event of an inadvertent release.

During O&M, periodic maintenance may be required. If onshore cable repairs are required at the landfall sites, the cables would typically be accessed through manholes installed at the transition vaults, thereby avoiding or minimizing ground disturbance.

4.4.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to coastal habitats during Vineyard Northeast are summarized below:

- The Massachusetts OECC and Connecticut OECC were sited to avoid or minimize potential impacts to sensitive habitats and resources to the extent possible. Throughout the OECC routing process, the Proponent consulted with numerous agencies and stakeholders, and, based on their feedback, consolidated the offshore export cables with other developers' proposed cables to the extent feasible.

- The Proponent will avoid identified areas of eelgrass near the Connecticut landfall sites to the extent feasible.

- At the landfall sites, HDD is expected to be used to avoid or minimize disturbance to coastal habitats.

- The Proponent will develop an HDD Inadvertent Release Response Plan, which will describe measures to reduce the risk of an inadvertent release and the immediate corrective actions that will be taken in the unlikely event of an inadvertent release.

- The offshore export, inter-array, and inter-link cables will be buried beneath the stable seafloor at a target depth of 1.5 to 2.5 m (5 to 8 ft)[43] to minimize impacts to coastal habitats.

- The Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route. The Proponent will evaluate the feasibility of using nature-inclusive cable protection designs.

- The Proponent anticipates that the offshore export cables will include a monitoring system to continuously monitor the cables' status.

- Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.

- For vessels other than cable laying vessels (which must maintain tension on anchor lines), where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, the use of mid-line anchor buoys will be considered (where feasible and considered safe) as a potential measure to reduce impacts from anchor line sweep.

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43 Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

4.5 Benthic Resources

This section addresses the potential impacts and benefits of Vineyard Northeast on benthic resources in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the proposed measures to avoid, minimize, and mitigate potential effects to benthic resources during the construction, operation, and decommissioning of Vineyard Northeast.

Essential Fish Habitat (EFH) is discussed in Appendix II-D, entrainment of larvae is analyzed in Appendix II-N, and electromagnetic field (EMF) modeling is presented in Appendix II-O.

4.5.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities.

This section presents a summary of benthic habitat and shellfish within the Lease Area and within and around the Massachusetts and Connecticut OECCs. This description of benthic resources is based on a review of existing literature and survey data. Surveys, datasets, studies, and literature were identified and then assessed for applicability. The most relevant data and sources for characterizing benthic resources in the affected environment include:

- Northeast Fisheries Science Center (NEFSC) multispecies bottom trawl surveys
- Northeast Area Monitoring and Assessment Program (NEAMAP) spring and fall trawl surveys
- National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Data Portal database (NOAA 2022a, 2022b)
- Massachusetts Office of Coastal Zone Management (MA CZM) and the United States Geological Survey (USGS) sediment and biological component data
- Connecticut Department of Energy and Environmental Protection (CT DEEP) seasonal trawl surveys
- Preliminary Map Products from an Ecological Characterization of Eastern Long Island Sound and Fishers Island Sound Regions: Long Island Sound Cable Fund Phase II Survey Area (Babb et al. 2021)
- Vineyard Northeast's 2019 and 2022 benthic grab and video survey data

- University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST) fisheries data including 2003–2012 regional video survey data hosted on the Northeast Ocean Data Portal (NEODP) and 2019 and 2020 drop camera surveys that included the Lease Area (Bethoney et al. 2020; Stokesbury et al. 2022)

4.5.1.1 Lease Area OCS-A 0522

Habitat within the Lease Area was evaluated using geophysical trackline data, vibracores, 38 benthic grab samples, and 25 underwater video transects collected in 2019 (RPS 2021). In June 2022, 39 benthic grab samples and 19 underwater video transects were collected within the Lease Area. Analyses of these grab samples and video transects indicate the Lease Area contains mainly Soft Bottom habitat, ranging from Very Coarse/Coarse Sand to Sandy Mud, with coarser grained material in the northeast and finer grained material in the southwest to northern tip. Benthic features include ripples and megaripples, with areas of pitted sand surrounding the shell-filled furrows. The ripples and megaripples are present in the northeast corner of the Lease Area with additional ripples occurring in relatively isolated areas east and west of the shell furrow area.

A benthic survey collected 38 successful grab samples in the Lease Area in October and November 2019. These were generally sandy, comprised of 23–99.8% sand grains (0.075–2 millimeters (mm) [0.003–0.08 inches [in]) with a mean across samples of 80%. Twenty-nine samples contained no gravel-sized particles (> 2 mm) while six samples contained < 0.2% gravel. Just three samples were comprised of 0.8–1% gravel-sized particles, with maximum sieve sizes retaining sediment for these samples of 4.75 mm (0.19 in), 9.53 mm (0.38 in), and 25.4 mm (1 in), respectively. Fine silt and clay particles (< 0.075 mm [0.003 in]) comprised < 1–77% of each sample (mean of 20%), with seven samples containing more than 50% silt and clay. The fines component may be a slight overestimate because Coastal and Marine Ecological Classification Standards (CMECS) classify silt/clay at a smaller scale (< 0.0625 mm [0.002 in]) than the lab results (< 0.075 mm [0.003 in]). All samples had CMECS classifications of fine unconsolidated substrate (coarse/very coarse sand through sandy mud), except one sample that was classified as biogenic shell rubble with fine unconsolidated substrate.

The 2022 benthic survey in the Lease Area collected 39 successful grab samples. These samples were generally sandy, comprised of 5.3-99.8% sand (0.075–2 mm [0.003–0.08 in]) with a mean across samples of 89%. Thirty samples contained no gravel-sized particles (> 2 mm [0.08 in]), while one sample contained < 0.2% gravel. Fine silt and clay particles (< 0.075 mm [0.003 in]) comprised < 1-16.7% (mean of 4%), with no samples containing more than 50% silt and clay. The finest component may be a slight overestimate because CMECS classifies silt/clay at a smaller scale (< 0.0625 mm [0.002 in]) than the lab results (< 0.075 mm [0.003 in]). All samples had CMECS classifications of fine unconsolidated substrate (coarse/very coarse sand through sandy mud), except three samples that were classified as biogenic shell rubble with fine unconsolidated substrate. Video transects conducted in 2022 also confirmed the majority of the Lease Area is soft bottom habitat.

The 2019 grab samples were also assessed for macroinvertebrate abundance. Density across the 38 benthic grab sites ranged from 24 to 1,301 individuals/m^2. In the sample with the highest density of organisms, the majority (87%) were from a single taxon, nut clams classified in the Nuculidae family. The number of unique taxa represented in each sample ranged from 5 to 28 taxa. Over half (66%) of the total number of organisms collected across the 39 samples in the Lease Area were nut clams classified in the Nuculidae family (34%) or amphipods classified in the Ampeliscidae family (32%).

In 2022, macrofaunal communities were assessed from 14 grab samples. Overall, 58 unique taxa were identified. Species richness ranged from 9-25 species with a mean of 17 species in each sample; the lowest values reported from the northeastern section of the Lease Area. Density across the 14 benthic grab samples ranged from 2,088 to 249,483 individuals/m^2. The Atlantic nut clam (*Nucula* species [sp.]) was the most abundant taxon in the Lease Area, accounting for 42% of all individuals identified, followed by the ampeliscid amphipod (*Ampelisca* sp.) and the ischyrocerid amphipod (*Erichthonius* sp.) representing 19.6% and 15.6% of all identified taxa, respectively. Despite the Atlantic nut clam (*Nucula* sp.) being the most abundant species, it was not the most widespread taxon identified. The ampeliscid amphipod (*Ampelisca* sp.) was the most widespread taxa, found in 92% of all grab samples. These three taxa represented 77.2% of all identified organisms in the Lease Area, which were all associated with soft bottom habitats. This was consistent with the CMECS classification of the 14 grab station samples (all classified as fine unconsolidated substrates).

Twenty-five underwater video transects were conducted in the Lease Area in November and December 2019. The abundance of macrofauna > 4 centimeters (cm) (2 in) was recorded via video review. Six fish, 10 invertebrates, and two types of egg cases (skate and moon snail) were observed. A total of 6,751 macrofauna were counted, 83% (5,606 individuals) of which were sand dollars (*Echinarachnius parma*) present in large numbers across several video transects (see Table 4.5-1). After sand dollars, sea star (*Asterias* sp.), crab (*Cancer* sp.), sea urchin (Echinoidea), moon snail (Naticidae), and skate (Rajidae) were the next most abundant species. Two anemones (*Actinaria*) and six sea sponges (Porifera) were observed across transects.

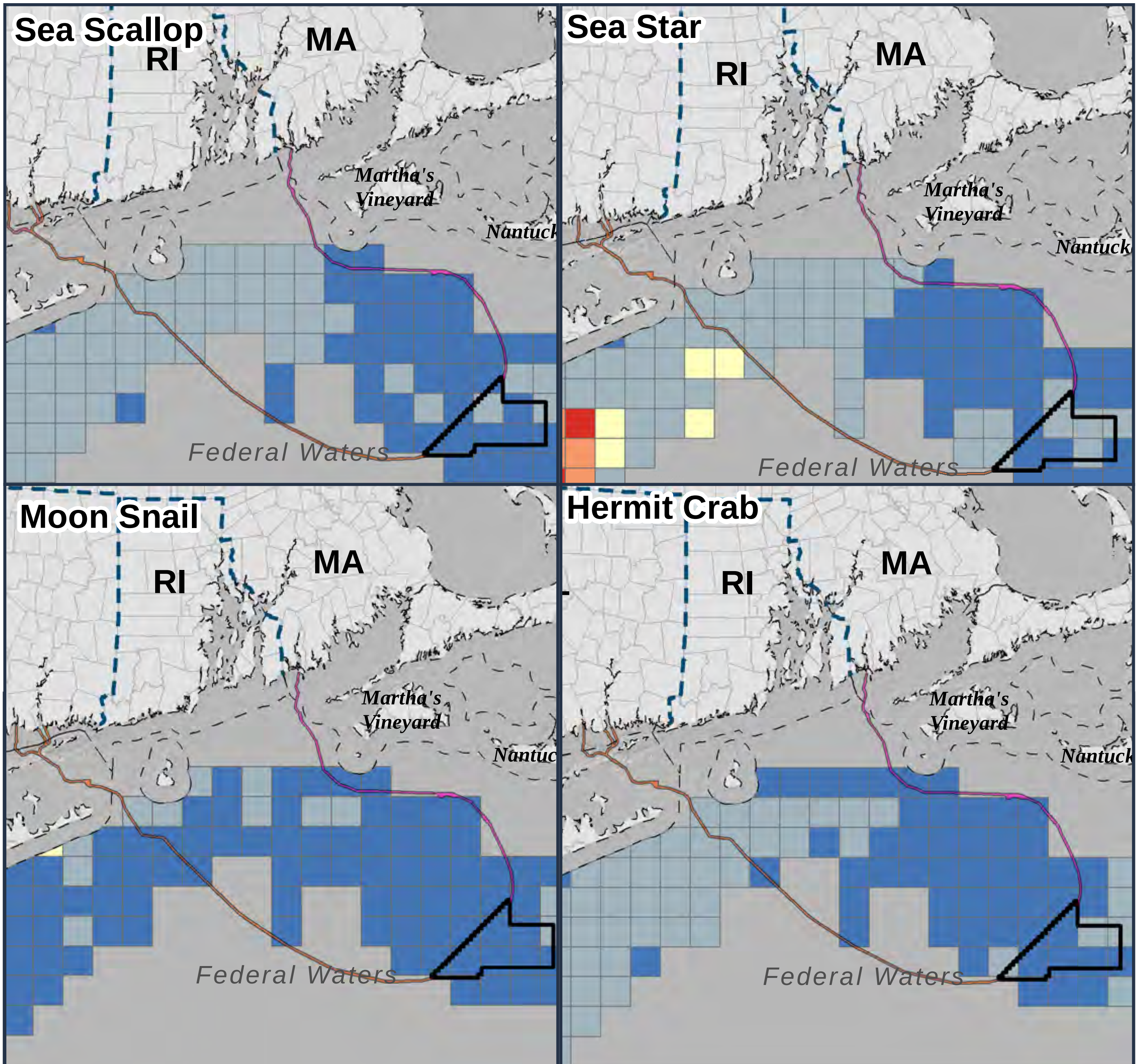
In 2022, 19 video transects were conducted to identify macrofauna and macroflora found within the Lease Area. The four most abundant invertebrate phyla identified in the video transects were Bivalvia, Crustacea, Annelida, and Echinodermata, which consisted of a total of 82.8% of all invertebrates within the Lease Area. The five most abundant vertebrate species identified were the Atlantic silverside (*Menidia menidia*), red hake (*Urophycis chuss*), silver hake (*Merluccius bilinearis*), cunner (*Tautogolabrus adspersus*), and unidentified flatfish, which comprised 53.4%, 22.47%, 7.17%, 3.96%, and 2.31%, respectively, of vertebrate observations in the Lease Area.

Table 4.5-1 Taxa Observed in Lease Area during 2019 Towed Video Camera Survey

Common Name	Lowest Taxonomic Grouping	Total Counted
American eel	*Anguilla rostrata*	1
Anemone	Actinaria	2
Cancer crab	*Cancer* sp.	105
Flounder	Pleuronectiformes	1
Hake	*Merluccius* sp.	20
Hermit crab	*Pagurus* sp.	14
Little skate	*Leucoraja erinacea*	1
Moon snail	Naticidae	86
Moon snail egg case	Naticidae egg case	2
Northern sea robin	*Prionotus* sp.	4
Sand dollar	*Echinarachnius parma*	5,606
Sea scallop	*Placopecten meagellanicus*	2
Sea sponge	Porifera	6
Sea urchin	Echinoidea	49
Sea star	*Asterias* sp.	773
Shrimp	Decapoda	9
Skate	Rajidae	34
Skate egg case	Rajidae egg case	14
Unidentified fish	Actinopterygii	22
Total		**6,751**

In addition to benthic surveys specific to offshore wind development, several other surveys have occurred in the Lease Area. The Atlantic Marine Assessment Program for Protected Species (AMAPPS) collects broad-scale data on the spatiotemporal variation of marine mammals, sea turtles, and sea birds (Palka et al. 2021), and part of this research encompasses collecting data on lower trophic level organisms such as fish, plankton, and benthic invertebrates. From February to April 2014, the survey collected 233 sediment grabs and conducted 70 beam trawl tows. Of these, eight grab samples and one beam trawl occurred in the Lease Area. Results of the eight AMAPPS benthic samples correspond with the benthic data collected in 2019 for Vineyard Northeast. Approximately 69% percent of the total macroinvertebrate abundance was dominated by nut clams (39%) and amphipods (30%).

Of the SMAST drop camera data collected in the region from 2003–2012, there were ten sampling blocks that at least partially overlapped with the Lease Area (see Figure 4.5-1). Benthic macrofaunal abundance was generally low, with sea stars exhibiting the highest abundance with presence in 60% of samples (0–24 individuals). In order of decreasing percent



LEGEND

- Lease Area OCS-A 0522
- Massachusetts OECC
- Connecticut OECC
- State/Federal Boundary

1 inch = 51 km Scale 1:2,000,000

0 40 80 km

	Sea Scallop	Sea Star	Moon Snail	Hermit Crab
Dark blue	0	0	0	0
Grey-blue	>0 - 4	0 - 24	>0 - 0.2	>0 - 0.78
Yellow	5 - 7	25 - 40	0.3	0.79 - 1.2
Orange	8 - 10	41 - 56	0.4	1.3 - 1.7
Red	11 - 32	57 - 140	0.5 - 0.8	1.8 - 6.2

Figure 4.5-1

Average Abundance of Benthic Invertebrates Observed in SMAST Video Surveys from 2003 to 2012 (SMAST 2016)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

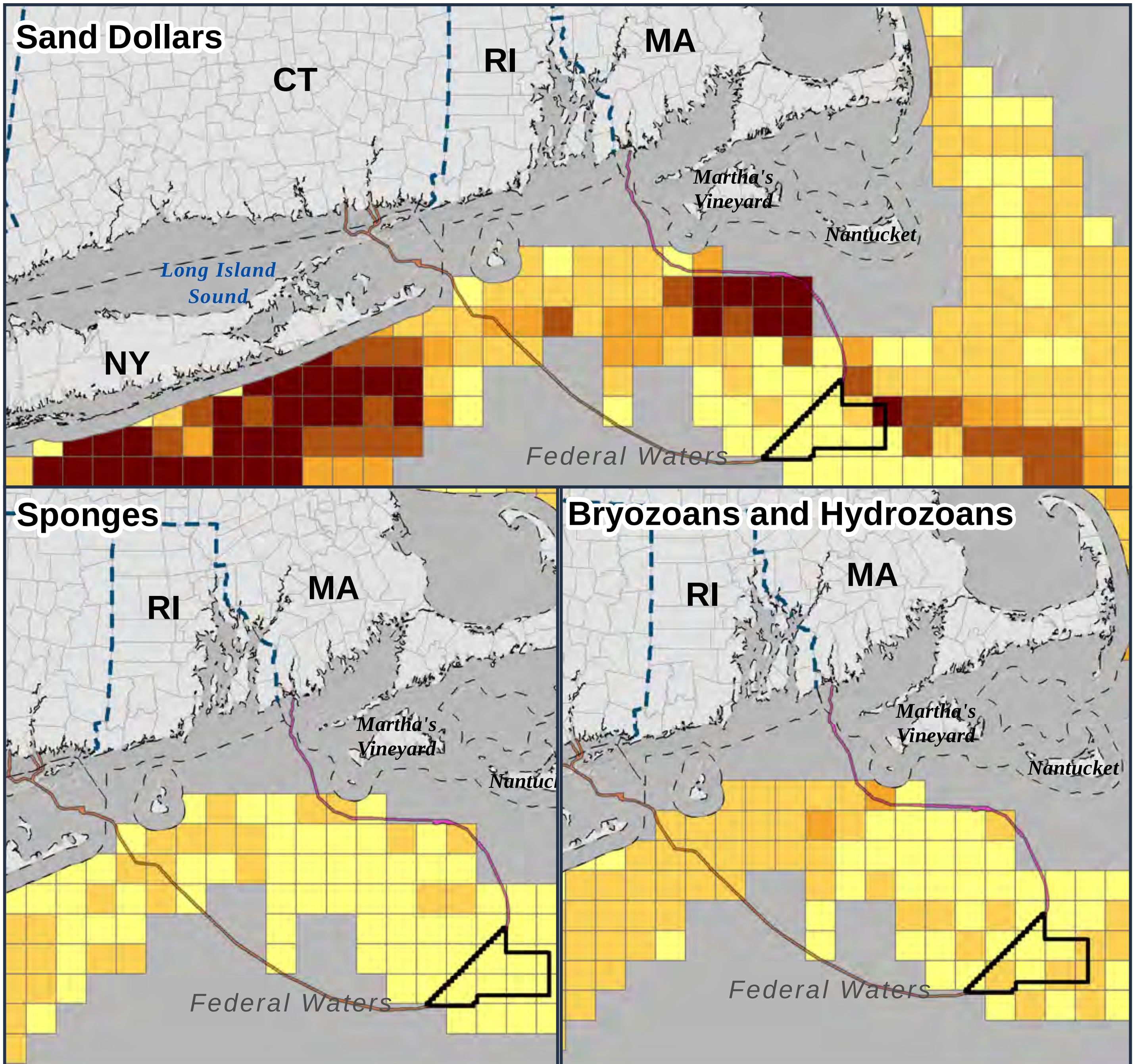
presence, hermit crabs (30%; > 0–0.78 individuals), sea scallops (20%; 0–4 individuals), and moon snails (10%; > 0–0.2 individuals) were also sampled. Forty percent of SMAST sampling blocks had sparse coverage (> 0–25%) of bryozoans and hydrozoans (see Figure 4-5-2). Sponges were not present in any Lease Area samples, and sand dollars were only present in the northeastern portion of the Lease Area with one sampling block consisting of > 0–25% sand dollar coverage and the other block with > 75–100% sand dollar coverage (see Figure 4.5-2). Results of the SMAST camera drops are discussed further in Section 4.6.

In 2019 and 2020, SMAST conducted drop camera surveys of 22 stations within the Lease Area in the summer and fall, with four quadrats of 2.3 square meters (m^2) (10.8 square feet [ft^2]) photographed at each site (Bethoney et al. 2020). In 2019, sea stars were the most abundant organism observed (141 individuals) and were seen in 10 of the 88 quadrats. Crabs (*Cancer* sp.) were seen more often, with presence in 34 of the 88 total quadrats, but were less abundant (75 individuals). Sand was the dominant and largest substrate type observed in the majority of stations, with gravel only present at five stations (Bethoney et al. 2020). In 2020, crabs had the highest number of observations (73 individuals). Other species (less than 11 individuals) include red hake, silver hake, unidentified skate, unidentified flatfish, and Atlantic sea scallop (Stokesbury et al. 2022). Sand was the only substrate type present in the 2020 surveys.

NOAA's Deep Sea Coral Data Portal database provides spatial data on the presence of living bottom occurring in waters greater than 50 meters (m) (164 feet [ft]) deep through live sampling and observational surveys, records from archived samples from research institutions and museums, and records from scientific literature (NOAA 2022a, b; Hourigan et al. 2017). One unspecified sponge was documented within the Lease Area. Other living bottom observed in the area include two observations of sea pen documented south of the Lease Area with the closest observation located 11.7 kilometers (km) (7.3 miles [mi]) away. There were also observations made of two unspecified sponges, three demosponges, and one sea pen east of the Lease Area with the closest observation located 15.8 km (9.8 mi) away (see Figure 4.5-3). However, it is important to note that the National Database for Deep Sea Corals and Sponges does not include "observations of absence." Areas which depict no observations in the database should not be interpreted as lacking for these taxa as limited areas have been surveyed for deep sea corals and sponges (NOAA 2020). Additionally, the NOAA National Centers for Coastal Ocean Science uses statistical modeling to predict areas that can support both deep-sea stony and soft corals (NOAA 2022a, b). Modeled results indicated no habitat suitability for deep-sea hard or soft coral species near the Lease Area (NROC 2009).

Lease Area Species of Commercial and Recreational Importance

Species of commercial and recreational importance were rare within the Lease Area, with only 2 individual sea scallops and 105 *Cancer* crabs observed during the towed video camera survey in 2019 (see Table 4.5-1). Within the SMAST drop camera data, sea scallops were observed in only 20% of sampling blocks at low densities (0–4 individuals; see Figure 4.5-1).



LEGEND

- Lease Area OCS-A 0522
- Massachusetts OECC
- Connecticut OECC
- State/Federal Boundary

Scale 1:2,000,000

1 inch = 51 km

0 40 80 km

SMAST: Average Percent of Samples with Sand Dollars, Sponges, and Bryozoans and Hydrozoans

- 0
- >0 - 25
- >25 - 50
- >50 - 75
- >75 - 100

Figure 4.5-2

Average Percent of Samples with Sand Dollars, Sponges, or Bryozoans and Hydrozoans in SMAST Video Surveys from 2003-2012 (SMAST 2016)

VINEYARD NORTHEAST

VINEYARD OFFSHORE

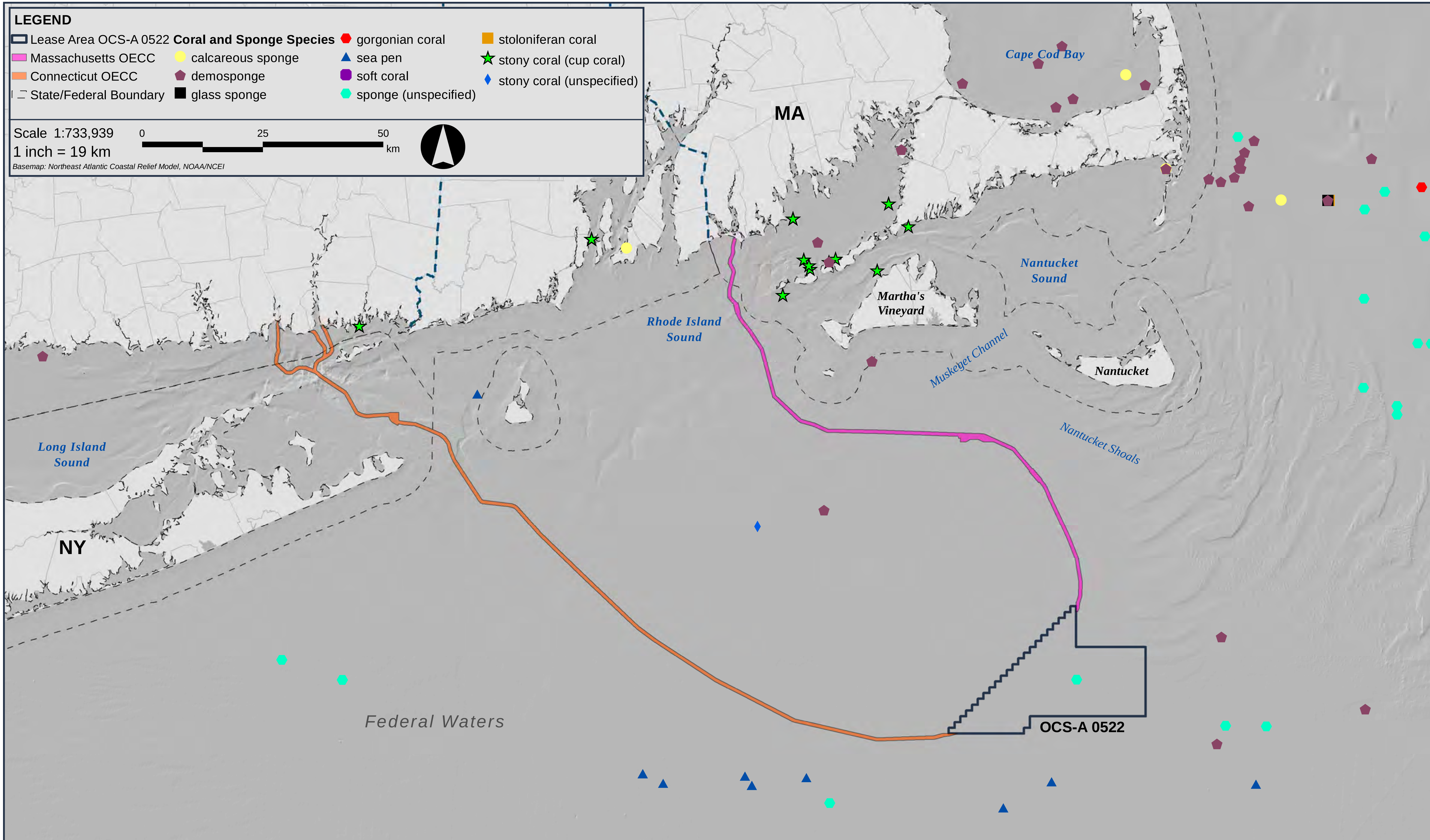


Figure 4.5-3

Locations of Observed Deep-Sea Coral and Sponge Species in the Offshore Development Area (NOAA 2022a, b)

4.5.1.2 Massachusetts OECC

Data interpretation from the 2022 field program and publicly available datasets of benthic samples (usSEABED and US Geological Survey (USGS) East-Coast Sediment Texture Database), and NOAA sonar data show a diverse array of habitat types within the Massachusetts OECC. Soft sediments are dominant in the eastern portion of the OECC nearest to the Lease Area, with areas of coarser gravels from pebble/granule size to boulders present in the area south of Southwest Shoal. Soft sediments become more prominent north of Southwest Shoal until close to landfall, though patches of Gravelly Sand and Sandy Gravel are also present. Localized areas containing boulders and boulder fields can also be found within this range. Benthic features present include rippled scour depressions scattered throughout the corridor, though most common in the eastern and central portions of the route.

The MA CZM and the USGS collaborated in collecting data on the seafloor, which includes sediment grab samples, video transects, and bottom photographs collected within Buzzards Bay and Vineyard Sound in 2010 (Ackerman et al. 2015; Huntley et al. 2018). Between both surveys, a total of 144 sampled sites overlapped the area within 8 km (5 mi) of the Massachusetts OECC. Surficial sediment samples collected were identified further to sediment classifications which included gravel, gravelly sediment, sand, sandy silt, silt, and silty sand (see Figure 4.5-4). Out of the 144 sampled sites, 77% (n=111) were composed of sand or finer while 23% (n=33) were composed of gravel or gravelly sediment.

In addition to sediment samples, seafloor photographs from the MA CZM and USGS survey were classified according to CMECS to identify the biotic component. A total of 484 benthic images overlapped the area within 8 km (5 mi) of the Massachusetts OECC. Figure 4.5-5 divides this data into four different panes representing CMECS biotic subclasses of Soft Sediment Fauna, Attached Fauna, Faunal Bed, and Inferred Fauna. Inferred Fauna was not further broken down in this dataset into CMECS biotic groups within Inferred Fauna (groups egg masses, fecal mounds, pelletized/fluid surface layer, and tracks/trails) and therefore was the most dominant biotic group. Across all benthic images in this analysis, biotic groups within the Massachusetts OECC area were classified as inferred fauna (33%), burrowing fauna (24%), tunnelling megafauna (10%), and no biotic component (14%). The other biological group classifications consisted of filamentous algal bed (7%), attached bryozoans (4%), attached sponges (3%), barnacles (2%), tube-building fauna (1%), and attached anemones (1%). Biological group classifications with only one benthic image near the Massachusetts OECC included attached hydroids, crustose coralline algal bed, mobile mollusks on hard or mixed substrates, and tracks/trails (see Figure 4.5-5).

In June 2022, 117 grab samples were collected to analyze the sediment composition of the Massachusetts OECC. These samples were comprised of 37.4-100% sand (0.075–2 mm [0.003–0.08 in]) with a mean across samples of 91.8%. Forty-three samples contained no gravel-sized particles (> 2 mm [0.08 in]), while 22 samples contained > 5% gravel. Nine samples contained > 30% gravel and had a maximum sieve size of 85.2 mm (3.35 in). Fine silt and clay particles

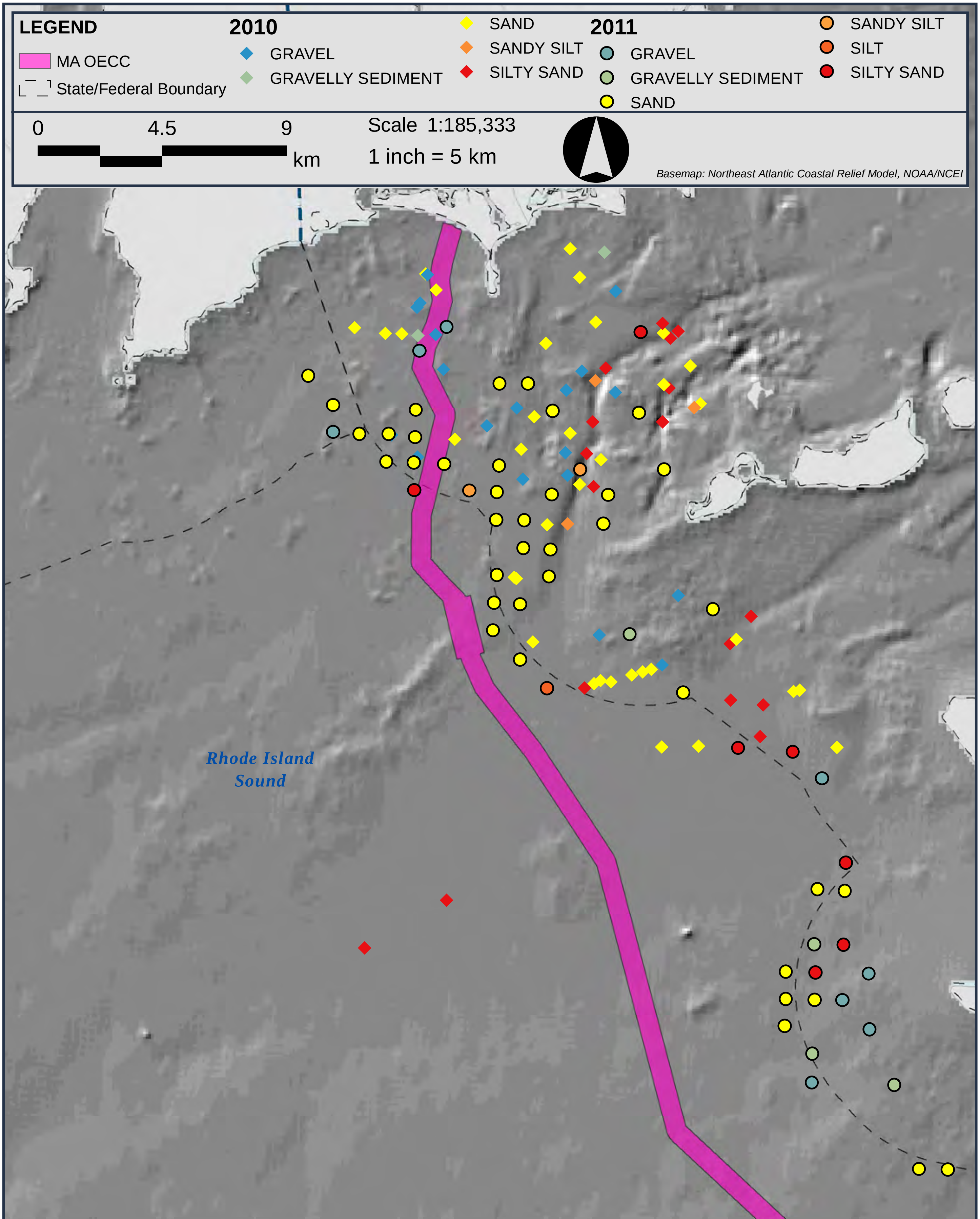


Figure 4.5-4
2010 and 2011 Sediment Classifications from the Massachusetts Office of Coastal Zone Management and the United States Geological Survey

VINEYARD NORTHEAST
VINEYARD OFFSHORE

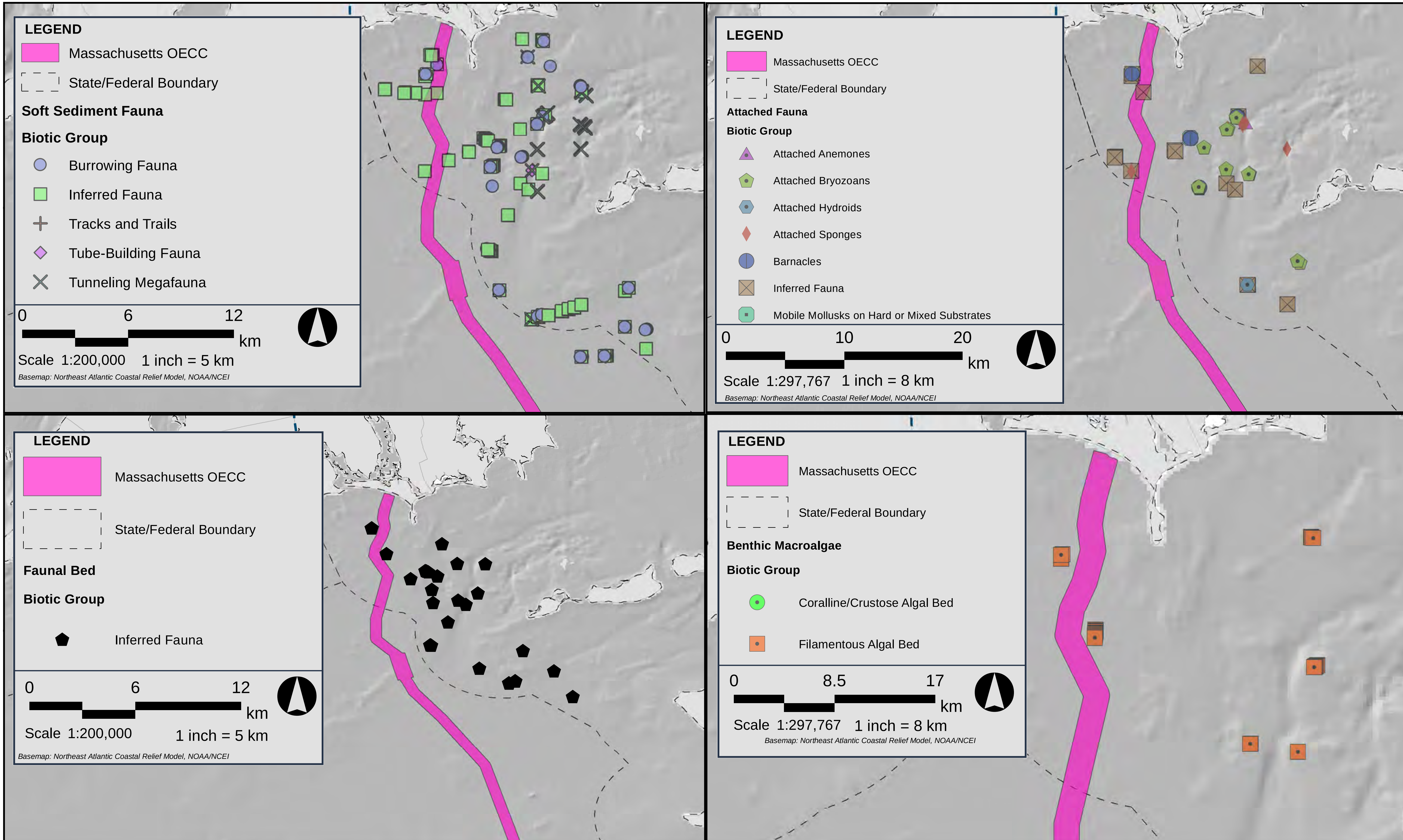


Figure 4.5-5

2010 Coastal and Marine Ecological Classification Standards for Biotic Components from the Massachusetts Office of Coastal Zone Management and the United States Geological Survey

VINEYARD NORTHEAST
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(<0.075 mm [0.003 in]) ranged from 0.0-26.5% with a mean of 2.4%, with no samples containing more than 50% silt and clay. The finest component may be a slight overestimate because CMECS classifies silt/clay at a smaller scale (< 0.0625 mm [0.002 in]) than the lab results (< 0.075 mm [0.003 in]). Ninety-six samples had CMECS classifications of fine unconsolidated substrate (coarse/very coarse sand through sandy mud), while 22 samples were classified as coarse unconsolidated substrate (Gravelly Sand and Sandy Gravel). No samples were classified as biogenic shell rubble with fine/coarse unconsolidated substrate. These results are consistent with previous habitat data collected by the MA CZM and USGS grab samples collected within the Massachusetts OECC. Video transects conducted in 2022 also confirmed that the majority of the Lease Area is soft bottom habitat.

Macrofaunal communities were also assessed in 2022 from 27 grab stations in the Massachusetts OECC. Overall, 70 unique taxa were identified with taxa richness ranging from 4 to 19 taxa and a mean of 10 taxa present in each sample. The samples with the highest species richness were found closer to shore (southwest of Nantucket) but, overall, the Massachusetts OECC had a patchy distribution of taxa richness compared to the Lease Area, which was more consistent throughout. Macrofaunal density in the Massachusetts OECC ranged from 1,044 to 43,451 individuals/m^2. The most abundant phyla in the Massachusetts OECC were Annelida and Mollusca representing 50.2% and 41.8% of species identified in the samples, respectively. Similar to the Lease Area, the most abundant taxon in the Massachusetts OECC was the Atlantic nut clam comprising 38% of identified individuals. The most widespread of organisms identified were the Naididae oligochate worms, which were present in 66% of all samples collected. The most common species identified in this sampling area were associated with soft sediment habitat. Only one sample contained a common Atlantic slippersnail (*Crepdula fornicata*), which is typically found in hard bottom habitat. These results are corroborated by the sediment classifications from the same sample stations, which identified 85% (n=22 samples) as fine unconsolidated sediments and 15% (n=4 samples) as coarse unconsolidated substrates.

Fifty-nine video transects were conducted in the Massachusetts OECC to identify macrofauna. The four most abundant invertebrate phyla in the Massachusetts OECC were Porifera, Hydrozoa, Bryozoa, and Echinodermata, which, in total, comprised 75.4% of all invertebrates identified in the video transects. Scleractinian corals were also observed frequently in patchy distributions, providing evidence that hard bottom habitat was present for these sessile organisms to settle in dense clusters. The five most abundant vertebrate species identified were the American butterfish (*Peprilus triacanthus*), cunner (*Tautogolabrus adspersus*), red hake (*Urophycis chuss*), unidentified fish, and scup (*Stenotomus chrysops*), which comprised 22.39%, 16.31%, 14.59%, 8.66%, and 8.15% of vertebrate observations, respectively, in the Massachusetts OECC. The Massachusetts OECC displayed higher species evenness in its fish communities as compared to the Lease Area.

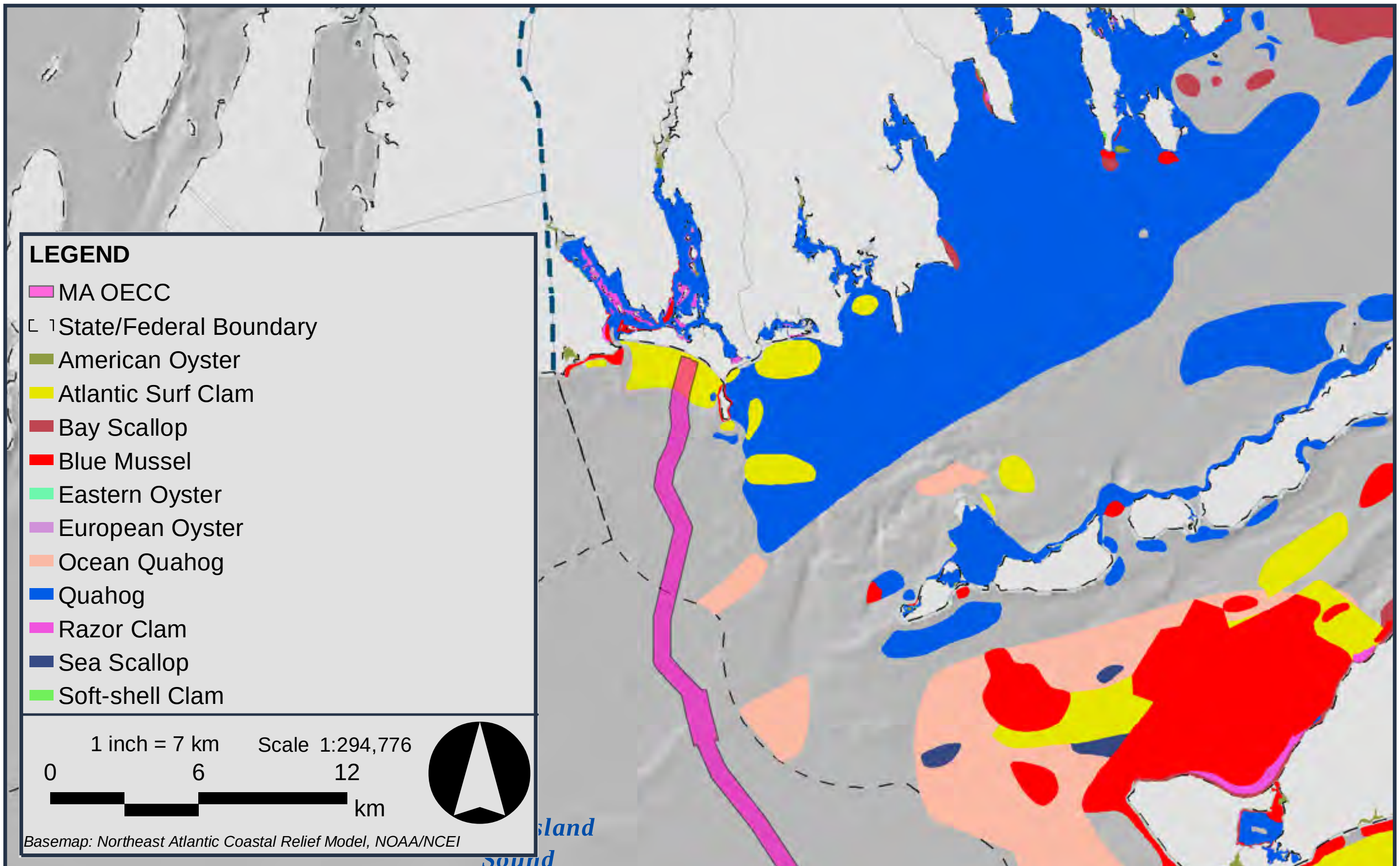
Currently, the Massachusetts Division of Marine Fisheries (MA DMF) manages five artificial reef sites. The Dartmouth site, which is a 0.014 km^2 (3.5 acre) reef of ~100 concrete reef balls, occurs 10 km (6.2 mi) east of the Massachusetts OECC in Buzzards Bay (MA DMF 2022). Observations within NOAA's Deep Sea Coral Data Portal database additionally indicate the presence of living bottom located to the east of the Massachusetts OECC (see Figure 4.5-3). Stony coral (cup coral) has two recorded observations in Vineyard Sound, and six observations within Buzzard's Bay. Three observations of demosponge were recorded in Buzzard's Bay and one observation south of Martha's Vineyard. Additionally, the NOAA National Centers for Coastal Ocean Science modeled results indicated no habitat suitability for deep-sea hard or soft coral species within or near the Massachusetts OECC (NROC 2009).

The Massachusetts OECC passes through a patchy mix of sand and gravel substrates through the waters off Horseneck Beach in Westport, Massachusetts. There are eelgrass beds that lie to the north of the landfall location in the Westport River, and ~1.2 km (0.8 mi) to the east, and there are eelgrass beds off Gooseneck Island (see Figure 4.5-6, NROC 2009). However, no eelgrass beds have been observed thus far within the Massachusetts OECC.

SMAST drop camera data from 2003–2012 covering much of the offshore portion of the Massachusetts OECC contained no presence of moon snails or hermit crabs (see Figure 4.5-1). There were, however, two sampling blocks in the central portion of the central Massachusetts OECC in which 0–24 sea stars were observed, with all other blocks containing no presence of sea stars. Sea scallops were not present in all sampling blocks except one near Noman's Island that had sparse (0–4 individuals) observations of sea scallops (see Figure 4.5-1). Similarly, there were areas of sparse coverage (0–25%) of sponges in the central portion of the Massachusetts OECC and no observations of sponges in the southern Massachusetts OECC near the Lease Area (see Figure 4.5-2). One sampling block near Noman's Island had 25–50% coverage of bryozoans and hydrozoans, two sampling blocks had sparse coverage (0–25%), and all other sampled areas there no bryozoans and hydrozoans observed. During the SMAST survey period there were instances of 75–100% coverage of sand dollars in benthic images of the central portion of the Massachusetts OECC, and 25–75% coverage of sand dollars in the southern portion near the Lease Area (see Figure 4.5-2).

Massachusetts OECC Species of Commercial and Recreational Importance

Areas of suitable shellfish habitat along the coast of Massachusetts have been observed since the mid-1970's, and currently, data provided by the MA DMF, local shellfish constables, commercial fishermen, maps, and studies are used in collaboration to generate shellfish suitability data maps (see Figure 4.5-6, NROC 2009). As the Massachusetts OECC makes landfall in the Town of Westport, it directly overlaps 1 km (0.6 mi) of clam habitat in which the most common species observed is the Atlantic surf clam (*Spisula solidissima*). Additionally, suitable habitat for mussels is located both to the west and east of the Massachusetts OECC in which the most common species recorded is blue mussel (*Mytilus edulis*). Suitable clam habitat



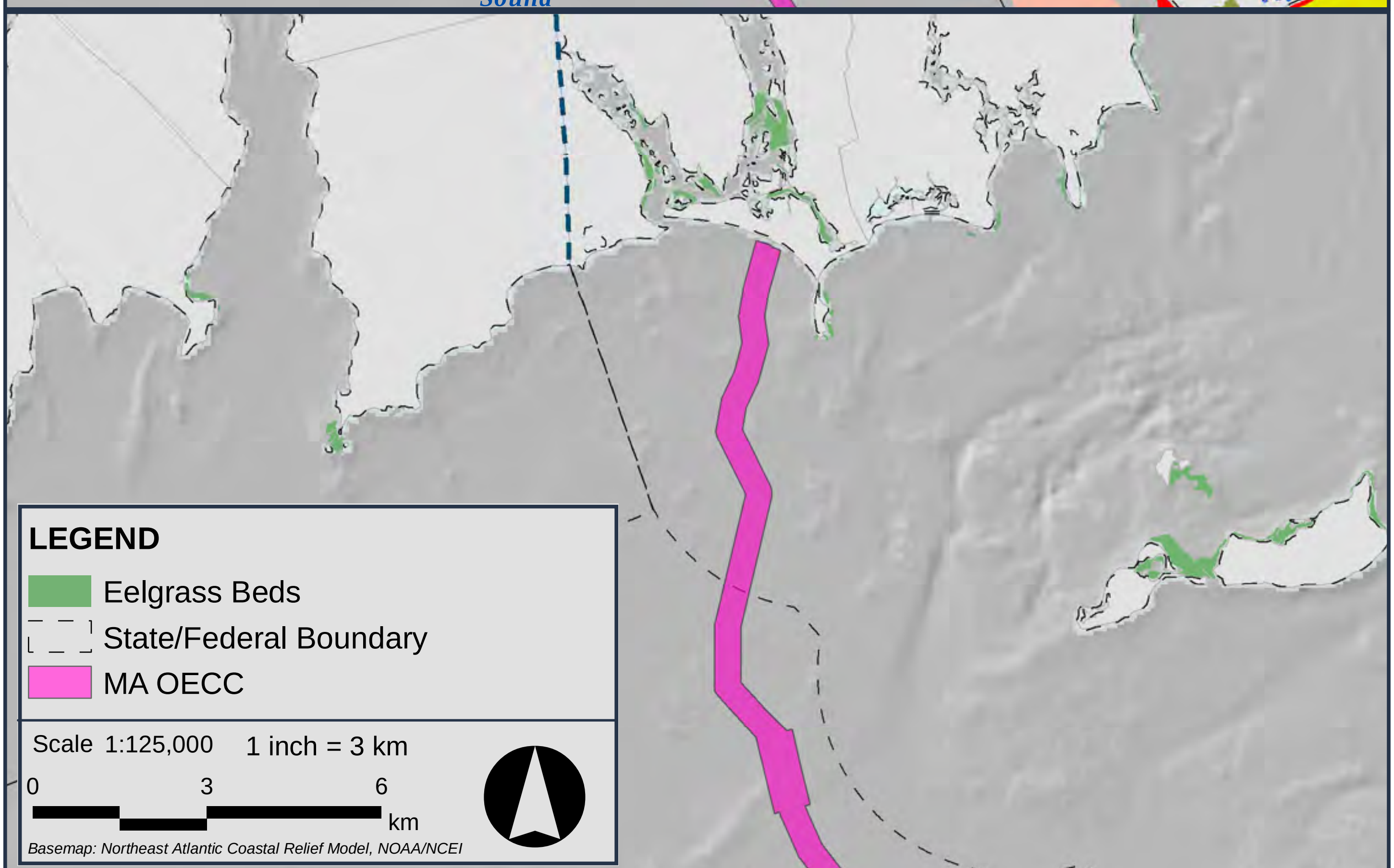


Figure 4.5-6

Shellfish Habitat and Eelgrass Beds Near the Massachusetts Offshore Export Cable Corridor

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in which quahog is most common species recorded is located east of the Massachusetts OECC. It has also been reported that channel/knobbed whelks (*Busycon carica* and *Busycotypus canaliculatum*) are abundant in Nantucket Sound coastal waters (Davis and Sisson 1988; USDOE MMS 2009).

The NEFSC program has conducted Atlantic surf clam and ocean quahog (*Arctica islandica*) surveys near the Massachusetts OECC. Eleven tows for the NEFSC Atlantic surf clam and ocean quahog survey were conducted in 2002, 2005, 2008, 2011, 2013, 2015, and 2018 and directly overlapped the buffered region of 8 km (5 mi) around the Massachusetts OECC. A total of 12,482 individuals were captured from 23 different taxa, across all years. The highest captured species was ocean quahog, ~95% of entire catch, with a total of 11,808 individuals.

4.5.1.3 Connecticut OECC

Interpretation of the 2022 field program (sonar and results from benthic grab samples, video transects, and vibracores) and publicly available datasets of benthic grab samples (usSEABED and USGS East-Coast Sediment Texture Database) were used to characterize the benthic habitats within the Connecticut OECC. Due to the large size of the Connecticut OECC and the presence of multiple landfall sites, the description of the habitat varies across the route. In the offshore region of the Connecticut OECC, heading west from the Lease Area and north towards landfall, the data show mainly Soft Bottom habitat with isolated areas of Gravelly Sand. Within state waters, the habitat type varies with more coarser gravels and boulders within deeper areas, shifting back to softer sediments with occasional patches of rocky outcroppings and shell hash near the landfall sites. Benthic features include ripples areas offshore and megaripples and sand waves near and within Connecticut state waters.

In June 2022, 255 grab samples were collected throughout the Connecticut OECC. These samples were generally sandy with 71.8% (n=183) of all samples classified as sand or fine unconsolidated substrate; 27.5% (n=70) classified as gravel or gravelly sediments; and the remaining 1% (n=2) classified as biogenic shell rubble. These samples were comprised of 2.3-99.9% sand (0.075–2 mm [0.003–0.08 in]) with a mean across samples of 80%. Sixty-nine samples contained no gravel-sized particles (> 2 mm), while 71 samples contained > 5% gravel of which 29 samples contained > 30% gravel and had a maximum sieve size of 47.6 mm (1.87 in). Fine silt and clay particles (< 0.075 mm [0.003 in]) ranged from 0.0-55.8%, with a mean of 8.1%, with five samples containing more than 50% silt and clay. The finest component may be a slight overestimate because CMECS classifies silt/clay at a smaller scale (< 0.0625 mm [0.002 in]) than the lab results (< 0.075 mm [0.003 in]). Of the 255 Connecticut OECC grab samples collected in 2022, 183 samples were identified as fine unconsolidated substrate. The remaining 72 samples were classified as coarse unconsolidated substrate or shell.

Video transects conducted in 2022 found the majority (54.6%) of the Connecticut OECC was soft bottom habitat. The video transects within the Connecticut OECC found the most common substrate type was Shell, representing 28.7% of the Connecticut OECC video transect area. Gravelly, Gravel Mixes, Gravel, or Bedrock substrates were identified in 11.5% of the video transects. The Connecticut OECC was the only habitat surveyed to have bedrock identified.

In 2022, macrofaunal communities were assessed from 64 grab sample stations in the Connecticut OECC. Overall, 126 unique taxa were identified. Species richness ranged from 2 to 27 species with a mean of 10 species present in each sample, with the highest values reported in coastal samples located north of Fisher and Plum Islands. Density of macrofauna across all 64 samples ranged from 216 to 82,117 individuals/m^2. Some of the highest density samples overlapped with samples that recorded the highest species richness and occurred closer to shore – north of Fisher and Plum Islands. The ampeliscid amphipod (*Ampelisca* sp), polygordiid polychaete, and cirratulid polychaete were the three most abundant taxa identified with relative abundances of 22.3%, 15.6%, and 5.1% of all individuals identified, respectively. In addition to being the most abundant taxa, the ampeliscid amphipod was found in 44% of all samples making it the most widely distributed species. Seven samples contained common Atlantic slippersnails, which are typically associated with hard bottom habitats that were more prevalent in the Connecticut OECC as compared to the Massachusetts OECC and Lease Area. However, the most common species found in the Connecticut OECC were those associated with soft sediment habitats. Overall, the species identified in all three project areas were consistent and often reflected the video transect and grab sample CMECS classifications.

Video transects (n=144) conducted in the Connecticut OECC to identify macrofauna showed the four most abundant invertebrate phyla were Porifera, Tunicata, Hydrozoa, and non-Scleractinian Anthozoa (soft corals, sea pens, and anemones), which, in total, comprised 69.8% of all invertebrates identified. Scleractinian corals were also observed frequently in patchy distributions, providing evidence that hard bottom habitat was present for these sessile organisms to settle in dense clusters. The five most abundant vertebrate species identified were the smooth dogfish (*Mustelus canis*), scup (*Stenotomus chrysops*), Atlantic silverside (*Menidia menidia*), witch flounder (*Glyptocephalus cynoglossus*), and black sea bass (*Centropristis striata*), which comprised 10.09%, 9.60%, 8.11%, 7.81%, and 6.69% of vertebrate observations in the Connecticut OECC, respectively. Connecticut OECC displayed the lowest abundance of vertebrate species of the three project areas.

Observations within NOAA's Deep Sea Coral Data Portal database indicate the presence of living bottom near the Connecticut OECC (NOAA 2022a, b; see Figure 4.5-3). A sea pen was recorded in Block Island Sound 10.6 km (6.6 mi) from the Connecticut OECC and one observation of unspecified sponge and five sea pens were recorded at the southern portion of the Connecticut OECC as it approaches the Lease Area, with the closest sea pen located at 11.1 km (6.9 mi) and the closest unspecified sponge at 14.8 km (9.2 mi). Additionally, one stony coral (cup coral) was observed 6.5 km (4 mi) to the east of the Eastern Point Beach Approach of the Connecticut OECC. The NOAA National Centers for Coastal Ocean Science modeled results indicated no habitat suitability for deep-sea hard coral species; however, low habitat suitability was identified for deep-sea soft coral species near the Block Channel and Montauk Point (NROC 2009).

The Long Island Sound Mapping and Research Collaborative identified epifauna and infauna benthic communities for ecological characterizations as part of the Long Island Sound Cable Fund Habitat Mapping Initiative (Babb et al. 2021). Benthic communities were characterized in eastern Long Island Sound from Duck Island, located west of the Connecticut River, to the Rhode Island border, including Fishers Island Sound, areas south of Fishers Island, and "the Race" deep-water channel. The aim of this project was to inform continuing analyses and discussions of renewable energy development projects that are being planned for offshore of Connecticut and New York. Samples and seafloor imagery were collected in the fall of 2017 and spring of 2018 aboard the USGS Seabed Observation and Sampling System. Preliminary results indicated the presence of 289 infaunal taxa identified from Van Veen grabs. Dominant infaunal taxa that were primarily found within the northern portions of the study area included a gammarid amphipod (*Ampelisca vadorum*), a polychaete worm (*Praxillella praetermissa*), and a spionid polychaete worm (*Marenzallaria viridis*), while dominant taxa that had spatially variable distributions in the study area included common slipper shells (*Crepidula fornicata*) and a polychaete worm (*Polycirrus medusa*). Dominant taxa found in deeper waters in the central portion of the study area and within Fisher's Island Sound included two polychaete worms (*Mediomastus ambiseta* and *Glycera capitata*), a spionid polychaete worm (*Spiophanes bombyx*), a chestnut astarte clams (*Astarte* sp.), and a gammarid amphipod (*Corophium* sp.). Epifauna and associated biogenic features were identified from seafloor imagery which included 119 taxa and 33 features. Common epifauna taxa included erect hydroids and bryozoan turfs, demosponges (*Cliona* sp.), northern star coral (*Astrangia poculata*), white anemones (*Diadumene leucolena*), an athecate hydroid (*Corymorpha pendula*), a colonial tunicate (*Didemnum vexillum*), common slipper shells, and blue mussels. Dominant flora identified within the study area included red algae (*Rhodophyta*) and brown kelp (Laminariaceae).

SMAST drop camera data from 2003–2012 covering much of the offshore portion of the Connecticut OECC contained no observations or very few observations (0–0.78) of moon snails or hermit crabs (see Figure 4.5-1). There was one block in the central portion of the Connecticut OECC where 25–40 sea stars were observed, and all other blocks had 0–24 sea stars. Sea scallops were sparse (>0–4 individuals) in SMAST sampling areas in the central portion of the Connecticut OECC as it approaches Block Island, and no sea scallops were observed in the southern portion of the Connecticut OECC near the Lease Area (see Figure 4.5-1). Similarly, there were areas of sparse coverage (>0–25%) of sponges, bryozoans, and hydrozoans near Block Island, and no observations of those species in the central and southern Connecticut OECC (see Figure 4.5-2). Sand dollars exhibited a similar pattern as well with >0–50% coverage near Block Island and no observations in the central and southern Connecticut OECC sampling areas.

The CT DEEP marine fisheries program has conducted 36 years of bottom trawl data from New London to Greenwich, Connecticut in water depths of 5–46 m (16–150 ft) in state waters. The Long Island Sound trawl survey uses a stratified-random sampling design, with two sites sampled in each depth and bottom type stratum. Each site is sampled with an otter trawl for a tow duration of 30 minutes at 3.5 knots. Various algal species, eelgrass, and benthic invertebrates are collected during survey activities. The invasive algal species, *Heterosiphonia japonica,* was the most caught algae species by weight with a total of 808 kilograms (kg) (1,781 pounds [lb]) with peak catches in 2016 and 2017; accounting for over half of the 1,441 kg (3,176 lb) of algal species captured. Most algal catch was concentrated approximately 1 km (0.62 mi) to the east and to the west of the OECC that approaches Niantic, Connecticut (see Figure 4.5-7). Eelgrass (*Zostera marina*) was rarely captured with only 0.5 kg (1 lb) caught in the 2010 to 2021 time-period. Very few shellfish were captured during survey activities, only spider crab (*Libinia emarginata*) exceeded 100 kg (220 lb), and all other captures of obligate benthic invertebrates were ≤ 20 kg (44 lb). Invertebrate catch was mainly comprised of longfin inshore squid (*Doryteuthis pealeii*). The other invertebrates that comprised ≤ 10 kg (22 lb) were lion's mane jellyfish (*Cyanea capillata*), common slipper shell, bushy bryozoan (*Bryozoa* sp.), and horseshoe crab (*Limulus polyphemus*).

Connecticut OECC Species of Commercial and Recreational Importance

The CT DEEP trawl surveys yielded small amounts of commercially and recreational important benthic species over 10 years, with American lobster (*Homarus americanus*; 7.8 kg), blue crab (*Callinectes sapidus*; 6.2 kg), channel/knobbed whelk (6.9 kg), Atlantic surf clam (0.2 kg), and bay scallop (*Argopecten irradians*; 0.1 kg) all yielding less than one kilogram per year.

Fourteen tows from the NEFSC Atlantic surf clam and ocean quahog survey were conducted in 2002, 2005, 2008, 2011 and 2013 which directly overlapped the buffered region of 8 km (5 mi) around the Connecticut OECC. A total of 10,371 individuals were captured from 18 different taxa, across all years. The highest captured species included, the ocean quahog, ~99% of entire catch, with a total capture of 10,218 individuals.

4.5.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect benthic resources during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.5-2.

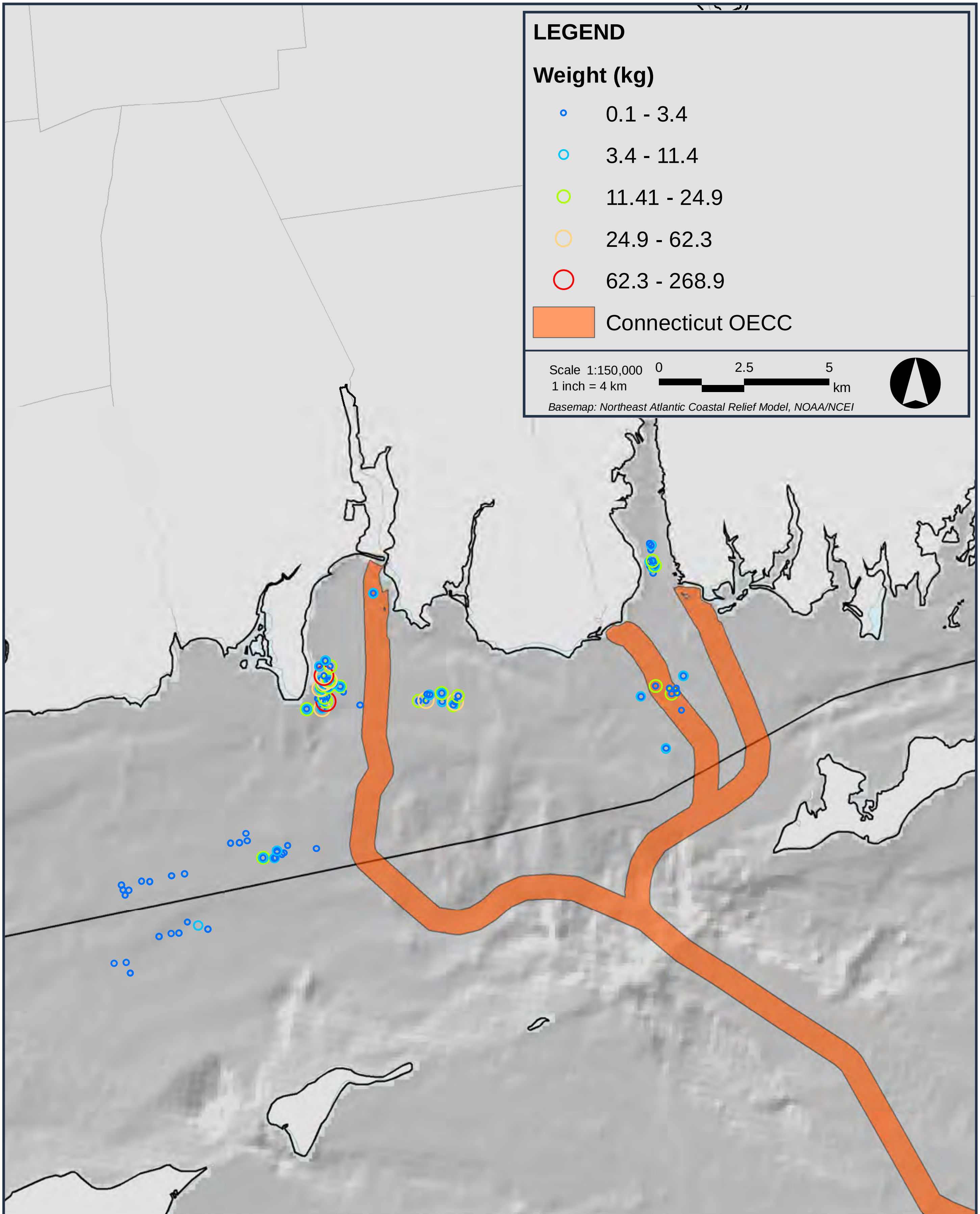

Figure 4.5-7
Weight (kg) of Incidental Capture of Algae and Eelgrass from CTDEEP trawl survey (2010-2021)

Table 4.5-2 Impact Producing Factors for Benthic Resources

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Seafloor Disturbance and Habitat Modification	•	•	•
Suspended Sediments and Deposition	•	•	•
Entrainment and Impingement	•	•	•
Electromagnetic Fields		•	
Noise	•		•

Potential effects to benthic resources were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

4.5.2.1 Seafloor Disturbance and Habitat Modification

Temporary to long-term seafloor disturbance may occur from the installation, maintenance, and decommissioning of foundations (for the wind turbine generator (WTG), electrical service platform (ESP), and booster station), scour protection, export cables, inter-array and inter-link cables, and cable protection (if required). Long-term habitat modification may result from installation of foundations, scour protection, and cable protection (if required). Additional temporary habitat modification may result from installation, maintenance, and decommissioning of export, inter-array, and inter-link cables; pre-installation activities (such as sand bedform dredging, boulder clearance, and a pre-lay grapnel run); and usage of equipment that contacts the seafloor (such as jack-up vessels, vessel anchors or spud legs). Table 4.5-3 provides the expected long-term and temporary seafloor impacts. Additional details are available in Section 3.11 of COP Volume I.

Table 4.5-3 Summary of Maximum Potential Seafloor Disturbance

Activity	Long-Term Seafloor Disturbance	Temporary Seafloor Disturbance	Total Seafloor Disturbance
Maximum Total Disturbance in the Lease Area	2.03 km^2 (501 acres)	7.15 km^2 (1,767 acres)	9.08 km^2 (2,244 acres)
Maximum Total Disturbance in the Massachusetts OECC	0.35 km^2 (87 acres)	4.35 km^2 (1,075 acres)	4.37 km^2 (1,079 acres)
Maximum Total Disturbance in the Connecticut OECC	0.17 km^2 (43 acres)	4.31 km^2 (1,066 acres)	4.31 km^2 (1,066 acres)

Direct impacts from seafloor disturbance during construction, maintenance activities, or decommissioning include the physical displacement, injury, and mortality of organisms in both the Lease Area and OECCs. Sessile and slow-moving benthic and demersal species such as shellfish and early life stages of invertebrates and fishes such as eggs and larvae are most at risk of injury and death from physical trauma as foundations, scour protection, cables, anchors, anchor lines, jack-up legs, and spud legs contact the seafloor. If construction occurs during cooler temperatures, species that bury themselves in the winter such as horseshoe crabs (Walls et al. 2002) and blue crabs (Millikin 1984) have greater risks of impact. Export, inter-array, and inter-link cable installation and maintenance may affect organisms up to the target cable burial depth of 1.5–2.5 m (5–8 ft) beneath the stable seafloor,[44] or deeper where dredging is required prior to cable installation, and foundation installation may affect organisms up to the maximum foundation penetration depth as listed in Section 3.3 and 3.4 of COP Volume I. Overall, these impacts are expected to be localized and limited to the relatively small impact areas from construction (see Table 4.5–3). In addition, the Massachusetts Wind Energy Area (MA WEA) was selected by the Bureau of Ocean Energy Management (BOEM) because it contains very little sensitive finfish and invertebrate habitat (Guida et al. 2017). Mobile invertebrates are expected to be impacted temporarily as they move to avoid physical contact and motions perceived as threats. These temporary avoidance impacts occur over a relatively short time period and are comparable to existing disturbances by vessel traffic and fishing gear with organisms expected to return after the action ceases. Impacts from sedimentation during construction are discussed in Section 4.5.2.2.

Temporary habitat modifications, including temporary alterations to bathymetry, are expected to primarily affect benthic resources. Within the Lease Area, temporary habitat modifications may particularly affect benthic and demersal species that associate with soft bottom habitats because the Lease Area is primarily comprised of fine substrate as described in Section 4.5.1.1. Effects could range from minor ecological benefits to benthic species from increased hard substrate (scour and cable protection) to settle on in soft sediment dominant areas, to limited impacts from loss of key prey species due to mortality in affected areas. However, these effects are considered temporary because habitats are expected to begin recovery once construction, maintenance, or decommissioning activities are completed, and the local severity of these impacts is comparable to ongoing fishing dredge impacts along the Northeast US shelf and potential impacts are relatively small in spatial scale (see Table 4.5–3). Dynamic, sandy physical habitat begins to recover substantially within a few months of disturbance and can fully recover abundance within two years and recover biomass and diversity in two to four years (Van Dalfsen and Essink 2001; Dernie et al. 2003). Additionally, the Proponent will work to minimize temporary habitat effects. For vessels other than cable laying vessels (which must maintain tension on anchor lines), where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, the use of mid-line anchor buoys will be considered (where

[44] Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

feasible and considered safe) as a potential measure to reduce impacts from anchor line sweep. In addition, a benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECCs).

Long-term modification may affect benthic species through the alteration of habitat type. Foundations and scour protection will create hard, vertical structure in the water column and along the seafloor that previously did not exist, and cable protection will cover existing habitat with anthropogenic hard bottom. Therefore, foundations, scour protection, and cable protection are expected to have localized ecological benefits for structure-associated species through the conversion of habitat, with potential localized adverse impacts to species that prefer fine substrates. The newly-created foundation structure throughout the water column can be compared to the addition of artificial reefs which have been shown to lead to ecological benefits (Langhamer 2012). Some of these benefits observed around WTGs include increased biodiversity and abundances of fishes (Wilhelmsson et al. 2006; Andersson and Öhman 2010; Riefolo et al. 2016; Raoux et al. 2017). The addition of foundations may also alter trophic dynamics from the bottom up through the introduction of new surfaces for filter feeders to colonize and consume plankton (Coates et al. 2014; Slavik et al. 2017). Cable protection is expected to have similar impacts in places where it is placed on fine substrate but, where it is placed on hard/complex habitat, it may have temporary negative impacts to structure-oriented species until it is colonized by the benthic community. Both cable protection and scour protection have potential for providing long-term benefits via increased cobble/boulder-like habitat which is a key habitat for lobsters (Linnane et al. 1999; Selgrath et al. 2007) and other species.

Additional research focused on changes in community assemblages related to habitat around offshore wind farms found that species that prefer complex habitat became newly established after installation while communities in nearby soft-bottom habitats remained unchanged (Stenberg et al. 2015). Wind farms have also been found to have localized increases in abundances (Løkkeborg et al. 2002) and improved condition and growth rates (Reubens et al. 2013) of commercially valuable species. However, the habitat created by the addition of project components also has potential to benefit non-indigenous species and provide a mechanism for wider dispersal of potentially harmful non-indigenous species through a steppingstone effect (Glasby et al. 2007; Adams et al. 2014) resulting in localized impacts to sessile invertebrates through competition for space.

Overall, any such long-term changes due to the introduction of foundations, scour protection, and cable protection are only anticipated to affect a small percentage of the available habitat in the Lease Area and OECCs. For example, long-term impacts are only approximately 0.4% of the total size of the Lease Area. Additionally, the Proponent’s goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route.

Another potential long-term indirect effect from the presence of foundations could include modification of pelagic habitats for planktonic life stages of invertebrates. The presence of foundations may alter hydrodynamics and cause changes in recruitment and dispersal of pelagic eggs and larvae. However, modeling of larval transport in and around simulated wind farms in the MA WEA determined that WTGs would not significantly affect southward larval transport coming from Georges Bank during storms (Chen et al. 2016). Additional information on potential changes to hydrodynamics is provided in Section 3.2.

Finally, deflagration or detonation of unexploded ordnances (UXO) and/or discarded military munitions (DMM) has the potential to affect benthic resource through seafloor disturbance, direct mortality, and underwater noise; this IPF is discussed further in Section 4.5.2.5.

During decommissioning, all physical components will be removed, although the offshore cables may be retired in place or removed. Temporary effects from decommissioning are expected to be similar to those experienced during construction. The long-term modification of habitat is expected to be reversed upon decommissioning when offshore components on the seafloor and water column are removed such as foundations and scour protection (unless cable and scour protection are retired in place, in which case they will continue to function as hard/complex bottom unless buried by sedimentation).

4.5.2.2 Suspended Sediments and Deposition

Temporary increases in suspended sediments and subsequent sediment deposition may occur in the Lease Area and OECCs from the installation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, foundations, and scour protection. Specifically, sediment is expected to be suspended into the water column during cable pre-installation activities (e.g., sand bedform dredging, boulder clearance, and a pre-lay grapnel run), cable installation, seabed preparation prior to foundation installation (if needed), installation of cable protection (where required), the use of other equipment that contacts the seafloor (e.g., jack-up vessels, vessel anchors, or spud legs), and excavation of the temporary horizontal directional drilling (HDD) exit pit. These activities would occur during construction with potential for limited maintenance if cables require repair or maintenance; however, any maintenance impacts would be expected to be far less than those from construction activities. Impacts from suspended sediments and deposition would be temporary and confined to a small area close to the location of the installation activity.

Direct effects on benthic resources from suspended sediments can include burial, blockage of filter feeding apparatuses, and reducing filter feeding abilities. Although many benthic organisms have developed behavioral and physiological mechanisms to deal with the resuspension of sediments that often follows natural events (i.e., storms, tidal flows, and currents), the scope, timing, duration, and intensity of dredging-related suspended sediment plumes may create an environment that some species are less able to tolerate. Benthic suspension feeders are particularly sensitive because suspended particles can remain suspended in the water column for weeks and interfere with feeding and growth (Wilber et al.

2005; Smit et al. 2008). Severity of impacts from suspended sediments during construction, maintenance activities, or decommissioning would vary based on the concentration and duration of suspended material. Minimum threshold effects for various benthic organisms have been determined in laboratory settings and are shown in Table 4.5–4. As shown, the suspended sediment threshold for the most sensitive species is 10 milligrams per liter (mg/L) for 24 hours. The value for the most sensitive species is derived from studies of tropical coral that are not present within the Offshore Development Area; however, cold-water corals have been found in Massachusetts and Rhode Island state waters. Observations of cold-water corals occurred more than 8 km (5 mi) to the east of the Massachusetts OECC and approximately 6 km (3.7 mi) to the east of the Connecticut OECC (see Figure 4.5–3). The available literature does not provide a definitive suspended sediments threshold for cold-water corals; therefore, the 10 mg/L threshold for tropical coral is conservatively retained as a potential threshold for the most sensitive species (i.e., cold-water coral) that may be present. The suspended sediment threshold for the next most sensitive benthic species that may be present within the Offshore Development Area, which likely provides a more reasonable conservative threshold, is either 100 mg/L for one day or 200 mg/L for 12 hours.

Table 4.5-4 Suspended Sediment Minimum Effects Threshold for Benthic Organisms

Organism Group (Life Stage)	Minimum Effects Threshold for Suspended Sediment
Mollusks (eggs)[1]	200 milligrams per liter (mg/L) for 12 hours
Mollusks (juveniles and adults)[2]	100 mg/L for 24 hours
Crustaceans (all life stages)[3]	100 mg/L for 24 hours
Corals (eggs)[4]	50 mg/L for 24 hours (preventing fertilization)
Corals (larvae)[4]	10 mg/L for 24 hours (altering larval settlement)
Corals (adults)[4]	25 mg/L for 24 hours (reducing calcification rate)

Notes:

1. Based on the concentration and duration at which sublethal effects were observed to the development of eastern oyster eggs (Cake 1983; Wilber and Clarke 2001).
2. Based on sublethal effects (i.e., reduced growth and reduced respiration) observed in northern quahog (*Mercenaria mercenaria*; Murphy 1985; Wilber and Clarke 2001).
3. Based on sublethal effects (i.e., reduced growth and reduced respiration) observed in copepods, and euphausiids (Anderson and Mackas 1986).
4. See Rogers 1990; Gilmour 1999; Fabricius 2005. Studies investigate tropical species that are not present within the Lease Area.

Direct effects on benthic resources from the resettlement of suspended sediments can include mortality or injury, particularly for immobile species or life stages from burial and smothering. Severity of impacts from deposited sediments during construction, maintenance activities, or decommissioning would vary based on the thickness of material. Taxonomic groups react differently and have varying levels of tolerance for sedimentation, with sessile and attached organisms having the lowest tolerance and highest mortality rate during sedimentation events (Wilber et al. 2005; Gates and Jones 2012). However, some attached bivalve species, such as mussels and oysters, have survived deposition levels of several millimeters (Wilber et al. 2005). Organisms that burrow or feed in subsurface sediments will likely be less sensitive to burial as they can unbury themselves.

The most sensitive life stage of the species considered for Vineyard Northeast is demersal eggs. Several species of fish and invertebrates have demersal eggs, including the Atlantic wolffish (*Anarhichas lupus*), winter flounder (*Pseudopleuronectes americanus*), longfin inshore squid, and whelk species. For demersal eggs, deposition greater than 1 mm (0.04 in) can result in the burial and mortality of that life stage (Berry et al. 2011). Although the early life stages of some warm, shallow water coral species can be sensitive to deposition levels of 0.2 mm (0.008 in), the coral species likely present and previously observed in the region, the Northern star coral, is a cold-water species that is less sensitive to sedimentation (Peters and Pilson 1985). In addition, cold-water corals tend to form in areas with strong bottom currents, which keep corals free of sediment and prevent local deposition (Freiwald et al. 2004; Rogers 2004). Therefore, 1 mm (0.04 in) of deposition is the lowest threshold of concern for Vineyard Northeast.

A second threshold of concern was selected for shellfish. Reported thresholds for the lethal burial depths of bivalves vary among species, but it is currently understood that the most sensitive species are those that are sessile or surface-oriented, such as blue mussel, soft-shell clam, and oysters (*Ostrea* sp.) (Essink 1999). One of the more comprehensive studies available is an early lab and field experiment of the effect of sudden burial on 25 species of bivalves from eight different "life habit types" defined by habitat (infaunal, epifaunal), feeding method (suspension, deposit), and burrowing behavior (Kranz 1974). The author determined that epibenthic suspension-feeders that use byssal attachments (i.e., sessile and lack a digging foot) are less capable of escaping deposition via traveling through the sediment, while many deposit feeder mollusks (e.g., *Macoma* clams and others within the Tellinacea or Nuculacea superfamilies) and infaunal mucus tube feeders (e.g., Lucinidae family bivalves) can escape burial thicknesses in native sediment up to 400 mm (16 in) by rapidly burrowing and/or better tolerating anoxic conditions (Kranz 1974). While the literature has shown sensitivity of bivalves to sedimentation varies greatly among species and can range up to several hundred millimeters of deposition, a sedimentation threshold of 20 mm (0.8 in) was used as the general threshold for shellfish. This threshold is inclusive of thresholds for most species and life stages, including more sensitive subtidal mussel and oyster beds, and is conservatively based on the work of Essink (1999), Colden and Lipcius (2015), and Hendrick et al. (2016). While Kranz (1974) reported zero escape potential (i.e., cannot move through sediment) for attached epifauna, he also noted that mussels can withstand burial for several months, so the escape potential thickness is not synonymous with a sedimentation tolerance threshold. Therefore, while attached shellfish may be unable to escape burial by burrowing up to the sediment surface similar to other bivalve groups (Kranz 1974), they have other adaptive responses that enable survival under sedimentation. For example, oysters can clear themselves of sediment (Wilber and Clarke 2001) and partial burial can lead to increased shell growth rates to reach the sediment surface (Colden and Lipcius 2015). Thus, based on these findings and on the wide range of sedimentation thicknesses and durations tolerated by bivalves in general, a 20 mm (0.8 in) threshold is a reasonably conservative threshold for assessment of impacts.

To assess the impacts of suspended sediments and deposition, sediment transport modeling was completed for three activities: export cable and inter-array cable installation, HDD exit pit construction,[45] and sand bedform dredging (see Appendix II-P). Activities were modeled separately within the Lease Area, Massachusetts OECC, and the Connecticut OECC. Model results provided the following estimates of the durations and concentrations of suspended sediment during construction:

- **Export and inter-array cable installation:** Above-ambient total suspended solids (TSS) concentrations substantially dissipate within one to two hours and fully dissipate in less than four to 12 hours. The modeling analyses predict that suspended sediment concentrations induced by installation of the cables will largely be of short duration, confined to the near-bottom portion of the water column, and will return to ambient conditions within several hours after the installation device has passed. Additionally, if a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), it is anticipated this would occur with sufficient time for any suspended sediment concentrations to return to ambient conditions prior to cable installation.

- **HDD exit pit construction:** Above-ambient TSS concentrations may be present throughout the entire water column because sediments were released at the water surface but are predicted to return to ambient conditions within six hours.

- **Sand bedform dredging and dumping:** Above-ambient TSS concentrations originating from the potential dredging equipment are intermittent along the route and coincide with the representative dredge locations (due to drag arm disturbances at the seafloor) and representative dumping locations. Above-ambient TSS concentrations substantially dissipate within two to three hours and fully dissipate within either four to six hours (for the Lease Area, Massachusetts OECC, and Eastern Point Beach Approach model scenarios) or six to 12 hours (for the Niantic Beach Approach and the Connecticut OECC model scenarios).

Because suspended sediments are expected to dissipate within 12 hours for all modeled scenarios and do not exceed the conservative effects threshold of concentrations of 100 mg/L for 24 hours or 200 mg/L for 12 hours, suspended sediments from construction and operation activities are not expected to have lethal or sublethal effects to finfish and invertebrates in the

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[45] As described in Appendix II-P, the modeling for HDD exit pit construction focused on backfilling since it may result in greater water quality effects than excavation under the conservative assumption that dredged material is released at the water surface.

Offshore Development Area. In addition, suspended sediments are expected to be localized, with high concentrations not expected to travel greater than a few km (few miles) from the centerline.

Model results also provided estimates of the extent, area, and range of thicknesses of deposited sediment during construction (see Appendix II-P). Model results for export cable and inter-array cable installation, HDD exit pit construction, and sand bedform dredging and dumping provided the following estimates:

- **Export and inter-array cable installation:** The model predicted a depositional thickness between 1 mm (0.04 in) and 10 mm (0.4 in).

- **HDD exit pit construction:** The model predicted a depositional thickness of less than 5 mm (0.2 in) for the Massachusetts Landfall Site HDD Exit Pit Construction model scenario and less than 100 mm (4 in) for the Connecticut Landfall Site HDD Exit Pit Construction model scenario, although it is noted that only a small area (0.02 km^2 [5 acres]) near the Connecticut HDD exit pit is predicted to have greater than 20 mm (0.8 in) of deposition.

- **Sand bedform dredging and dumping:** The model predicted the cumulative sediment deposition from the representative sand bedform dredging simulations within the Lease Area, Massachusetts OECC, and Connecticut OECC to be less than 5 mm (0.2 in) and to remain close to the drag arm disturbances (i.e., within 0.09 km [0.06 mi] of the disturbance location) and within the OECC. The deposition associated with overflow and dumping exceeded a thickness of 100 mm (4 in) but was predicted to remain around the dump locations (i.e., within 0.1 km [0.06 mi] to 0.43 km [0.27 mi] depending on the simulation), with a thickness of 1 to 5 mm (0.04 to 0.2 in) occurring in isolated and patchy locations depending on the location of the prevailing currents at the time of release.

For export cable installation and HDD exit pit construction, the model predicted the deposition in most areas would be below the 20 mm (0.8 in) sensitivity threshold for shellfish, with only a small area (0.02 km^2 [5 acres]) predicted to have deposition above 20 mm (0.8 in). If a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), the predicted deposition is expected to be similar to that of the export cable installation scenario and remain below the 10 mm (0.4 in) threshold. Sufficient time is also anticipated between the pre-pass jetting run and cable installation to allow for some of this sediment deposition to be redistributed due to the forcing of surrounding currents.

Dredging and dumping activities are predicted to cause additional areas receiving deposition above 20 mm (0.8 in), primarily due to dumping activities at discrete locations along each OECC and within the Lease Area. The modeled areas with predicted deposition above 20 mm (0.8 in) range between 0.04 km^2 (10 acres) to 0.92 km^2 (227 acres) depending on the location (Lease Area, Massachusetts OECC, or Connecticut OECC and associated landfall sites).

However, the potential impact to benthic resources from deposition above 20 mm (0.8 in) is a small portion of the available habitat. For example, the extent of deposition above 20 mm (0.8 in) along the Connecticut OECC using the Niantic Beach Approach, the scenario with the highest sediment deposition results from modeling (see Appendix II-P), is expected to be restricted to a maximum distance of 0.43 km (0.27 mi) from the route centerline (see Appendix II-P). Additionally, if all of the area that would be impacted by the predicted deposition above 20 mm (0.8 in) along the Connecticut OECC using the Niantic Approach was conservatively assumed to be heterogeneous complex and complex habitat (see Appendix II-D), this would only potentially impact approximately 3% of the available habitat within the OECC, with additional habitat available in the regions surrounding the OECC. Similarly, since the areas of sediment deposition above 20 mm (0.8 in) are predicted to be less for the Massachusetts OECC and Lease Area than for the Connecticut OECC, the percentage of habitat impacted is expected to be an even smaller portion of the available habitat. For this reason, though there are expected to be short-term to longer term (several years) impacts on the benthic resources along the Connecticut OECC, Massachusetts OECC, and Lease Area, these are not anticipated to result in population-level effects. In addition, a benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECCs).

4.5.2.3 Entrainment and Impingement

Localized entrainment and potentially impingement of pelagic life stages of demersal finfish and invertebrates may occur in the Lease Area and OECCs from the installation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, foundations, and scour protection. Short-term impacts may result from vessel cooling systems used during all phases and from other pump intakes such as the potential use of jetting equipment to install export, inter-array, and inter-link cables. If the selected ESP includes high voltage direct current (HVDC) equipment, impacts may result from the seawater cooling water intake structure (CWIS) which may be required.[46]

To estimate the impacts of entrainment from an HVDC CWIS, an assessment using anticipated flow rates and local zooplankton data was completed as described in Appendix II-N. Model results provided estimates of the composition and magnitude of intake mortality for ichthyoplankton and total other zooplankton. Additionally, equivalent losses of age-one fish

[46] This analysis assumes an open-loop CWIS is required; however, the HVDC ESP(s) could potentially use closed-loop water cooling (where no water is withdrawn from or discharged to the sea) if such technology becomes technically and commercially feasible. Although this technology is not currently available in the offshore wind market, the Proponent is aware of a number of firms that are working to develop and test closed loop cooling systems for use in offshore wind HVDC ESPs.

were calculated for some demersal species. Based on the magnitudes of the results, ecological and socioeconomic effects from entrainment by the HVDC CWIS will likely be undetectable. See Section 4.6.2.3 for additional details.

4.5.2.4 Electromagnetic Fields

EMFs would be produced by energized export, inter-array, and inter-link cables during operation. EMFs consist of two components: electric fields and magnetic fields (MFs). The characteristics of the EMF can vary greatly depending on the type of (alternating vs. direct) of transmission technology, current and energy flow of electricity (Tricas 2012). Due to cable configuration and shielding, electric fields are not expected in the marine environment from Vineyard Northeast cables. Therefore, the following discussion describes EMF generally and then focuses on MFs when discussing the potential effects from Vineyard Northeast. As described further in Sections 3.5 and 3.6 of COP Volume I, export cables in the Connecticut OECC will use HVDC transmission technology and export cables in the Massachusetts OECC may use HVDC or high voltage alternating current (HVAC) transmission technology, although HVDC is more likely. Inter-array cables are expected to be HVAC cables but could also be HVDC cables; inter-link cables are expected to be the same cable type as the offshore export cables or the inter-array cables.

Effects on benthic resources from EMF are not fully understood but can include disorientation and other behavioral responses (e.g., avoidance, changes in prey detection or feeding activity) (Riefolo et al. 2016). Severity of impacts from EMF during operation would vary based on the strength of the EMF and the electrosensitivity of organisms. Of species potentially present in the Offshore Development Area, electrosensitivity has been primarily documented in sea slugs and sea urchins; however, they have sensitivity thresholds above modeled electric fields and are therefore not expected to be impacted (Normandeau et al. 2011). The effects of EMF would be localized because EMFs produced by cables decrease with distance. In addition, at the target burial depth for the cables of 1.5–2.5 m (5–8 ft) beneath the stable seafloor,[47] EMFs at the seabed would be expected to be weak and likely only detectable by demersal species (Normandeau et al. 2011). In areas where seafloor type potentially prohibits cable burial, cable protection would serve as a similar although thinner barrier to exposure.

A white paper review study funded by BOEM determined that EMFs produced by HVDC/HVAC power transmission cables would result in negligible, if any, effects on six demersal invertebrates: Atlantic sea scallop, deep-sea red crab (*Chaceon quinquedens*), Atlantic surf clam, ocean quahog, American lobster, and Jonah crab (*Cancer borealis*; Snyder et al. 2019). Other reviews have concluded that effects of EMFs on invertebrates can be measurable but impacts from EMF are not expected as almost all cables will be buried (Albert et al. 2020; Gill and Desender 2020). For example, there is some evidence of attraction to EMF for a species of

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[47] Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

Cancer crab at an EMF strength hundreds of times greater than expected based on modeling for Vineyard Northeast (Scott et al. 2021; see Appendix II-O). Similarly, although there were changes in the behavior of little skate, an elasmobranch, and American lobster in the presence of energized HVDC cables, EMFs from cables did not act as a barrier to movement in any way (Hutchison et al. 2018, 2020). In a laboratory study on a benthic polychaete (*Hediste diversicolor*), no avoidance or attraction to EMF levels (50 Hz, 1 mT) typically recorded near submarine cables was observed. Burrowing activity and ammonia excretion was increased in the EMF treatment, showing a potential bioturbation increase; however, the mechanisms of this effect are unknown (Jakubowska et al. 2019). Other research investigating habitat use around energized cables found no evidence that invertebrates were attracted to or repelled by EMFs emitted by cables (Love et al. 2017). Further, there are already subsea transmission cables present in the Offshore Development Area, including three cables between Martha's Vineyard and Falmouth and two cables between Nantucket and Cape Cod. Surveys in this area show benthic resources occur near cable burial sites, but EMF impacts are expected to be negligible as the cables will be buried.

For HVDC cables, other manmade sources of perturbations to Earth's steady direct current (DC) geomagnetic field in coastal environments include shore-based structures such as docks, jetties, and bridges; sunken ships; pipelines; and ferromagnetic mineral deposits (Normandeau et al. 2011; CSA Ocean Sciences Inc. and Exponent 2019). Additionally, Normandeau et al. (2011) reported that MF impacts nearby to these sources can be on the order of tens of milliGauss (mG), while CSA Ocean Sciences Inc. and Exponent (2019) observed that undersea sources of DC MFs including steel ships and bridges can create DC MFs up to 100 times greater than MFs from DC submarine cables.

For HVAC cables, a seven-year study reported the first findings in the United States of the responses of demersal fish and invertebrates to construction and operation of an offshore wind project (Wilber et al. 2022). This study analyzed catch data from monthly demersal trawl surveys conducted by local fisherman and scientists during construction and operation of the Block Island Wind Farm. This study did not identify harmful impacts of EMF from the 60-Hz alternating current (AC) submarine export cables or other offshore electrical infrastructure, and instead reported evidence of increased populations of several fish species near the wind farm during the operation time period relative to the reference areas.

To assess the potential effects of Vineyard Northeast cables, modeling of MFs from HVDC and HVAC cables was completed (see Appendix II-O).[48] Model results provided estimates of the magnitude and extent of MFs from a range of loads during operation and for cables that are either buried at a depth of 1.5 m (5 ft) or surface-laid. Surface laid cables are assumed to have 0.5 m (1.6 ft) thick cable protection covering. Modeling demonstrated that MFs at the seafloor

48 Modeling was focused on export cables because inter-array cables are expected to have lower currents and MFs. Inter-link cables are expected to have similar or lower MFs.

from the buried cables decline with distance, with a maximum MF directly above the centerline that decreases rapidly with distance. Tables 4.5-5 and 4.5-6 show the rapid drop-off in MF levels with increased lateral distance from the HVAC cables or HVDC cable bundles for each of the modeling scenarios. More specifically, the analysis shows > 95 to > 99% reductions in MF levels cables at lateral distances of ±25 ft (±7.6 m) from the centerlines of HVAC cables or HVDC cable bundles. At lateral distances of ±25 ft (±7.6 m), there is a negligible difference in MF levels for the buried versus the surface-laid cables. These model results indicate that MFs are likely only able to be sensed, if at all, directly over the buried cable centerline. Therefore, any effects from EMF are expected to be localized with only behavioral impacts, if any at all, for most benthic species.

Table 4.5-5 Summary of Modeled Magnetic Fields for HVDC Offshore Export Cables, as Deviations from Earth's Steady DC Magnetic Field

Cable Voltage	Installation Scenario[2]	DC Magnetic Field Deviation[1,3] (mG)			
		Maximum (above cables)	± 10 ft	± 25 ft	± 50 ft
±320 kV	Buried	-268 to 271	-49.9 to 51.8	-11.5 to 11.5	-2.9 to 2.9
	Surface-laid	-266 to 2,039	-72.4 to 72.5	-11.5 to 11.5	-2.8 to 2.8
±525 kV	Buried	-296 to 300	-55.4 to 57.8	-12.9 to 12.9	-3.3 to 3.3
	Surface-laid	-268 to 2,207	-81.0 to 81.2	-12.9 to 12.9	-3.2 to 3.2

Notes:
1. MFs are presented as the deviation from the Earth's steady DC magnetic field of 508 mG and are maximum positive and negative deviations across modeling cases that include two representative cable orientations (north-south and east-west) and both possible current flow direction scenarios for each representative cable orientation. Negative values are the maximum reductions below the Earth's steady DC magnetic field of 508 mG.
2. MFs at the seabed are reported for buried cables. Surface-laid cables are assumed to have 0.5-m (1.6-ft) thick cable protection covering. For these scenarios, MFs are reported at the top of the cable protection, specifically at 0.65 m (2.14 ft) for the ±320-kV cables, and 0.67 m (2.20 ft) for the ±525-kV cables.
3. Horizontal distance is measured from the center of the cable bundle.

Table 4.5-6 Summary of Modeled Magnetic Fields for HVAC Offshore Export Cables

Cable Voltage	Installation Scenario[1]	AC Magnetic Field[2] (mG)			
		Maximum	± 10 ft	± 25 ft	± 50 ft
230 kV, 3-phase	Buried	191	43.6	9.0	2.8
	Surface-laid	1,243	54	9.3	2.8
345 kV, 3-phase	Buried	214	49.6	10.2	3.1
	Surface-laid	1,354	61.6	10.7	3.2

Notes:
1. MFs at the seabed are reported for buried cables. Surface-laid cables are assumed to have 0.5 m (1.6-ft) thick cable protection covering. For these scenarios, MFs are reported on top of the cable protection, specifically at 0.79 m (2.58 ft) for 220-kV cables, and 0.82 m (2.68 ft) for 345-kV cables.
2. Horizontal distance is measured from the center of the cable bundle.
   The offshore export cable MF modeling assumes straight-laid phase-conductor cable cores, as opposed to the actual helical or "twisted" phase-conductor cores. A helical design achieves a considerable degree of magnetic field cancellation; hence, the modeled MF levels are expected to be overestimates of actual MF levels.

4.5.2.5 Noise

Temporary to long-term increases in noise may occur in the Lease Area and OECCs from the installation, operation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, and foundations. The intensity and duration of noises should vary based on activity, with construction producing the largest increase in sound exposure to benthic resources. Temporary construction noise is expected to include both repetitive, high-intensity (impulsive) sounds produced by pile driving, and continuous (non-impulsive), lower-frequency sounds produced by vessel propulsion, drilling, vibratory installation of foundations, and cable pre-installation/installation activities. Noise will also be produced during UXO detonation (if UXO detonation is needed). Long-term operational noise is expected to be continuous (non-impulsive) noise from WTGs and vessel traffic. Some other continuous noise may be produced temporarily during cable maintenance or aircraft activities, however the intensity of produced operational sound pressure levels is expected to be lower than ambient noise from existing boat and air traffic.

There has also been a suite of air gun studies examining a variety of invertebrate life stages. New Zealand scallop (*Pecten novaezelandiae*) larvae exposed to extended periods of air gun signals during their ontogeny had increases in abnormality and mortality rates (Aguilar de Soto et al. 2013). André et al. (2011) and Solé et al. (2013) provide evidence of acoustic trauma in four cephalopod species—common cuttlefish (*Sepia officinalis*), common octopus (*Octopus vulgaris*), European squid (*Loligo vulgaris*), and southern shortfin squid (*Illex condietii*)—which they exposed (underwater) for two hours to low-frequency sound. Both studies reported permanent and substantial morphological and structural alterations of the sensory hair cells of the statocysts following noise exposure, with no indication of recovery.

Benthic invertebrates are mostly in constant contact with the sediment, and this type of sound pressure vibration is likely similar or greater than sound propagated through water (Roberts and Elliot 2017). The scientific literature on sound sensitivity in marine invertebrates is extremely scarce (Roberts et al. 2016), and only some studies have found sessile mollusks to close their siphons or mobile species to move away from the sound source (Ellers 1995; Kastelein et al. 2008). Although one study saw a 5 to 15% increase in scallop mortality when they were directly exposed to a seismic air gun array (Day et al. 2016), that level of sound exposure (191 to 213 decibels [dB] re 1μPa peak-peak SPL) is not expected to occur from pile-driving and the mechanism that caused mortality in the study was not known. However, a different study in the Bass Strait, Australia showed no evidence of increases in scallop mortality, or effects on scallop shell size, gonad size, or gonad stage, attributable to the seismic survey conducted in the area (Przeslawski et al. 2018).

The installation of piles with impact hammers will be the largest sound source during the construction process, and peak sound pressure levels can exceed 180 dB re 1μPa (US NRC 2012); however, sound modeling indicated that peak-to-peak SPLs will not exceed 191 dB re 1 μPa (see Appendix II-E). In studies, blue mussel clearance (i.e., filtration rate) increased with pile driving sound, likely in response to increased metabolic demands triggered by stress

(Spiga et al. 2016). Sediment vibration from pile driving activities can also cause responses from benthic invertebrates, although relatively little research on vibration effects has been conducted to date and the sensitivities of benthic invertebrates to vibration are unknown (Roberts et al. 2016). In a semi-field experiment using a small-scale pile driving located 295 ft (90 m) away at the edge of an enclosed dock, blue mussels exhibited behavioral and physiological variation in valve gape and oxygen demand (Roberts et al. 2016). Hermit crab behavior did not significantly change during this experiment, highlighting that impacts to benthic resources will be species-specific and that mobile individuals will be able to vacate the area. In this same experiment, the authors observed that the vibration signal propagated farther away in shallower water than in deep water; the signal in the sediment was low frequency (< 100 Hz) and concentrated around 25 to 35 Hz, and the signal was strongest along the vertical axis near the pile (Roberts et al. 2015, as cited in Roberts et al. 2016). Sound and vibration impacts to benthic resources from pile driving are expected to be temporary, localized, and non-lethal.

Direct effects on invertebrates from noise can include behavioral changes, stress responses, and possibly injury. Noise could also affect the functionality and sensitivity of the sensory systems of marine invertebrates but most studies on these effects have been performed *ex situ*, making it difficult to control and assess the acoustic conditions and typically only measure and report on the pressure component of sound. Although understanding of the impact of sound on invertebrates is extremely limited, there is no evidence based on current studies of significant impacts from expected operational sound, including pile driving, on benthic invertebrates.

If potential unexploded ordnances UXO and/or discarded military munitions DMM are discovered in the Lease Area or OECCs, the Proponent will prioritize avoidance of UXO/DMM wherever possible by micro-siting structures and cables. Where avoidance is not possible (e.g., due to layout restrictions, presence of archaeological resources, etc.), UXO/DMM will be relocated or otherwise disposed of (e.g., via deflagration [burning without detonating], detonation, or dismantling the UXO/DMM to extract explosive components). The exact number and type of UXO/DMM that may be present, and which subset of those UXO/DMM cannot be avoided by micro-siting, are unknown at this time and further evaluation is ongoing. For the purposes of impact analyses, the Proponent conservatively assumes that up to two UXO in the Lease Area, four UXO in the Massachusetts OECC, and four UXO in the Connecticut OECC may need to be detonated in place (each detonation would occur on different days). Deflagration or detonation of UXO/DMM has the potential to affect benthic resource through seafloor disturbance, direct mortality, and underwater noise. Such impacts would be short term and localized.

4.5.2.6 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to benthic resources during Vineyard Northeast are summarized below:

- Offshore export cable installation will avoid sensitive habitats, including eelgrass and hard/complex bottom, where feasible.

- The Proponent will require the cable installation contractor to prioritize the least environmentally impactful cable installation alternative(s) that are practicable for each segment of cable.

- For vessels other than cable laying vessels (which must maintain tension on anchor lines), where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, the use of mid-line anchor buoys will be considered (where feasible and considered safe) as a potential measure to reduce impacts from anchor line sweep.

- At the landfall sites, HDD is expected to be used to avoid or minimize disturbance to coastal habitats by drilling underneath them.

- The target cable burial depth is 1.5–2.5 m (5–8 ft) beneath the stable seafloor,[49] which will reduce effects of EMFs. In areas where seafloor type or cable crossings potentially prohibit cable burial, cable protection would serve as a similar barrier to exposure.

- The Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route.

- The Proponent will apply a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing mobile species to move out of the activity area before the full-power pile driving begins.

- A noise abatement system will be used to reduce sound levels by a target of approximately 10 dB during pile driving.

- A benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECCs).

- Large portions of the Lease Area will be undisturbed by WTG and ESP installation.

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49 Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

4.6 Finfish and Invertebrates

This section addresses the potential impacts and benefits of Vineyard Northeast on finfish and invertebrates in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to finfish and invertebrates during the construction, operation, and decommissioning of Vineyard Northeast.

Essential Fish Habitat (EFH) is discussed in Appendix II-D and a zooplankton and ichthyoplankton entrainment assessment is included as Appendix II-N. Recreational fisheries are described in Section 5.3 and commercial and for-hire recreational fisheries are described in Section 5.4.

4.6.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities.

This description of finfish and invertebrate resources is based on a review of existing literature and survey data. Surveys, datasets, studies, and literature were identified and then assessed for applicability. The most relevant data and sources for characterizing finfish and invertebrates in the affected environment include:

- Northeast Fisheries Science Center (NEFSC) multispecies bottom trawl surveys (NEFSC 2022a, 2022b)
- NEFSC Atlantic surfclam and ocean quahog surveys (NEFSC 2022c)
- NEFSC Atlantic sea scallop dredge surveys (NEFSC 2022d)
- Northeast Area Monitoring and Assessment Program (NEAMAP) spring and fall trawl surveys (NEAMAP 2022)
- Massachusetts Division of Marine Fisheries (MA DMF) trawl and trap surveys (MA DMF 2022a, 2022b)
- Connecticut Department of Energy and Environmental Protection (CT DEEP) seasonal trawl surveys (CT DEEP 2022)
- Vineyard Northeast's 2019 (RPS 2019) and 2022 benthic grab and video survey data
- Northeast Ocean Data Portal (NEODP) (NROC 2009)

- Bureau of Ocean Energy Management's (BOEM) Revised Environmental Assessment for the Massachusetts Wind Energy Area (MA WEA) (BOEM 2014)

- University of Massachusetts Dartmouth School of Marine Science and Technology (SMAST) demersal trawl survey reports for the Lease Area (He and Rillahan 2020a, 2020b, 2020c, 2020d)

- SMAST fisheries data and regional video survey data (2003-2012), hosted on the NEODP, and drop camera surveys (2019 and 2020) for the Lease Area (Bethoney et al. 2020; Stokesbury et al. 2022)

4.6.1.1 Offshore Development Area

Several survey programs (CT DEEP, MA DMF, NEAMAP, NEFSC, and SMAST) have conducted biological and optical fishery independent surveys in and around the Offshore Development Area. Figure 4.6-1 shows the locations of surveys that occurred within the Lease Area and within 8 kilometers (km) (5 miles [mi]) of the Massachusetts and Connecticut OECCs.

The NEFSC has conducted surveys annually since 1963 and the NEFSC spring and fall bottom trawl surveys have the most complete coverage in the Offshore Development Area across the 2010 to 2019 time series. Two metrics—total biomass and species richness—derived from this survey show the distribution of fish assemblages in the Offshore Development Area relative to surrounding locations (see Figure 4.6-2 through Figure 4.6-7). The total biomass of fish is moderate to high across the Offshore Development Area, while species richness is high. For forage fish, these surveys found that Atlantic herring *(Clupea harengus*), butterfish (*Peprilus triacanthus*), and round herring (*Etrumeus teres*) had the highest biomass of forage fish across all seasons in the MA WEA. Seasonal variations in biomass were apparent for all three species, with Atlantic herring observed at higher biomass in the spring trawl surveys (conducted primarily from February to April) and butterfish and round herring observed at higher biomass in the fall trawl surveys (conducted primarily from September to November) (NROC 2009)[50] (see Figure 4.6-4 and 4.6-5).

Seasonal trawl surveys conducted by NEFSC from 2010–2019 found that little skate (*Leucoraga erinacea*), winter skate (*Leucoraja ocellata*), silver hake (*Merluccius bilinearis*), and spiny dogfish (*Squalus acanthias*) were consistently dominant in catches from the MA WEA (Guida et al. 2017; NROC 2009) (see Figure 4.6-6 and 4.6-7). Additionally, American sand lance (*Ammodytes americanus*) and northern sand lance (*Ammodytes dubius*), two important forage fish species that serve as prey to other forage fish, squid, marine mammals, and seabirds (Staudinger et al.

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[50] Data accessed on Northeast Ocean Data Portal in 2021.

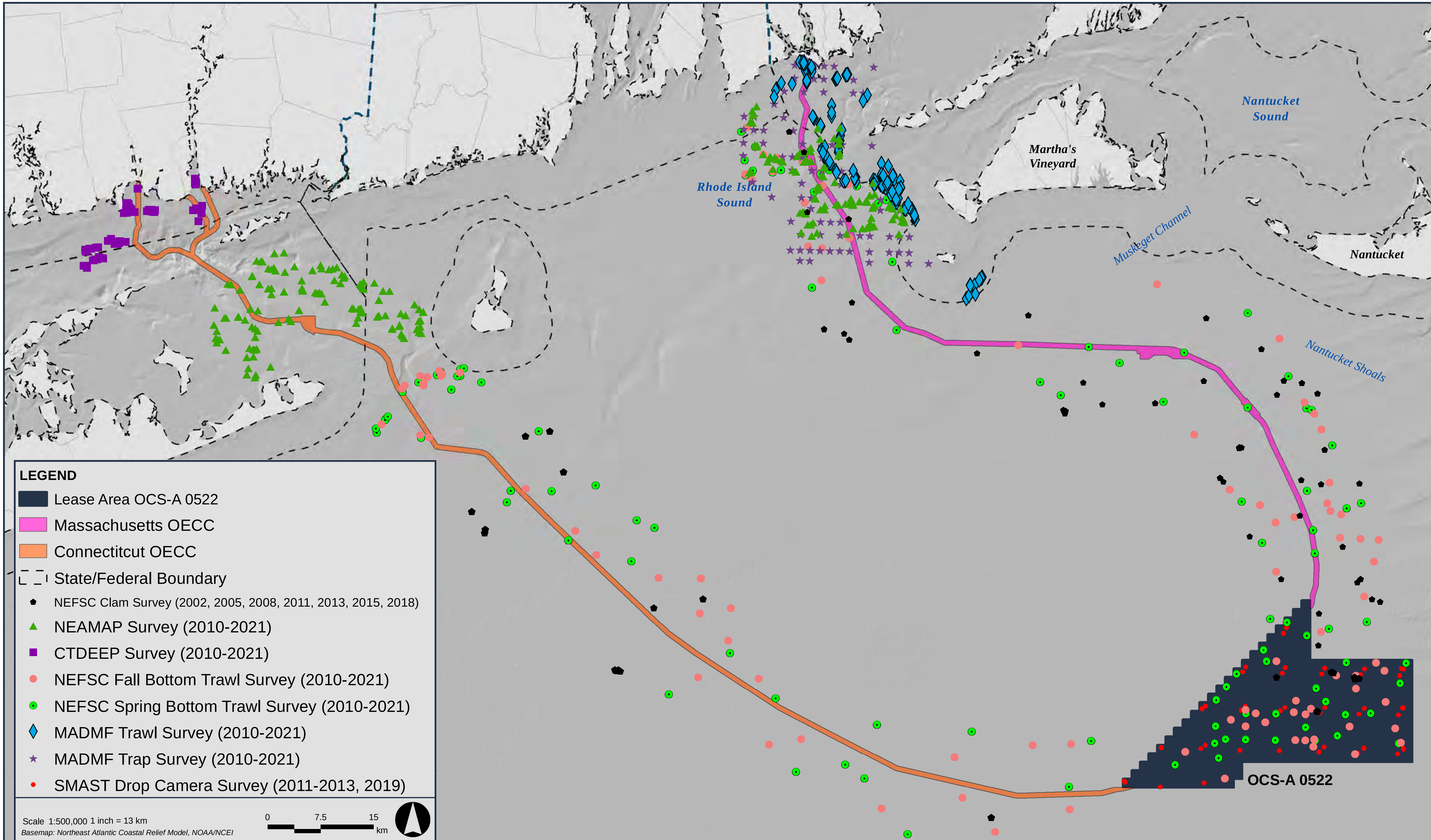

Figure 4.6-1
Locations of Various Fishery Surveys in the Offshore Development Area

VINEYARD NORTHEAST
VINEYARD OFFSHORE

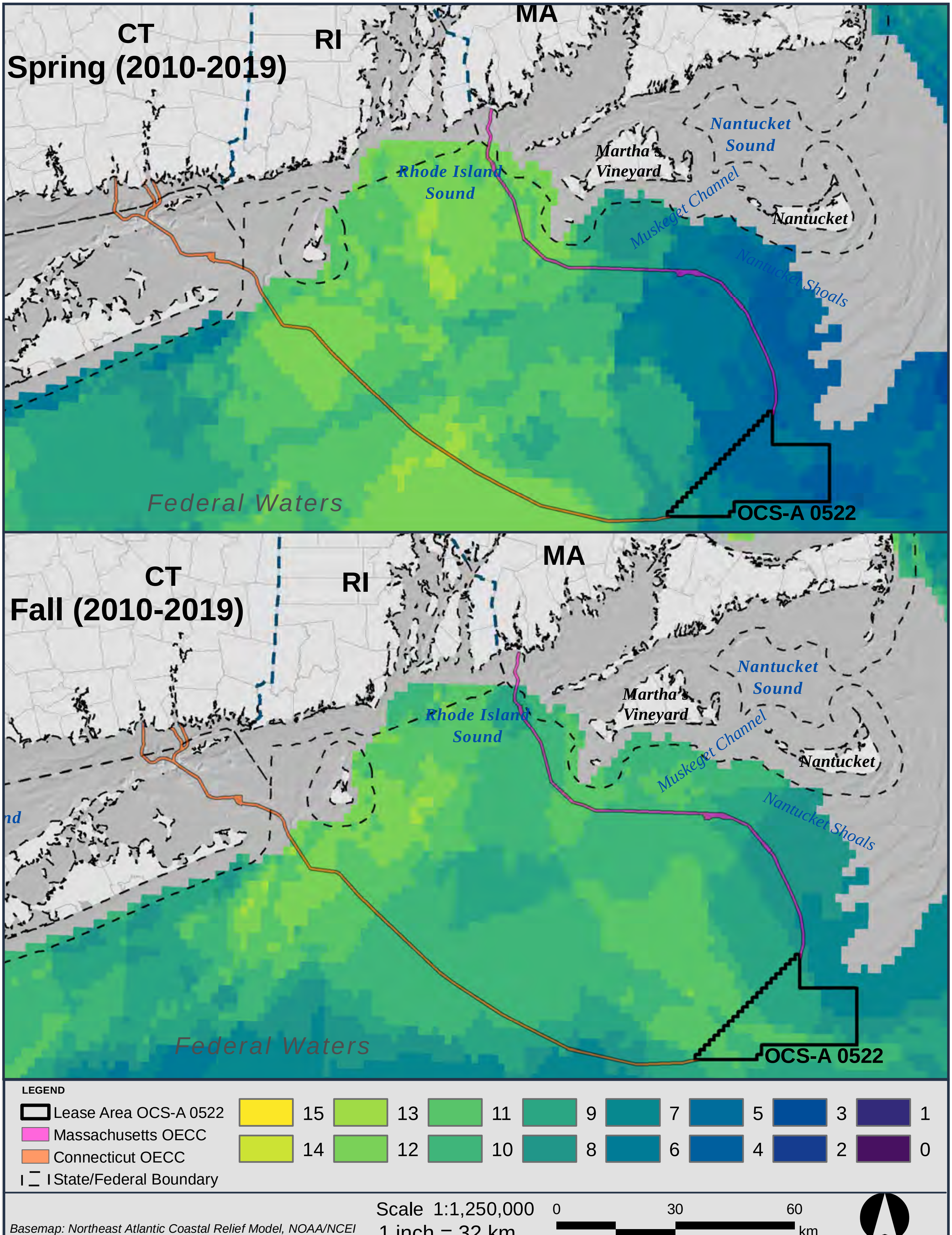

Figure 4.6-2

Expected Species Richness of the Fish Captured in Spring and Fall NEFSC Bottom Trawl Surveys (NROC 2009)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

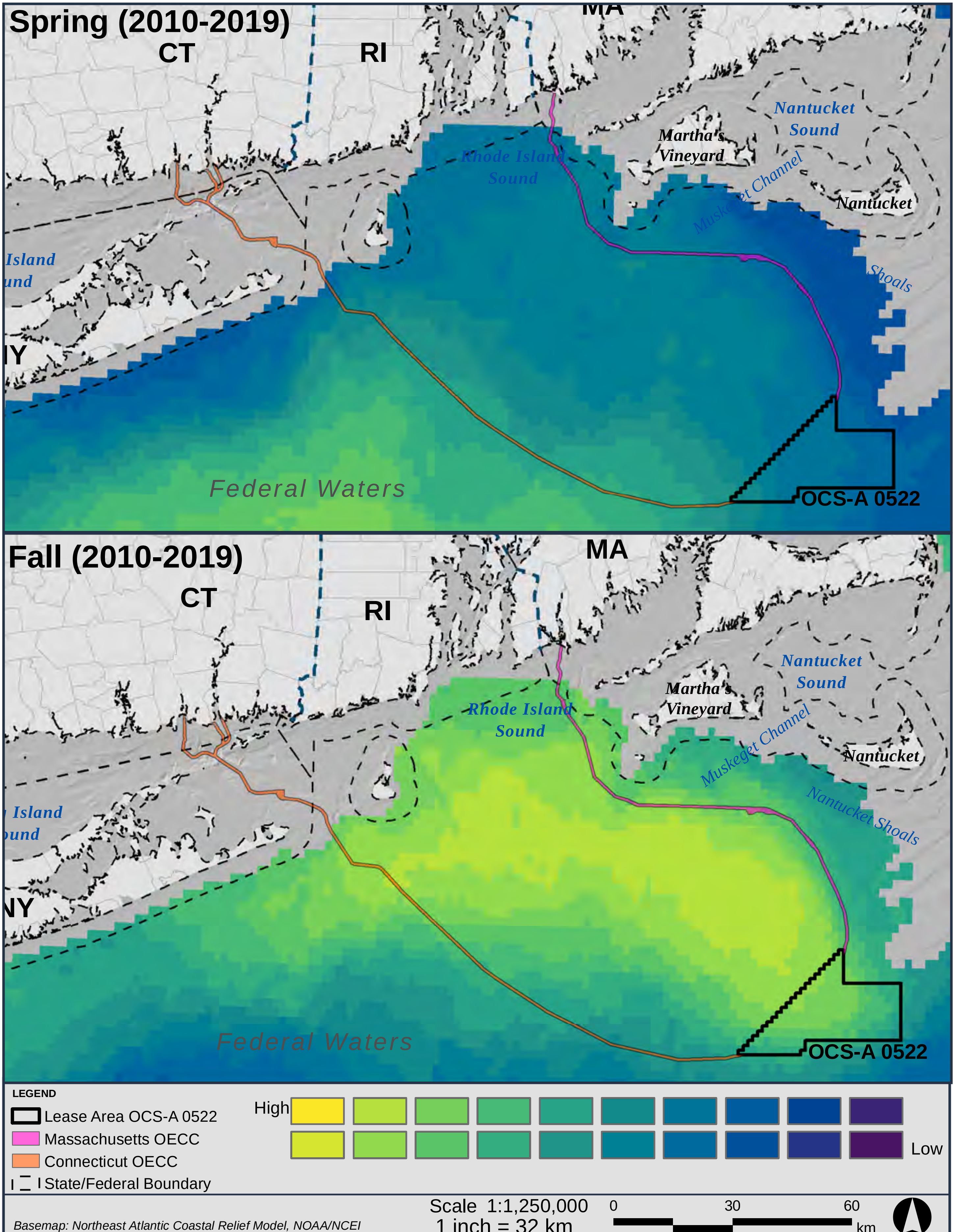

Figure 4.6-3

Expected Biomass of the Fish Captured in Spring and Fall NEFSC Bottom Trawl Surveys (NROC 2009)

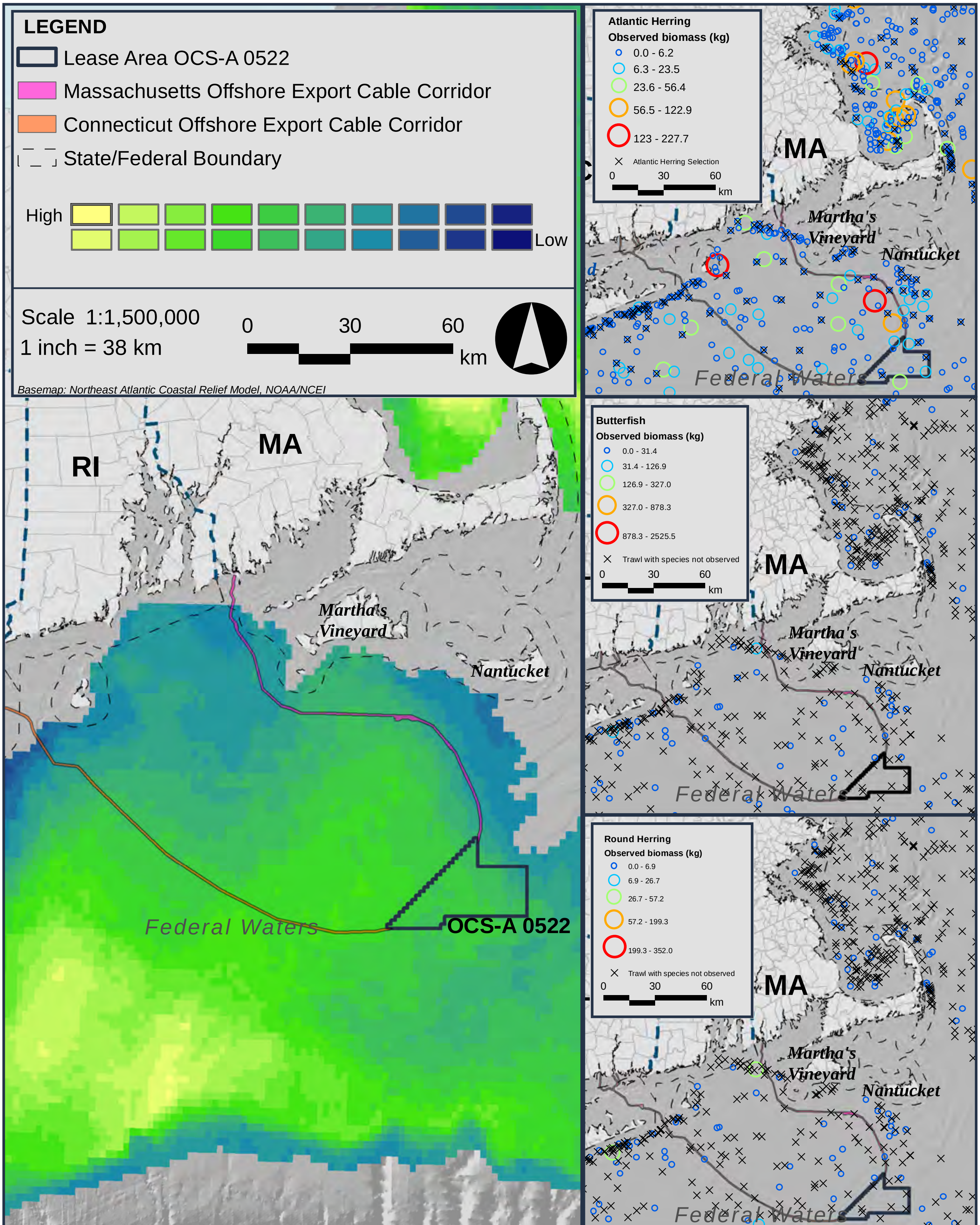

Figure 4.6-4

Expected Forage Fish Biomass and Individual Biomass for Butterfish, Round Herring, and Atlantic Herring Captured in Spring NEFSC Bottom Trawl Surveys from 2010-2019 (NROC 2009)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

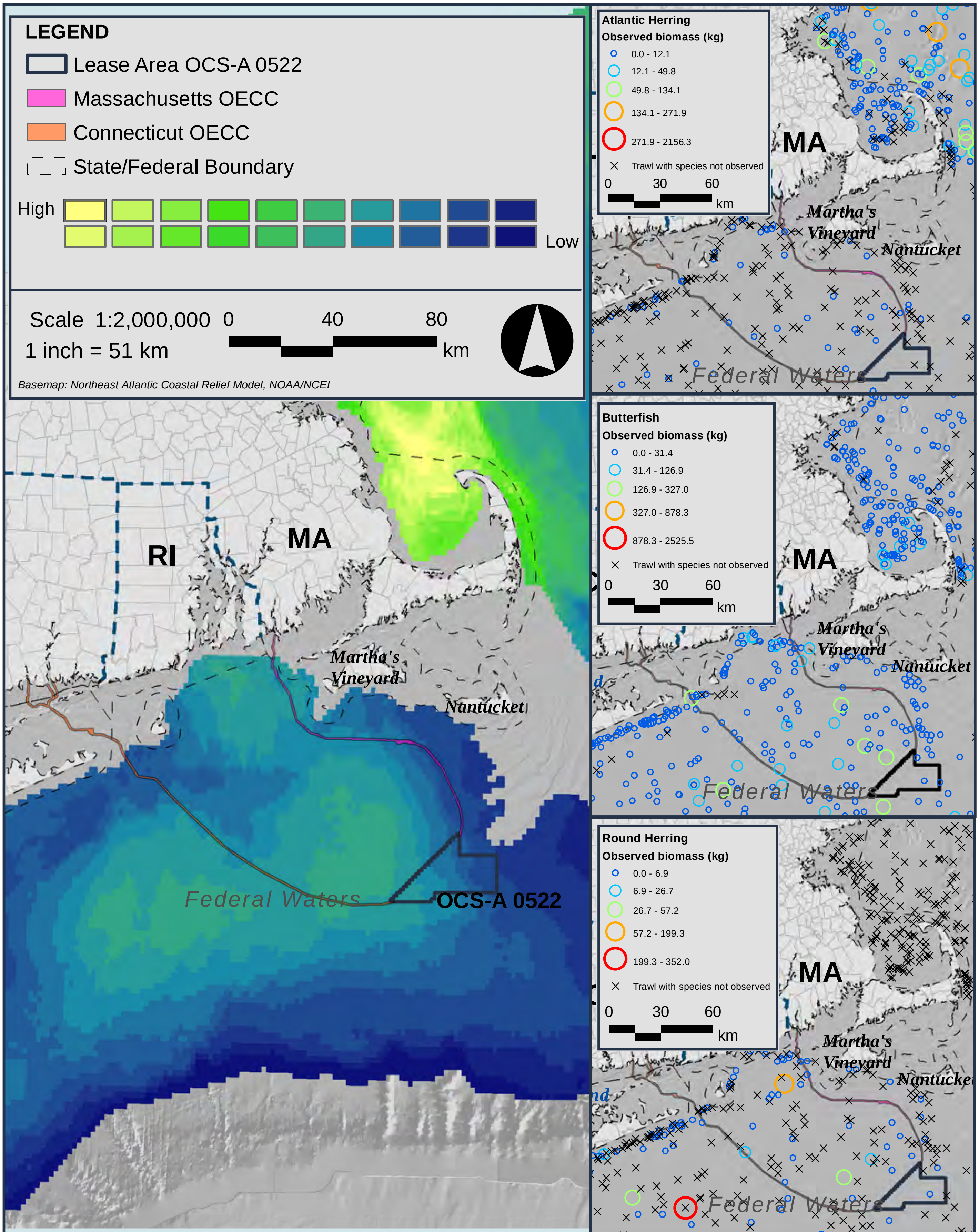

Figure 4.6-5

Expected Forage Fish Biomass and Individual Biomass for Butterfish, Round Herring, and Atlantic Herring Captured in Fall NEFSC Bottom Trawl Surveys from 2010-2019 (NROC 2009)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

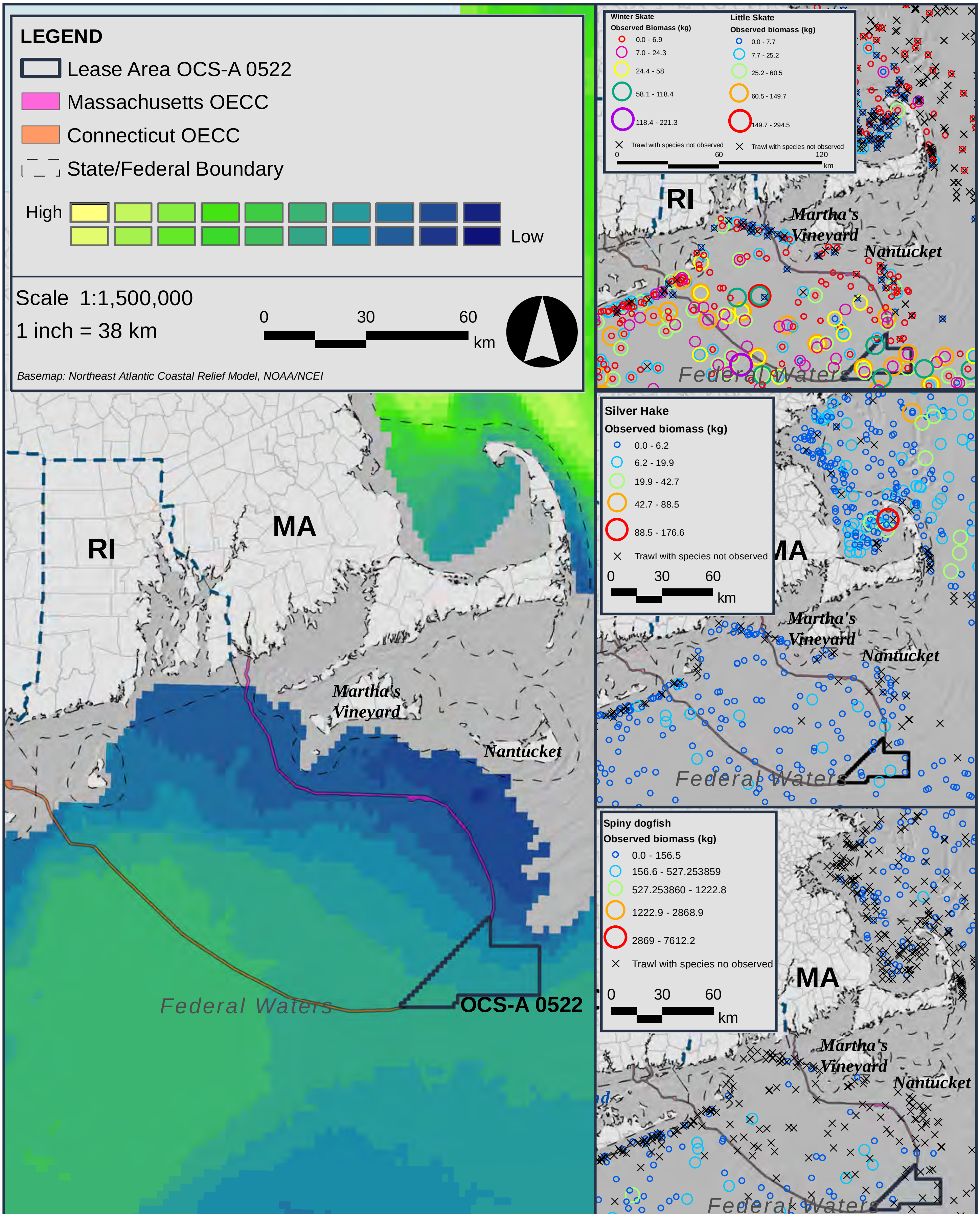

Figure 4.6-6
Expected Demersal Fish Biomass and Individual Biomass for Little Skate, Winter Skate, Silver Hake, and Spiny Dogfish Captured in Spring NEFSC Bottom Trawl Surveys from 2010-2019 (NROC 2009)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

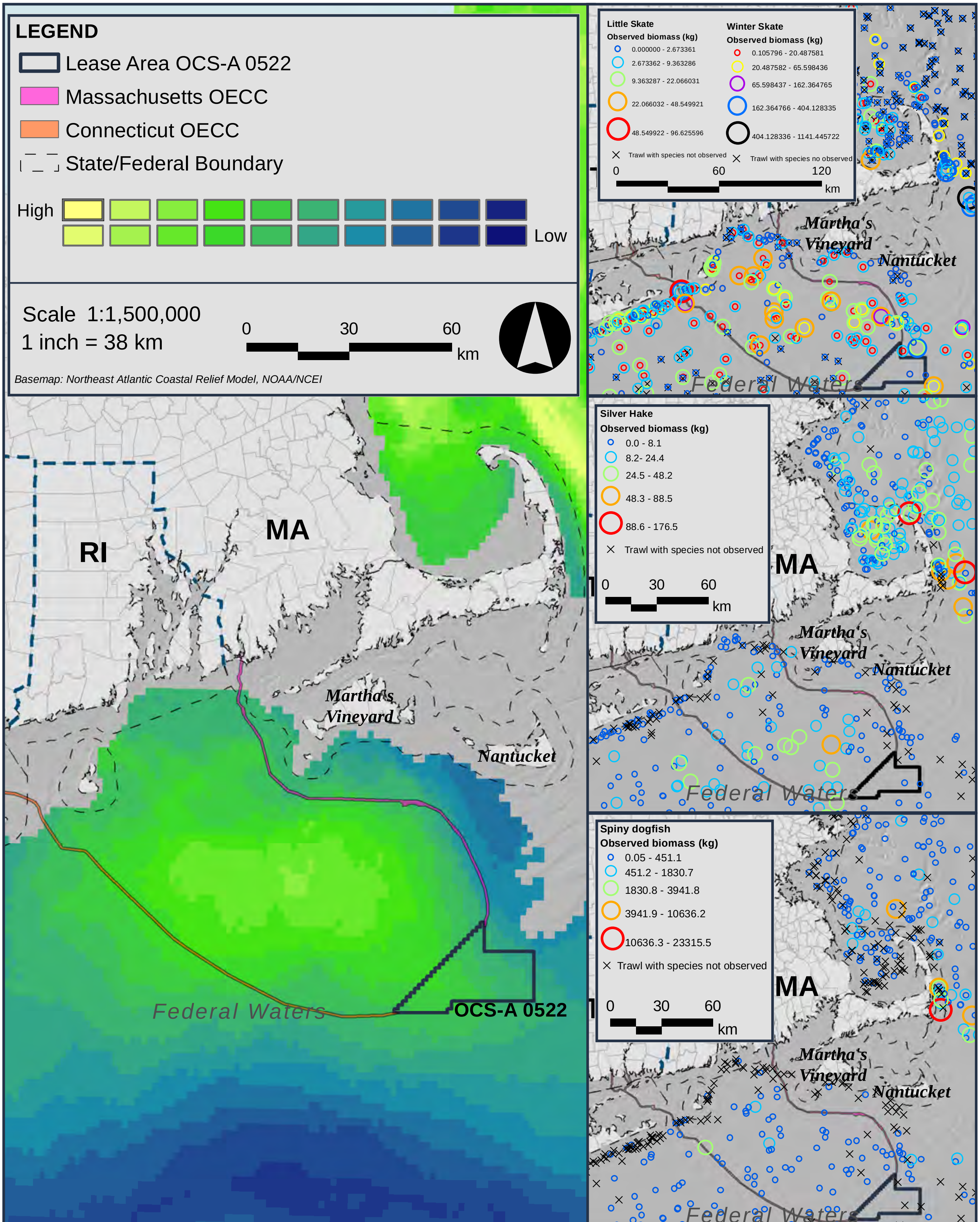

Figure 4.6-7
Expected Demersal Fish Biomass and Individual Biomass for Little Skate, Winter Skate, Silver Hake, and Spiny Dogfish Captured in Fall NEFSC Bottom Trawl Surveys from 2010-2019 (NROC 2009)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

2020), did not occur frequently in the Offshore Development Area (see Figure 4.6-8) (NEFSC 2022a, 2022b; MA DMF 2022b). Catches of sand lance that did occur in the Offshore Development Area were less than 1 kilogram (kg) (2.23 pounds [lb]).

Table 4.6-1 provides a summary of the species with ecological, recreational, and commercial significance likely found in the Offshore Development Area based on NEFSC trawl data, NEAMAP trawl data, and the MA WEA Revised Environmental Assessment (BOEM 2014). Species were deemed commercially and recreationally important if they comprised the top 99% of commercial landings value or top 99% of recreational landings weight in 2020 from Massachusetts, Rhode Island, Connecticut, and New York combined (NOAA 2022).

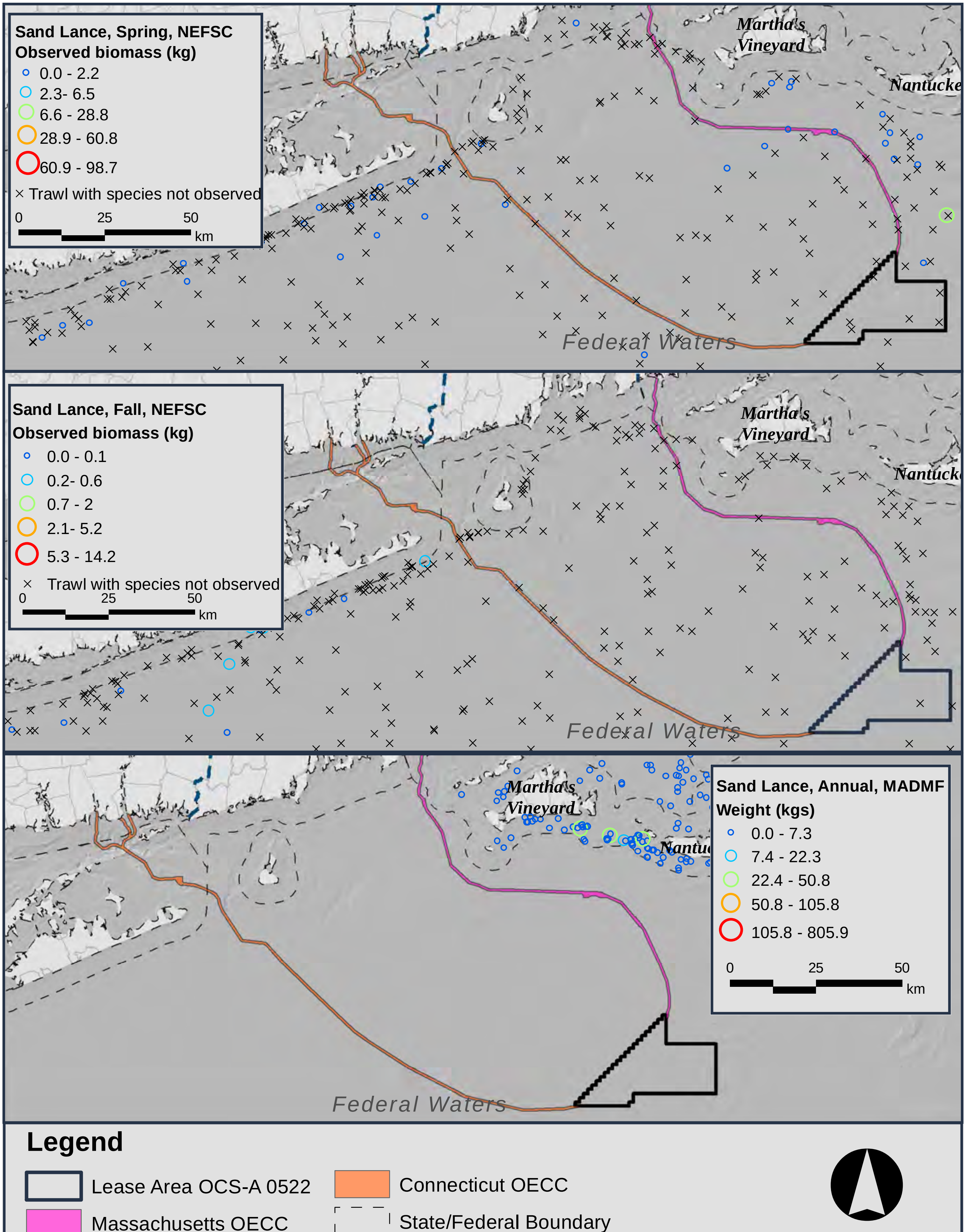

Figure 4.6-8

Trawl Survey Catch Data (2010-2019) For American Sand Lance and Northern Sand Lance in the Offshore Development Area

Table 4.6-1 Finfish and Significant Invertebrates Recently Recorded Within the Offshore Development Area

Common Name	Species Name	Listing Status	Commercial/ Recreational Importance	Adult Lifestyle	EFH Presence
Acadian redfish	*Sebastes fasciatus*		C,R	Demersal	
Alewife	*Alosa pseudoharengus*			Pelagic	
American conger	*Conger oceanicus*			Demersal	
American eel	*Anguilla rostrata*			Pelagic	
American lobster	*Homarus americanus*		C	Benthic	
American plaice	*Hippoglossoides platessoides*		C	Benthic	
American shad	*Alosa sapidissima*			Pelagic	
American sand lance	*Ammodytes americanus*			Demersal	
Atlantic albacore tuna	*Thunnus alalunga*			Pelagic	I
Atlantic bigeye tuna	*Thunnus obesus*		C,R	Pelagic	
Atlantic bluefin tuna	*Thunnus thynnus*			Pelagic	I
Atlantic bonito	*Sarda sarda*		R	Pelagic	
Atlantic butterfish	*Peprilus triacanthus*		C	Demersal / Pelagic	I
Atlantic cod	*Gadus morhua*		C,R	Demersal	I
Atlantic halibut	*Hippoglossus hippoglossus*		C	Benthic	
Atlantic menhaden	*Brevoortia tyrannus*		C,R	Pelagic	
Atlantic mackerel	*Scomber scombrus*		C,R	Pelagic	I
Atlantic salmon	*Salmo solar*	E		Pelagic	
Atlantic skipjack tuna	*Katuwonus pelamis*			Pelagic	I
Atlantic sea herring	*Clupea harengus*		C,R	Pelagic	I
Atlantic sea scallop	*Placopecten magellanicus*		C	Benthic	I
Atlantic sturgeon	*Acipenser oxyrhynchus*	T/E		Demersal	
Atlantic surf clam	*Spisula solidissima*		C	Benthic	I
Atlantic wolffish	*Anarhichas lupus*			Demersal	I
Atlantic yellowfin tuna	*Thunnus albacares*		R	Pelagic	I
Barndoor skate	*Dipturus laevis*			Demersal	I
Basking shark	*Cetorhinus maximus*			Pelagic	I
Bay scallops	*Argopecten irradians*		C	Benthic	
Beardfish	*Polymixia lowei*			Demersal	

Table 4.6-1 Finfish and Significant Invertebrates Recently Recorded Within the Offshore Development Area (Continued)

Common Name	Species Name	Listing Status	Commercial/ Recreational Importance	Adult Lifestyle	EFH Presence
Black sea bass	*Centropristis striata*		C,R	Demersal	I
Blue mussels	*Mytilus edulis*		C	Benthic	
Blue shark	*Prionace glauca*			Pelagic	I
Bluefin tuna	*Thunnus thynnus*		C	Pelagic	I
Bluefish	*Pomatomus saltatrix*		R	Pelagic	I
Blueback herring	*Alosa aestivalis*			Pelagic	
Channeled whelk	*Busycotypus canaliculatus*		C	Benthic	
Cobia	*Rachycentron canadum*			Pelagic	I
Common thresher shark	*Alopias vulpinus*			Pelagic	I
Cunner	*Tautogalabrus adspersus*		R	Demersal	
Cusk	*Brosme brosme*	CS		Demersal	
Dusky shark	*Carcharhinus obscurus*			Pelagic	I
Eastern oyster	*Crassostrea virginica*		C	Benthic	
Fourspot flounder	*Hippoglossina oblonga*			Demersal	
Giant manta ray	*Manta birostris*	T		Pelagic	
Golden tilefish	*Lopholatilus chamaeleonticeps*		C	Demersal	
Gulfstream Flounder	*Citharichthys arctifrons*			Demersal	
Greater amberjack	*Seriola dumerili*		R	Pelagc	
Haddock	*Melanogrammus aeglefinus*		C,R	Demersal	I
Hagfish	*Myxine glutinosa*			Demersal	
Horseshoe crab	*Limulus Polyphemus*			Benthic	
Jonah crab	*Cancer borealis*		C	Benthic	
King mackerel	*Scomberomorus cavalla*			Pelagic	I
Knobbed whelk	*Busycon carica*			Benthic	
Lightning whelk	*Busycon contrarium*			Benthic	
Little skate	*Leucoraja erinacea*			Demersal	I
Longfin squid	*Doryteuthis pealeii*		C	Pelagic	I

Table 4.6-1 Finfish and Significant Invertebrates Recently Recorded Within the Offshore Development Area (Continued)

Common Name	Species Name	Listing Status	Commercial/ Recreational Importance	Adult Lifestyle	EFH Presence
Longhorn sculpin	*Myoxocephalus octodecemspin-osus*			Demersal	
Mahi-mahi	*Coryphaena hippurus*		R	Pelagic	
Monkfish	*Lophius americanus*		C	Demersal	I
Northern puffer	*Sphoeroides maculatus*		R	Demersal	
Northern quahog	*Mercenaria mercenaria*		C	Benthic	
Northern sand lance	*Ammodytes dubius*			Demersal	
Northern sea robin	*Prionotus carolinus*			Demersal	
Ocean pout	*Macrozoarces americanus*			Demersal	I
Ocean quahog	*Artica islandica*		C	Benthic	I
Pollock	*Pollachius pollachius*		C,R	Demersal	I
Porbeagle shark	*Lamna nasus*			Pelagic	I
Rainbow smelt	*Osmerus mordax*			Pelagic	
Red hake	*Urophycis chuss*		R	Demersal	I
Rock crab	*Cancer irroratus*			Benthic	
Round herring	*Etrumeus teres*			Pelagic	
Sand lance	*Ammodytes* spp.			Demersal/ Pelagic	
Sand tiger shark	*Carcharias taurus*			Pelagic	I
Sandbar shark	*Carcharhinus plumbeus*			Pelagic	I
Sea raven	*Hemitripterus americanus*			Demersal	
Scup	*Stenotomus chrysops*		C,R	Demersal/ Pelagic	I
Shortfin mako	*Isurus oxyrinchus*	CS	R	Pelagic	I
Shortfin squid	*Illex illecebrosus*		C	Pelagic	I
Shortnose greeneye	*Chlorophthalmus agassizi*			Demersal	
Shortnose sturgeon	*Acipenser brevirostrum*	E		Demersal	
Silver hake	*Merluccius bilinearis*		C	Demersal	
Smooth dogfish	*Mustelus canis*			Demersal	I
Spanish mackerel	*Scomberomorus maculatus*			Pelagic	I

Table 4.6-1 Finfish and Significant Invertebrates Recently Recorded Within the Offshore Development Area (Continued)

Common Name	Species Name	Listing Status	Commercial/ Recreational Importance	Adult Lifestyle	EFH Presence
Spotted hake	*Urophycis regius*			Demersal	
Spiny dogfish	*Squalus acanthias*		C,R	Demersal	I
Striped bass	*Morone saxatilis*		C,R	Pelagic	
Striped sea robin	*Prionotus evolans*		R	Demersal	
Summer flounder	*Paralichthys dentatus*		C,R	Demersal	I
Swordfish	*Xiphias gladius*		C	Pelagic	
Tautog	*Tautoga onitis*		C,R	Demersal	
Thorny skate	*Amblyraja radiata*			Demersal	I
Tiger shark	*Galeocerdo cuvier*			Pelagic	I
Weakfish	*Cynoscion regalis*			Demersal	
White hake	*Urophycis tenuis*		C	Demersal	
White shark	*Carcharadon carcharias*			Pelagic	I
Windowpane flounder	*Scopthalmus aquosus*			Demersal	I
Winter flounder	*Pseudopleuronec-tes americanus*		C,R	Demersal	I
Winter skate	*Leucoraja ocellata*		C	Demersal	I
Witch flounder	*Glyptocephalus cynoglossus*		C	Demersal	
Wrymouth	*Cryptacanthodes maculatus*			Demersal	
Yellowtail flounder	*Limanda ferruginea*		C	Benthic	I

Notes:
1. BOEM 2014; He and Rillahan 2020a, 2020b, 2020c, 2020d; NOAA 2022; NEFSC 2022a, 2022b; NEAMAP 2022.
2. CS= candidate, T= threatened, E = endangered, C = commercial importance, R = recreational importance.
3. There are five distinct population segments (DPSs) of Atlantic sturgeon along the Atlantic coast: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. The Gulf of Maine DPS is listed as threatened whereas the remaining four DPSs are listed as federally endangered (ASSRT 2007; NOAA Fisheries 2017).

Threatened and Endangered Fish

Four federally listed threatened or endangered fish species may occur off the Northeast coast: shortnose sturgeon (*Acipenser brevirostrum*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), Atlantic salmon (*Salmo salar*), and giant manta ray (*Manta birostris*). Further descriptions of these species are provided below.

Atlantic Sturgeon

The Atlantic sturgeon is an anadromous species that spends much of its life in estuarine and marine waters throughout the Atlantic Coast, but adults ascend coastal rivers in spring to spawn in flowing freshwater. Sturgeon eggs are adhesive and attach to gravel or other hard substrata. Larvae develop as they move downstream to the estuarine portion of the spawning river, where they reside as juveniles for several months before migrating to coastal areas. Subadults will move into coastal ocean waters where they may undergo extensive movements usually confined to shelly or gravelly bottoms in 10–50 meters (m) (33–164 feet [ft]) water depths (Dunton et al. 2010).

Atlantic sturgeon distribution varies by season. They are primarily found in shallow coastal waters (bottom depth less than 20 m [66 ft]) during the summer months (May to September) and move to deeper waters (20–50 m [66–165 ft]) in winter and early spring (December to March) (Dunton et al. 2010).

There are five distinct population segments (DPSs) of Atlantic sturgeon along the Atlantic coast: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic. The Gulf of Maine DPS is listed as threatened whereas the remaining four DPSs are listed as federally endangered (ASSRT 2007; NOAA Fisheries 2017). Currently, there are no published population abundance estimates for any of the five DPSs. Population abundance estimates of mature or spawning adults exists for some of the 22 confirmed spawning rivers. Estimates of mature adults for individual rivers in the United States (US) range from 0–23 individuals in the Neuse River, North Carolina to 1,000–2,000 individuals in the Altamaha River, Georgia (NOAA Fisheries 2019). There were an estimated 18,000–21,000 adults between 2013–2015 in the St. John River, Canada (Dadswell et al. 2017).

National Oceanic and Atmospheric Administration (NOAA) Fisheries presumed that Atlantic sturgeon in the MA WEA would most likely be from the New York Bight DPS; however, genetic analyses and tagging studies indicated that the range of all five DPSs overlaps and extends from Canada to Florida (ASSRT 2007; NOAA Fisheries 2017). For the New York Bight DPS, spawning is only known to occur in the Delaware and Hudson Rivers, with critical also occurring in the Connecticut and Taunton Rivers (ASSRT 2007; NOAA Fisheries 2017). An individual Atlantic sturgeon was found near the mouth of the Thames River, Connecticut in 2016, but it has not been confirmed that the river is regularly used by this species (Benson 2016). Federally designated Critical Habitat for Atlantic sturgeon is assigned in the freshwater and coastal estuarine regions of known spawning rivers, none of which overlap with the Offshore Development Area (NOAA Fisheries 2017). Primary threats to Atlantic sturgeon include bycatch in trawl and gillnet fisheries, habitat degradation and loss, ship strikes, and general depletion from historical fishing. Limited Atlantic sturgeon have been captured in commercial fisheries or fisheries-independent surveys in the MA WEA, with no recorded catches within the Offshore Development Area (Dunton et al. 2010; Stein et al. 2004).

Shortnose Sturgeon

The shortnose sturgeon is an anadromous species found in larger rivers and estuaries on the east coast of North America from the St. Johns River in Florida to the St. Johns River in Canada. The shortnose sturgeon was listed as endangered in 1967 because the US Fish and Wildlife Service concluded that the fish had been eliminated from the rivers in its historic range (except the Hudson River) and was in danger of extinction because of pollution, loss of access to spawning habitats, and direct and incidental overfishing in the commercial fishery for Atlantic sturgeon (NOAA 2015). Shortnose sturgeon DPSs are currently identified in North Carolina, South Carolina, Georgia, and northern Florida river systems (NOAA 2015).

In the northern portion of its range, shortnose sturgeon are found in the Chesapeake Bay system, Delaware River, Hudson River, Connecticut River, Housatonic River, the lower Merrimack River, and the Kennebec River northward to the St. John River in New Brunswick, Canada. The closest populations to the Offshore Development Area are the Connecticut and Housatonic rivers, which drain into Long Island Sound (Shortnose Sturgeon Status Review Team 2010). Shortnose sturgeon occur primarily in fresh and estuarine waters and occasionally enter the coastal ocean. Adults ascend rivers to spawn from February to April, and eggs are deposited over hard bottom, in shallow, fast-moving water (Dadswell et al. 1984). Because of their preference for mainland rivers and fresh and estuarine waters, shortnose sturgeon are unlikely to be found near the Offshore Development Area.

Atlantic Salmon

Atlantic salmon is an anadromous species that historically ranged from northern Quebec southeast to Newfoundland and southwest to Long Island Sound. The Gulf of Maine DPS of the Atlantic salmon, which spawns within eight coastal watersheds within Maine, is federally listed as endangered. In 2009, the DPS was expanded to include all areas of the Gulf of Maine between the Androscoggin River and the Dennys River (NOAA 2016).

The life history of Atlantic salmon consists of spawning and juvenile rearing in freshwater rivers to extensive feeding migrations in the open ocean. Adult Atlantic salmon ascend the rivers of New England in the spring through fall to spawn. Suitable spawning habitat consists of gravel or rubble in areas of moving water. Juvenile Atlantic salmon remain in the rivers for one to three years before migrating to the ocean. The adults will undertake long marine migrations between the mouths of US rivers and the northwest Atlantic Ocean, where they are widely distributed seasonally over much of the region. Typically, most Atlantic salmon spend two winters in the ocean before returning to freshwater to spawn (NOAA 2016).

It is possible that adult Atlantic salmon may occur off the Massachusetts coast while migrating to rivers to spawn. However, only certain Gulf of Maine populations are listed as endangered, and Gulf of Maine salmon are unlikely to be encountered south of Cape Cod (BOEM 2014).

Giant Manta Ray

The giant manta ray is a global pelagic species listed as threatened throughout its range in 2018 under the Endangered Species Act (ESA) with scattered individual populations found both offshore and along productive coastlines (CITES 2013). The species is highly migratory and inhabits mostly tropical and subtropical waters with occasional presence in temperate waters. Giant manta rays can tolerate temperatures from 15-30 °Celsius [C] (59-86 °Fahrenheit [F]) and sightings primarily occur nearshore at shelf-edges (Farmer et al 2021). Individuals are typically observed as far north as New Jersey in the Western Atlantic basin. While the Offshore Development Area contains habitat that can support giant manta rays, occurrence is unlikely as it is at the northern edge of the species' range and sightings north of New Jersey occur farther offshore, along the continental shelf edge (Farmer et al. 2021). Giant manta rays are viviparous, producing live neonate offspring about 1 m (3.3. ft) in length capable of swimming, so there is no potential for effects on eggs or larvae in the Offshore Development Area (Miller and Klimovich 2017). In addition, the Biological Assessment for Vineyard Wind 1 determined that giant manta ray presence in their nearby project area would be rare, and impacts are not expected (BOEM 2018).

4.6.1.2 Lease Area OCS-A 0522

To characterize fish species occurring within the Lease Area on a seasonal basis, the Proponent contracted SMAST to conduct seasonal trawl surveys starting in spring 2019 through fall 2021 This ongoing survey was adapted from the NEAMAP nearshore trawl survey. Ten randomly selected tow locations, one in each of ten sub-areas (~53.6 square kilometer [km^2] [20.69 square miles [mi^2]/sub-area), were determined for each sampling season. Table 4.6-2 shows the total weight of all species caught in the four seasons sampled. For species richness, 27 species were caught in winter, 35 species in spring, 28 species in summer, and 35 species in fall. Fall also had the highest catch by weight of species with 11,770 kg (25,948 lb). The single highest catch of any species occurred in the summer with 3,651 kg (8,049 lb) of scup. Overall, the top five species caught in the Lease Area were little skate, red hake, spiny dogfish, scup, and silver hake. The top 10 species captured accounted for 93% of the total catch or 11,309 kg (24,932 lb). Other species of commercial or regulatory significance captured were American lobster, Atlantic cod, Atlantic halibut, Atlantic sea scallop, haddock, summer flounder, winter flounder, and yellowtail flounder (He and Rillahan 2020a, 2020b, 2020c, 2020d).

In 2019 and 2020, SMAST conducted drop camera surveys in the Lease Area. Over the 2-year period, 22 stations, spaced ~5.6 km (3.47 mi) apart, were systematically sampled each year in the Lease Area. Every station had four images (n = 440) of the seafloor taken with a high-resolution camera. The 2019 and 2020 surveys followed the same design with 88 images taken in both surveys at two different months of the year. In the 2019 survey, drop camera surveys of the Lease Area were conducted in July and October. In the 2020 survey, drop camera surveys were conducted in August and October. In both surveys, observations of marine organisms were relatively low, with 18 benthic animal groups observed, as well as a decline in species present from the summer to fall sampling. Sea stars had the highest number of observations

(141 individuals) in the 2019 surveys. The 2019 surveys contained more species observed than the 2020 surveys with benthic animal groups such as crabs, hermit crabs, and red hake containing more than 20 observations, while the 2020 surveys only had one group with over 20 observations (crabs). Other species observed (less than 10 individuals) include Atlantic sea scallop, flatfish species, red hake, haddock, northern sea robin, silver hake, ocean pout, and hagfish. Results from the 2020 survey are similar in number of organisms observed; unidentified crabs were the highest observed species with 73 individuals. Other species (less than 11 individuals) include silver hake, unidentified skate, unidentified flatfish, and Atlantic sea scallop (Bethoney et al. 2020; Stokesbury et al. 2022).

Additionally, the New England Aquarium and University of Massachusetts Boston have collected data on the Highly Migratory Species (HMS) likely to occur in the Lease Area. Generally, recreational fishing effort for HMS is low, with approximately 0.69% to 2.63% of all fishing effort with the MA WEA occurring in the Lease Area (Kneebone and Capizzano 2020). Reported recreational capture of HMS include bluefin tuna, mahi-mahi, and yellowfin tuna. Conventional tag data consists of blue marlin, blue shark, bluefin tuna, sandbar shark, shortfin mako, white marlin and yellowfin tuna (Kneebone and Capizzano 2020).

Other relevant data sources include the NEFSC program, which has collected data in and around the Offshore Development Area since 1963. The NEFSC spring and fall bottom trawl surveys use a stratified random sampling design. Generally, three stations are planned within each depth-based stratum. Since 1968, 30 spring tows have been made in the Lease Area, six of which were conducted between 2010 and 2019. Total catch of individual species ranged from 301 individuals in 2017 to 6,453 individuals in 2010; relative abundance was dominated by silver hake, Atlantic herring, and little skate. In 2017 and 2019, however, no Atlantic herring were caught, and little skate dominated the catch in 2019. For fall-time surveys, 27 tows were conducted in the Lease Area from 1964, and from 2010 to 2022, two tows were conducted in the Lease Area, one in 2016 and one in 2021. There was significant variability between the two survey years with 13,444 individuals across 22 species caught in 2016 and only 1,842 across 21 species caught in 2021. In 2016, catch was dominated by scup, haddock, and longfin squid. Catches of scup and longfin squid were one to two orders of magnitude greater in 2016 vs 2021; 7,652 scup were caught in 2016 and only 54 individuals were caught in 2021. Further, 2016 was one of the only years over the entire survey that haddock occurred in the Lease Area. The 2021 catch was dominated by northern sea robin, gulf stream flounder, and silver hake (NEFSC 2022a, 2022b).

NEFSC data also includes Atlantic surf clam/ocean quahog and Atlantic sea scallop surveys. While much of the scallop data were greater than 20 years old, the Atlantic surf clam/ocean quahog survey had more recently sampled stations. Eleven tows were conducted from 2002 to 2008. A total of 2,373 individuals from ten taxa were captured. The highest captured taxa included ocean quahog with a total of 2,327 individuals (NEFSC 2022d).

Table 4.6-2 Weights (kg) of Species Captured During SMAST Trawl Surveys of the Lease Area from 2019–2021

Common Name	Winter	Spring	Summer	Fall	Total
Spiny dogfish	67.1	1,907.5	4.8	5,727.2	7,706.6
Scup	0	0.7	3,651.7	1,709.8	5,362.2
Little skate	822.6	672.8	1,028.3	1,773	4,296.7
Red hake	0.8	1,206.7	1036	202.7	2,446.2
Silver hake	143.5	434.3	676.7	395.4	1,649.9
Butterfish	2.8	170.4	667.9	655.9	1,497.0
Winter skate	20.6	618.3	0	353.2	992.1
Alewife	2.6	793.6	21.0	0.2	817.4
Barndoor skate	1.4	666.9	20.4	17.2	705.9
Northern sea robin	0	10.4	252.4	326.5	589.3
Atlantic longfin squid	0.1	98.2	152.1	197.5	447.9
Monkfish	2.4	223.9	31.4	23.2	280.9
Summer flounder	0.2	59.4	43.2	85.1	187.9
Atlantic herring	153.5	14.1	0	19.5	187.1
Smooth dogfish	0	5.6	174.5	2.3	182.4
Spotted hake	1.9	0	71.8	103.3	177.0
Fourspot flounder	2.2	55.1	69.1	42.3	168.7
Shortfin squid	0	109.2	0	0	109.2
Windowpane flounder	4.9	3.1	12.0	55.7	75.7
American shad	2.8	65.9	0	3.0	71.7
Longhorn sculpin	23.6	8.9	0	18.4	50.9
Atlantic mackerel	27.9	8.8	0.1	0.3	37.1
Bluefish	0	0	6.4	23.4	29.8
Rock crab	3.7	8.2	12.3	4.1	28.3
Ocean pout	0.1	27.6	0	0	27.7
Haddock	2.5	14.8	8.1	0	25.4
Gulfstream flounder	0	18.2	2.5	2.2	22.9
Black sea bass	0	1.8	5.6	10.1	17.5
Atlantic cod	13.3	0	0	3.8	17.1
Winter flounder	0	1.6	6.1	0.5	8.2
Weakfish	0	0	0	7.0	7.0
Yellowtail flounder	0.5	3.1	0.6	0	4.2
White hake	0	0	0	3.2	3.2
Sea raven	2.3	0.9	0	0	3.2
Atlantic sea scallop	1.0	0.5	0.5	0.9	2.9
Cancer crab	2.6	0	0	0	2.6
American lobster	0	0.8	1.7	0	2.5
Blueback herring	0.3	1.9	0	0	2.2
Conger eel	0	0	0	1.1	1.1
Northern kingfish	0	0	0	1.0	1.0
American flounder	0	0.8	0	0	0.8
Surf clam	0	0	0	0.5	0.5
Witch flounder	0	0.4	0	0	0.4
Atlantic menhaden	0	0	0.4	0	0.4
Cusk	0	0	0.2	0	0.2
Atlantic cutlassfish	0	0	0	0.1	0.1
Lizardfish	0	0	0	0.1	0.1
Total	**1,307.2**	**7,214.4**	**7,957.8**	**11,769.7**	**28,249.1**

4.6.1.3 Massachusetts OECC

The MA DMF conducts bottom trawl surveys for a suite of finfish and invertebrates, and a ventless trap survey for American lobster. The inshore bottom trawl survey occurs in the spring and fall, operates during daylight hours, and when possible, runs continuously until completed (Camisa et al. 2016). Tows are 20 minutes long at 0.5 meters per second (m/s) (2.5 knots) (Camisa et al. 2016). The number of individuals captured in tows that occurred within an 8 km (5 mi) buffer of the Massachusetts OECC from 2010 to 2021 were evaluated. Twelve of the 73 tows directly overlap the proposed OECC. The most abundant species captured was scup, with a total of 143,716 individuals that primarily represent the young-of-year cohort spawned in the spring/summer, based on weight. Many of the species captured exhibit strong seasonal trends. Most scup (80%), butterfish (92%), longfin squid (96%), bay anchovy (99%), Atlantic moonfish (100%), and black sea bass (76%) were captured in the fall. Conversely, most red hake (96%), silver hake (84%), winter flounder (91%), Atlantic herring (96%), spotted hake (91%), summer flounder (65%), and fourspot flounder (87%) were caught in the spring (MA DMF 2022b). Figure 4.6-9 and Figure 4.6-10 show the catch of longfin squid in Massachusetts state waters around the proposed OECC. Further, Figure 4.6-11 shows the blue mussel and whelk species captured east of the proposed OECC.

The MA DMF ventless trap survey follows a random stratified approach (location and depth) in which sampling strata are divided by NMFS statistical areas and by three depth ranges (after 2011): 0–20 m (0-66 ft), 21–40 m (69-131 ft), 41–60 m (134-167 ft). For each year of the survey, new sampling stations were randomly selected in each stratum, for a total of 42 stations sampled each year from late spring to early fall. Each station is sampled with one six-trap trawl using alternating vented and ventless traps. Overall, no lobsters were caught within 8 km (5 mi) from the Massachusetts OECC and the most common species captured were Jonah, spider, and rock crabs during 2010 through 2021. The most abundant finfish were black sea bass, cunner, and scup; most (~60%) were caught during summer (Pugh and Glenn 2020, MA DMF 2022a).

For NEFSC spring trawl data within an 8 km (5 mi) buffer of the OECC, there were 127 tows conducted from 1968 to 2021, with 31 of these tows occurring from 2010 to 2021. The dominant species captured were Atlantic herring, silver hake, scup, little skate, and alewife. There were 39,939 Atlantic herring caught from 2010 to 2014, with the highest catch of 21,619 individuals in 2010; however, only 17 Atlantic herring were captured from 2015 to 2021(NEFSC 2022b).

For NEFSC fall trawl data, 30 tows occurred from 1964 to 2021 within an 8 km (5 mi) buffer of the OECC. Generally, catch was much higher in the fall with 155,771 individuals captured. Dominant species captured were scup, longfin squid, butterfish, silver hake, and little skate. The highest catch occurred in 2015 and 2016. Almost half of the entire catch (26,241 individuals) consisted of scup in 2015, while 30% of the catch (15,383 individuals) in 2016 consisted of longfin squid. In 2021, catch was dominated by butterfish, with 12,105 individuals captured, approximately 38% of the entire catch (NEFSC 2022a).

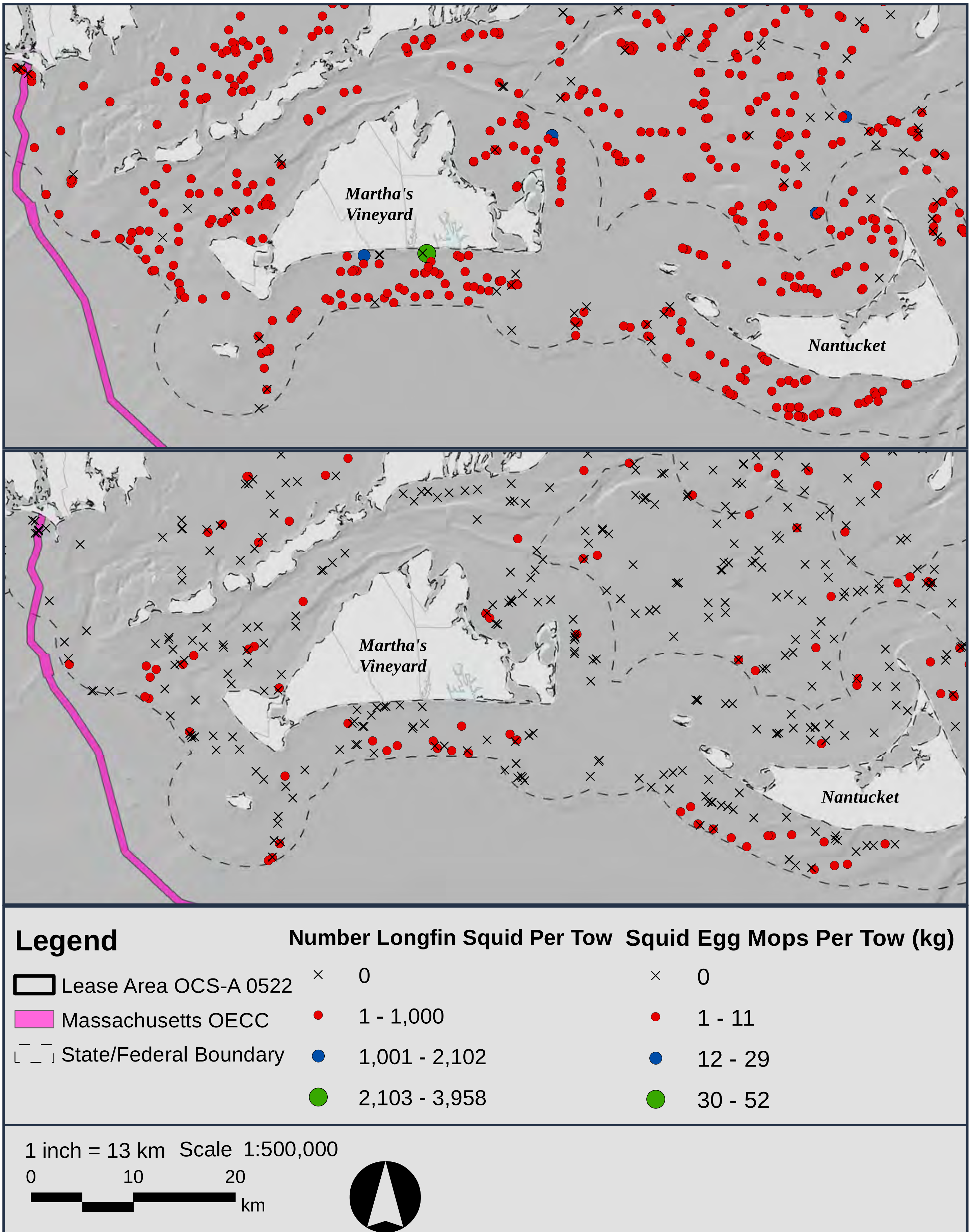

Figure 4.6-9

Longfin Squid (2007-2021) and Egg Mop (2007-2017) Catch Data from MADMF Bottom Trawl Spring Surveys

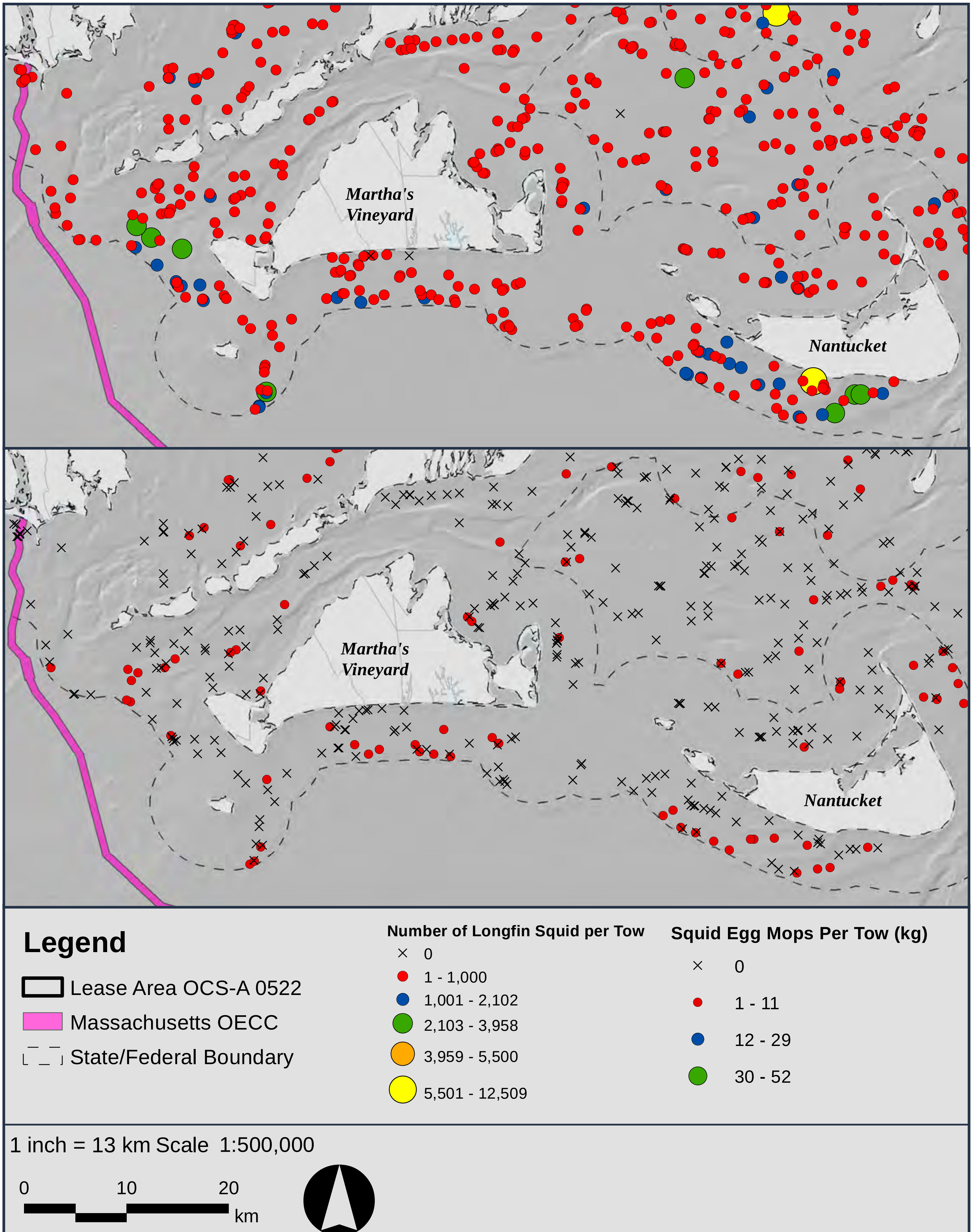

Figure 4.6-10

Longfin Squid (2007-2021) and Egg Mop (2007-2017) Catch Data from MADMF Bottom Trawl Fall Surveys

VINEYARD NORTHEAST

VINEYARD OFFSHORE

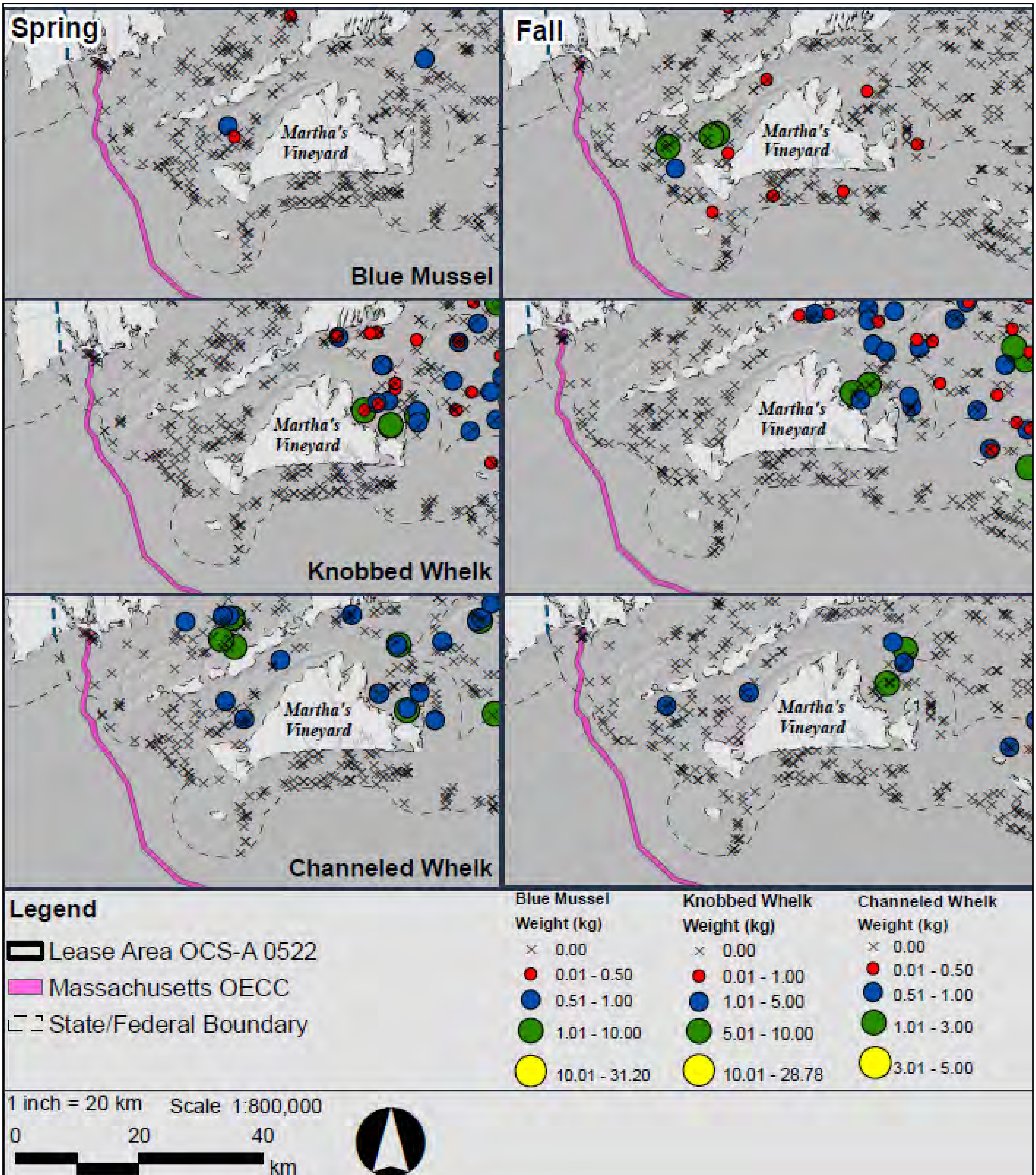

Figure 4.6-11

Commercial Invertebrate Species Data from Seasonal MADMF Bottom Trawl Surveys (2007-2021)

VINEYARD NORTHEAST

VINEYARD OFFSHORE

Eleven tows for the NEFSC Atlantic surf clam/ocean quahog survey were conducted in 2002, 2005, 2008, 2011, 2013, 2015, and 2018 and directly overlapped the buffered region of 8 km (5 mi) around the proposed Massachusetts OECC. A total of 12,482 individuals were captured from 23 different taxa, across all years. The highest captured species was ocean quahog, ~95% of the entire catch, with a total of 11,808 individuals (NEFSC 2022c).

The NEAMAP survey collects data biannually (spring and fall) in nearshore waters (Bonzek et al. 2014). Similar to the other surveys, NEAMAP follows a stratified random design using the same depth strata as the NEFSC trawl survey. At each station, a bottom trawl is towed for 20 minutes at 1.5 m/s (3 knots) (Bonzek et al. 2015). A total of 108 tows occurred from 2010 to 2021 within an 8 km (5 mi) buffer of the OECC. Butterfish, scup, silver hake, alewife, and longfin squid were the dominant species captured during the spring, with annual average catches of 3,770, 3,416, 2,847, 1,063, and 879 individuals, respectively. Annual catch varied significantly from a low of 2,937 individuals across all species caught in 2011 to a high of 35,475 individuals in 2018. NEAMAP fall catch was higher than the spring, with catch ranging from a low of 16,038 individuals in 2011 to 105,687 individuals in 2014. Catch was dominated by butterfish, scup, and longfin squid which made up 96% of the total catch across all years, with average annual catches of 347,458, 123,716, and 64,881 individuals, respectively (NEAMAP 2022).

4.6.1.4 Connecticut OECC

The CT DEEP marine fisheries program has conducted 36 years of bottom trawl data from New London to Greenwich, Connecticut in water depths of 5 to 46 m (16 to 151 ft) in state waters. The survey uses a stratified-random sampling design, with two sites sampled in each stratum. Each site is sampled with an otter trawl for a tow duration of 30 minutes at 1.8 m/s (3.5 knots). Dominant species were scup, longfin squid, butterfish, anchovy, and northern sea robin was consistently the highest species caught with an average catch of 5,286 individuals. The next most abundant species, longfin squid, had an average catch of 756 individuals annually (CT DEEP 2022).

The NEFSC spring trawl survey data within an 8 km (5 mi) buffer of the Connecticut OECC includes 143 tows from 1968 to 2021, 32 of which occurred from 2010 to 2021. Silver hake, Atlantic herring, little skate, spotted hake, and winter skate were the dominant species captured with annual average catches of 1,777, 940, 513, 263, and 132 individuals, respectively. Annual catch varied from a low of 285 individuals across all species caught in 2016 to a high of 12,321 individuals in 2010. For the fall, 138 tows occurred from 1963 to 2021; of these, 30 occurred from 2010 to 2019 (NEFSC 2022b).

The NEFSC fall trawl survey catch was generally higher than the spring, and similarly annual catch rates varied by several orders of magnitude from a low of 3,112 individuals in 2019 to 115,568 individuals in 2013. Catch was dominated by longfin squid, butterfish, haddock, scup, and silver hake with average annual catches of 6,233, 4,818, 4,069, 4,509, and 1,145 individuals respectively. The haddock catch was driven by an unusually high number of individuals captured in 2013, excluding this year, average catch of haddock was ~15 individuals captured annually (NEFSC 2022a).

Fourteen tows from the NEFSC Atlantic surf clam and ocean quahog survey were conducted in 2002, 2005, 2008, 2011 and 2013. A total of 10,371 individuals were captured from 18 different taxa, across all years. The highest captured species was the ocean quahog comprising ~99% of entire catch, with a total capture of 10,218 individuals (NEFSC 2022c).

For the NEAMAP survey, a total of 62 tows occurred from 2010 to 2021 within an 8 km (5 mi) buffer of the Connecticut OECC. Spring catch was dominated by scup, silver hake, longfin squid, butterfish, and northern sea robin with average annual catches of 1,567, 696, 610, 581, and 390 individuals, respectively. These five species were 72% of total catch. Annual catch varied significantly from a low of 1,019 individuals across all species caught in 2018 to a high of 22,604 individuals in 2017. Similar to the Massachusetts OECC, NEAMAP fall catch was higher than the spring, with catch ranging from a low of 5,397 individuals in 2019 to 70,152 individuals in 2014. Catch was dominated by scup, butterfish, and longfin squid which made up 94% of the total catch across all years, with average annual catches of 10,764, 9,080, and 3807 individuals, respectively (NEAMAP 2022).

4.6.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect finfish and invertebrates during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.6-3.

Table 4.6-3 Impact Producing Factors for Finfish and Invertebrates

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Seafloor Disturbance and Habitat Modification	•	•	•
Suspended Sediments and Deposition	•	•	•
Entrainment and Impingement	•	•	•
Electromagnetic Fields		•	
Noise	•	•	•

Potential effects to finfish and invertebrates were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

4.6.2.1 Seafloor Disturbance and Habitat Modification

Temporary to long-term seafloor disturbance and habitat modification may occur from the installation, maintenance, and decommissioning of Vineyard Northeast components in the Lease Area and OECCs. These components include foundations for the wind turbine generators (WTGs), electrical service platforms (ESP[s]), and booster station, scour protection, export cables, inter-array and inter-link cables, and cable protection (if required). Long-term habitat modification may result from installation of foundations, scour protection, and cable protection (if required). Additional temporary habitat modification may result from installation, maintenance, and decommissioning of export, inter-array, and inter-link cables; pre-installation activities (such as sand bedform dredging, boulder clearance, and a pre-lay grapnel run); and usage of equipment that contacts the seafloor (such as jack-up vessels, vessel anchors or spud legs). Table 4.6-4 provides the expected long-term and temporary seafloor impacts. Additional details are available in Section 3.11 of COP Volume I.

Table 4.6-4 Summary of Maximum Potential Seafloor Disturbance

Activity	Long-Term Seafloor Disturbance	Temporary Seafloor Disturbance	Total Seafloor Disturbance
Maximum Total Disturbance in the Lease Area	2.03 km^2 (501 acres)	7.15 km^2 (1,767 acres)	9.08 km^2 (2,244 acres)
Maximum Total Disturbance in the Massachusetts OECC	0.35 km^2 (87 acres)	4.35 km^2 (1,075 acres)	4.37 km^2 (1,079 acres)
Maximum Total Disturbance in the Connecticut OECC	0.17 km^2 (43 acres)	4.31 km^2 (1,066 acres)	4.31 km^2 (1,066 acres)

Direct impacts from seafloor disturbance during construction, maintenance activities, or decommissioning include the physical displacement, injury, and mortality of organisms in both the Lease Area and OECCs. Sessile and slow-moving benthic and demersal species, such as shellfish, and early life stages of invertebrates and fishes, such as eggs and larvae, are most at risk of injury and death from physical trauma as foundations, scour protection, cables, anchors, anchor lines, jack-up legs, and spud legs contact the seafloor. If construction occurs during cooler temperatures, species that bury themselves in the winter such as horseshoe crabs (Walls et al. 2002) and blue crabs (Millikin 1984) have greater risks of impact. Export, inter-array, and inter-link cable installation and maintenance may affect organisms up to the target cable burial depth of 1.5–2.5 m (5–8 ft) beneath the stable seafloor,[51] or deeper where dredging is required prior to cable installation, and foundation installation may affect organisms up to the maximum foundation penetration depth as listed in Sections 3.3 and 3.4 of COP Volume I. Overall, these impacts are expected to be localized and limited to the relatively small impact areas from

[51] Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

construction (see Table 4.6-4). In addition, the MA WEA was selected by BOEM because it contains very little sensitive finfish and invertebrate habitat (Guida et al. 2017). Mobile species and life stages including demersal and pelagic fishes and benthic and pelagic invertebrates are expected to be impacted temporarily as they move to avoid physical contact and motions perceived as threats. These temporary avoidance impacts occur over a relatively short time period and are comparable to existing disturbances by vessel traffic and fishing gear with organisms expected to return after the action ceases. Impacts from sedimentation during construction are discussed in Section 4.6.2.2. Deflagration or detonation of unexploded ordnances (UXO) and/or discarded military munitions (DMM) has the potential to affect fish and invertebrates through seafloor disturbance, direct mortality, and underwater noise; this IPF is discussed further in Section 4.6.2.5.

Temporary habitat modifications, including temporary alterations to bathymetry, are expected to primarily affect benthic and demersal fishes and invertebrates. Effects could range from minor benefits of increased available prey immediately after disturbance (Hiddink et al. 2008) or increased seafloor relief to limited impacts from loss of key prey species due to mortality in affected areas. However, these effects are considered temporary because habitats are expected to begin recovery once construction, maintenance, or decommissioning activities are completed. The local severity of these impacts is comparable to ongoing fishing dredge impacts along the Northeast US shelf and potential impacts are relatively small in spatial scale (see Table 4.6-4). Dynamic, sandy physical habitat begins to recover substantially within a few months of disturbance and can fully recover abundance within two years and recover biomass and diversity in two to four years (Van Dalfsen and Essink 2001; Dernie et al. 2003). Additionally, the Proponent will work to minimize temporary habitat effects. For vessels other than cable laying vessels (which must maintain tension on anchor lines), where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, the use of mid-line anchor buoys will be considered (where feasible and considered safe) as a potential measure to reduce impacts from anchor line sweep. In addition, a benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECCs). A fisheries monitoring plan will be developed to monitor key indicators before and after construction; such monitoring may be part of regional monitoring efforts.

Long-term modification may affect benthic/demersal and pelagic fishes and invertebrates through the alteration of habitat type. Foundations and scour protection will create hard, complex structure in the water column and along the seafloor that previously did not exist, and cable protection will cover existing habitat with anthropogenic hard bottom. Therefore, foundations, scour protection, and cable protection are expected to have localized benefits for structure-associated species through the conversion of habitat, with potential localized adverse impacts to species that prefer fine substrates. Demersal fishes, such as the sand lance, may be affected by the conversion of soft bottom habitat as they depend on coarse-grained sand for a suite of ecological functions. However, understanding sand lance population dynamics and abundance has proven to be quite difficult as their burrowing behavior allows them to evade bottom trawling (Staudlinger et al. 2020). Recently, the drivers of sand lance population fluctuations along the Northeast US shelf were examined and predation, hydrology and prey abundance were found to influence the abundance of sand lance. Specifically, declines were connected to increases in warm slope water and the abundance of Atlantic herring (*Clupea harengus*; Suca et al. 2021). Projections of current trajectory of sand land abundance indicate a decline in abundance and changes within the future complex of forage fish on the Northeast US shelf (Suca et al. 2021).

The newly-created foundation structure throughout the water column can be compared to the addition of artificial reefs which have been shown to lead to ecological benefits (Langhamer 2012). Some of these benefits observed around WTGs include increased biodiversity and abundances of fishes (Wilhelmsson et al. 2006; Andersson and Öhman 2010; Riefolo et al. 2016; Raoux et al. 2017). Addition of foundations may also alter foodweb dynamics from the bottom up through the introduction of new surfaces for filter feeders to colonize and consume plankton (Coates et al. 2014; Slavik et al. 2017). Cable protection is expected to have similar impacts in places where it is placed on fine substrate, but where it is placed on hard/complex habitat, it may have temporary negative impacts to structure-oriented species until it is colonized by the benthic community. Both cable protection and scour protection have potential for providing long-term benefits via increased cobble/boulder-like habitat which is a key habitat for lobsters (Selgrath et al. 2007; Linnane et al. 1999) and other species.

Additional research focused on changes in community assemblages related to habitat around offshore wind farms found that species that prefer complex habitat became newly established after installation while communities in nearby soft-bottom habitats remained unchanged (Stenberg et al. 2015). Wind farms have also been found to have localized increases in abundance (Løkkeborg et al. 2002) and improved condition and growth rates (Reubens et al. 2013) of commercially valuable species. However, the habitat created by the addition of offshore components also has potential to benefit non-indigenous species and provide a mechanism for wider dispersal of potentially harmful non-indigenous species through a steppingstone effect (Glasby et al. 2007) resulting in localized impacts to the finfish and invertebrates, such as blue mussels and fishes, that consume them.

Overall, any long-term changes due to the introduction of foundations, scour protection, and cable protection are only anticipated to affect a small percentage of the available habitat in the Lease Area and OECCs. For example, long-term impacts are only approximately 0.4% of the total size of the Lease Area. Additionally, the Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route.

Another potential long-term indirect effect from the presence of foundations could include modification of pelagic habitats for planktonic life stages of finfish and invertebrates. The presence of foundations may alter hydrodynamics and cause changes in recruitment and dispersal of pelagic eggs and larvae. However, modeling of larval transport in and around simulated wind farms in the MA WEA determined that WTGs would not significantly affect southward larval transport coming from Georges Bank during storms (Chen et al. 2016). Additional information on potential changes to hydrodynamics is provided in Section 3.2.

During decommissioning, all offshore components will be removed, although the offshore cables may be retired in place or removed. Temporary effects from decommissioning are expected to be similar to those experienced during construction. The long-term modifications of habitat are expected to be reversed upon decommissioning when offshore components are removed below the mudline (unless cable and scour protection are retired in place, in which case they will continue to function as hard/complex bottom unless buried by sedimentation).

4.6.2.2 Suspended Sediments and Deposition

Temporary increases in suspended sediments and subsequent sediment deposition may occur in the Lease Area and OECCs from the installation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, foundations, and scour protection. Specifically, sediment is expected to be suspended into the water column during cable pre-installation activities (e.g., sand bedform dredging, boulder clearance, and a pre-lay grapnel run), cable installation, seabed preparation prior to foundation installation (if needed), installation of cable protection (where required), the use of other equipment that contacts the seafloor (e.g., jack-up vessels, vessel anchors, or spud legs), and excavation of the temporary horizontal directional drilling (HDD) exit pit. Most of these activities would occur during construction, with potential for limited maintenance if cables require repair or maintenance; however, any maintenance effects would be expected to be far less impactful than those from construction activities. Impacts from suspended sediments and deposition would be temporary and confined to a small area close to the location of the installation activity.

Direct effects on finfish and invertebrates from suspended sediments can include visual impairment, asphyxiation, and reduced filter feeding abilities. Severity of impacts from suspended sediments during construction, maintenance activities, or decommissioning would vary based on the concentration and duration of suspended material. Sediment is suspended regularly by storm events so many species are adapted to periodic impacts from suspended sediment. Reduced growth and oxygen consumption of bivalves can occur when sediment concentrations of 100 milligrams per liter (mg/L) persist for two days (Wilber and Clarke 2001). Sublethal effects (i.e., non-lethal asphyxiation) were observed for adult white perch (*Morone americana*) when 650 mg/L of suspended sediments persisted for five days (Sherk et al. 1974). Lethal effects for other adult fish species can occur at concentrations greater than 1,000 mg/L that persist for at least 24 hours (Sherk et al. 1974; Wilber and Clarke 2001). Fish eggs and larvae are typically more sensitive, with delayed hatching observed for white perch at a sediment concentration of 100 mg/L for one day (Sherk et al. 1974). Therefore, 100 mg/L for 24 hours is considered a conservative threshold for impacts from suspended sediments. As described in Section 4.5, concentrations of 10 mg/L for 24 hours could potentially affect settlement of extremely sensitive life stages (i.e., coral larvae) and is therefore considered an extremely conservative threshold.

Direct effects on finfish and invertebrates from the resettlement of suspended sediments can include mortality or injury, particularly for immobile species or life stages from burial and smothering. Severity of impacts from deposited sediments during construction, maintenance activities, or decommissioning would vary based on the thickness of material. As discussed in Section 4.5, some infaunal bivalves can withstand deposition levels up to 300 millimeters (mm) (12 inches [in]) (Essink 1999). Sessile or seafloor surface-dwelling species, such as blue mussels and queen scallops (*Aequipecten opercularis*), are more sensitive to deposition levels and lethal effects have been observed with burial depths between 20–100 mm (0.8–4 in) (Essink 1999; Hendrick et al. 2016). For demersal eggs (fish [e.g., Atlantic wolffish (*Anarhichas lupus*), Atlantic herring, and winter flounder], squid [e.g., longfin inshore squid], and whelk species), deposition greater than 1 mm (0.04 in) can result in the burial and mortality of that life stage (Berry et al. 2011). Therefore, sediment deposition thicknesses of 1 mm (0.04 in) and 20 mm (0.8 in) are considered the conservative thresholds for demersal eggs and shellfish, respectively.

To assess the impacts of suspended sediments and deposition, sediment transport modeling was completed for three activities: export cable and inter-array cable installation, HDD exit pit construction,[52] and sand bedform dredging (see Appendix II-P). Activities were modeled separately within the Lease Area, Massachusetts OECC, and the Connecticut OECC. Model results provided the following estimates of the durations and concentrations of suspended sediment during construction:

- **Export and inter-array cable installation:** Above-ambient total suspended solids (TSS) concentrations substantially dissipate within one to two hours and fully dissipate in less than four to 12 hours. The modeling analyses predict suspended sediment concentrations induced by installation of the cables will largely be of short duration, confined to the near-bottom portion of the water column, and will return to ambient conditions within several hours after the installation device has passed. Additionally, if a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), it is anticipated this would occur with sufficient time for any suspended sediment concentrations to return to ambient conditions prior to cable installation.

[52] As described in Appendix II-P, the modeling for HDD exit pit construction focused on backfilling since it may result in greater water quality effects than excavation under the conservative assumption that dredged material is released at the water surface.

- **HDD exit pit construction:** Above-ambient TSS concentrations may be present throughout the entire water column because sediments were released at the water surface but are predicted to return to ambient conditions within six hours.

- **Sand bedform dredging and dumping:** Above-ambient TSS concentrations originating from the potential dredging equipment are intermittent along the route and coincide with the representative dredge locations (due to drag arm disturbances at the seafloor) and representative dumping locations. Above-ambient TSS concentrations substantially dissipate within two to three hours and fully dissipate within either four to six hours (for the Lease Area, Massachusetts OECC, and Eastern Point Beach Approach model scenarios) or six to 12 hours (for the Niantic Beach Approach and the Connecticut OECC model scenarios).

Due to the fact that suspended sediments are expected to dissipate within 12 hours for all modeled scenarios and do not exceed the conservative effects threshold of concentrations of 100 mg/L for 24 hours or 200 mg/L for 12 hours, suspended sediments from construction and operation activities are not expected to have lethal or sublethal effects to finfish and invertebrates in the Offshore Development Area. In addition, suspended sediments are expected to be localized, with high concentrations not expected to travel greater than a few km (few miles) from the centerline.

Model results also provided estimates of the extent, area, and range of thicknesses of deposited sediment during construction (see Appendix II-P). Model results for export cable and inter-array cable installation, HDD exit pit construction, and sand bedform dredging and dumping provided the following estimates:

- **Export and inter-array cable installation:** The model predicted a depositional thickness between 1 mm (0.04 in) and 10 mm (0.4 in).

- **HDD exit pit construction:** The model predicted a depositional thickness of less than 5 mm (0.2 in) for the Massachusetts Landfall Site HDD Exit Pit Construction model scenario and less than 100 mm (4 in) for the Connecticut Landfall Site HDD Exit Pit Construction model scenario, although it is noted that only a small area (0.02 km^2 [5 acres]) near the Connecticut HDD exit pit is predicted to have greater than 20 mm (0.8 in) of deposition.

- **Sand bedform dredging and dumping:** The model predicted the cumulative sediment deposition from the representative sand bedform dredging simulations within the Lease Area, Massachusetts OECC, and Connecticut OECC to be less than 5 mm (0.2 in) and to remain close to the drag arm disturbances (i.e., within 0.09 km of the disturbance location) and within the OECC. The deposition associated with overflow and dumping exceeded a thickness of 100 mm (4 in) but was predicted to remain around the dump locations (i.e., within 0.1 km [0.06 mi] to 0.43 km [0.27 mi] depending on the simulation), with a thickness of 1 to 5 mm (0.04 to 0.2 in) occurring in isolated and patchy locations depending on the location of the prevailing currents at the time of release.

For export cable installation and HDD exit pit construction, the model predicted that deposition in most areas would be below the 20 mm (0.8 in) sensitivity threshold for shellfish, with only a small area (0.02 km^2 [5 acres]) predicted to have deposition above 20 mm (0.8 in). If a pre-pass jetting run (using a jet plow or jet trencher) were to be conducted along the route (see Section 3.5.4 of COP Volume I), the predicted deposition is expected be similar to that of the export cable installation scenario and remain below the 10 mm (0.4 in) threshold. Sufficient time is also anticipated between the pre-pass jetting run and cable installation to allow for some of this sediment deposition to be redistributed due to the forcing of surrounding currents.

Dredging and dumping activities are predicted to result in additional areas receiving deposition above 20 mm (0.8 in), primarily due to dumping activities at discrete locations along each OECC and within the Lease Area. The modeled areas with predicted deposition above 20 mm (0.8 in) range between 0.04 km^2 (10 acres) to 0.92 km^2 (227 acres) depending on the location (Lease Area, Massachusetts OECC, or Connecticut OECC and associated landfall sites). However, the potential impact to finfish and invertebrate resources from deposition above 20 mm (0.8 in) is a small portion of the available habitat. For example, the extent of deposition above 20 mm (0.8 in) along the Connecticut OECC using the Niantic Beach Approach, the scenario with the highest sediment deposition results from modeling, is expected to be restricted to a maximum distance of 0.43 km (0.27 mi) from the route centerline (see Appendix II-P). Additionally, if all the area that would be impacted by the predicted deposition above 20 mm (0.8 in) along the Connecticut OECC using the Niantic Approach was conservatively assumed to be heterogeneous complex and complex habitat (see Appendix II-D), this would only potentially impact approximately 3% of the available habitat within the OECC, with additional habitat available in the regions surrounding the OECC. Similarly, since the areas of sediment deposition above 20 mm (0.8 in) are predicted to be less for the Massachusetts OECC and Lease Area than for the Connecticut OECC, the percentage of habitat impacted is expected to be an even smaller portion of the available habitat. For this reason, though there are expected to be short-term to longer term (several years) impacts on the finfish and invertebrate resources along the Connecticut OECC, Massachusetts OECC, and Lease Area, these are not anticipated to result in population-level effects. In addition, a benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECCs).

4.6.2.3 Entrainment and Impingement

Localized entrainment and potentially impingement of planktonic life stages of finfish and invertebrates may occur in the Lease Area and OECCs from the installation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, foundations, and scour protection. Short-term impacts may result from vessel cooling systems used during all phases and from other pump intakes including the potential use of jetting equipment to install export, inter-array, and inter-link cables. If the selected ESP includes high voltage direct current (HVDC) equipment, impacts may result from the seawater cooling water intake structure (CWIS) which may be required.[53]

Direct impacts from entrainment could be mortality of entrained organisms in both the Lease Area and OECCs. Impacts from impingement can range from injury to mortality. The rate of entrainment and impingement are dependent on the physical characteristics of the intake and composition of the local finfish and invertebrate community. The size of the intake screen controls the maximum size of organisms that can be entrained while intake flow velocities determine the capability of organisms to avoid entrainment and impingement. The intake flow volume influences the total number of organisms that may be impacted. Planktonic organisms, such as some egg and larval fish and invertebrates, are most at risk of mortality from entrainment due to their small size and zero to limited swimming ability. Although survival rates of entrained organisms may vary (Mayhew et al. 2000), it is conservatively assumed that entrained eggs and larvae would experience 100% mortality rates.

An HVDC CWIS is expected to intake up to 8.75 million gallons (33.1 million liters) per day throughout the operational period, which is roughly 0.0001% of the volume of water within the Lease Area assuming an average depth of 50 m (164 ft). Based on this volume and because more than 25% of the intake volume will be used for cooling, this new facility will be subject to the Track 1 requirements for new facilities defined at § 125.84(b) as it pertains to Section 316(b) of the Clean Water Act. Therefore, an additional permitting process will be performed in coordination with the Environmental Protection Agency (EPA) prior to construction of a CWIS that will further evaluate the potential impacts from entrainment and impingement. Intake screen designs can be modified to reduce intake velocities, so it is expected that impingement will not be a significant impact for most species.

Jetting equipment may be used to install export, inter-array, and inter-link cables during the construction period and could withdraw up to 0.71 million gallons (2.7 million liters) per hour when in use. However, due to the relatively short period of use, the total volume of entrained water from jetting equipment is expected to be at least two orders of magnitude less than the volume entrained over the life of the CWIS. In addition, modeling at nearby South Fork Wind

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53 This analysis assumes an open-loop CWIS is required; however, the HVDC ESP(s) could potentially use closed-loop water cooling (where no water is withdrawn from or discharged to the sea) if such technology becomes technically and commercially feasible. Although this technology is not currently available in the offshore wind market, the Proponent is aware of a number of firms that are working to develop and test closed loop cooling systems for use in offshore wind HVDC ESPs.

Farm (2019) and Cape Wind (MMS 2008) found entrainment impacts from jet plow cable installation to be small relative to total zooplankton abundance. Vessel CWIS volumes are also expected to be minimal relative to HVDC CWIS volumes.

To estimate the impacts of entrainment from an HVDC CWIS, an assessment using anticipated flow rates and local zooplankton data was completed as described in Appendix II-N. Model results provided estimates of the composition and magnitude of intake mortality for ichthyoplankton and total other zooplankton. Additionally, equivalent losses of age-one fish were calculated for some species. Based on seasonal mean densities and entrained water volumes, annual estimated ichthyoplankton losses from CWIS entrainment are expected to range from 0 to 10.2 million fish larvae depending on the species. Annual estimated zooplankton losses are expected to be 13.5 billion individuals. When considering the high mortality rates for fish early life stages, the number of equivalent age one fishes lost to entrainment are expected to be typically less than 10,000 individuals per species annually, which is a fraction of a percent of annual commercial landings for most species. Based on the magnitudes of the results, ecological and socioeconomic effects from entrainment by the HVDC CWIS will likely be undetectable.

4.6.2.4 Electromagnetic Fields

Electromagnetic fields (EMFs) would be produced by energized export, inter-array, and inter-link cables during operation. EMFs consist of two components: electric fields and magnetic fields (MFs). The characteristics of the EMF can vary greatly depending on the energy flow of electricity and the type of current: high voltage alternate current (HVAC) vs. high voltage direct current (HVDC) (Tricas 2012). Due to cable configuration and shielding, electric fields are not expected in the marine environment from Vineyard Northeast cables. Therefore, the following discussion describes EMF generally and then focuses on MFs when discussing the potential effects from Vineyard Northeast. As described further in Sections 3.5 and 3.6 of COP Volume I, export cables in the Connecticut OECC will use HVDC transmission technology and export cables in the Massachusetts OECC may use HVDC or HVAC transmission technology, although HVDC is more likely. Inter-array cables are expected to be HVAC cables but could also be HVDC cables; inter-link cables are expected to be the same cable type as the offshore export cables or the inter-array cables.

Effects on finfish and invertebrates from EMF are not fully understood but can include disorientation and other behavioral responses (e.g., avoidance, changes in prey detection or feeding activity) (Riefolo et al. 2016). Severity of impacts from EMF during operation would vary based on the strength of the EMF and the electromagnetic sensitivity of organisms. Of species potentially present in the Offshore Development Area, electromagnetic sensitivity has been primarily documented in elasmobranchs (sharks, skates, and rays), as well as some teleost fish species (ray-finned fishes), and invertebrates such as *Cancer* crabs. The effects of EMF would be localized because EMFs produced by cables decrease with distance. In addition, at the target burial depth (1.5–2.5 m [5–8 ft] beneath the stable seafloor)[54] for the cables, EMFs at the seabed would be expected to be weak and likely only detectable by demersal species (Normandeau et al. 2011). In areas where seafloor type potentially prohibits cable burial, cable protection would serve as a similar although thinner barrier to exposure.

A white paper review study funded by BOEM determined that HVAC EMFs produced by power transmission cables would result in negligible, if any, effects on bottom-dwelling commercial and recreational fish species and no negative effects on pelagic commercial and recreational fish species in southern New England (Snyder et al. 2019). Other reviews have concluded that effects of HVDC and HVAC EMFs on invertebrates can be measurable but generally not at the EMF strengths of offshore wind projects (Albert et al. 2020; Gill and Desender 2020). For example, there is some evidence of attraction to HVDC EMF for a species of *Cancer* crab at an EMF strength hundreds of times greater than expected based on modeling for Vineyard Northeast (Scott et al. 2021; Appendix II-O). Similarly, although there were changes in the behavior of little skate, an elasmobranch, and American lobster in the presence of energized HVDC cables, EMFs from cables did not act as a barrier to movement in any way (Hutchison et al. 2018, 2020). Other research investigating habitat use around energized cables found no evidence that fishes or invertebrates were attracted to or repelled by EMFs emitted by HVAC cables (Love et al. 2017).

For HVDC cables, other manmade sources of perturbations to Earth's steady direct current (DC) geomagnetic field in coastal environments include shore-based structures such as docks, jetties, and bridges; sunken ships; pipelines; and ferromagnetic mineral deposits (Normandeau et al. 2011; CSA Ocean Sciences Inc. and Exponent 2019). Additionally, Normandeau et al. (2011) reported that MF impacts nearby to these sources can be on the order of tens of milliGauss (mG), while CSA Ocean Sciences Inc. and Exponent (2019) observed that undersea sources of DC MFs including steel ships and bridges can create DC MFs up to 100 times greater than MFs from DC submarine cables.

For HVAC cables, a seven-year study reported the first findings in the US of the response of demersal fish and invertebrates to construction and operation of an offshore wind project (Wilber et al. 2022). This study reported findings for analyses of catch data from monthly demersal trawl surveys conducted by local fisherman and scientists during construction and operation of the Block Island Wind Farm. This study did not report findings supporting harmful impacts of EMF from the project 60-Hz alternating current (AC) submarine export cables or other offshore electrical infrastructure on local demersal fish and invertebrates, and instead reported evidence of increased populations of several fish species near the wind farm during the operation time period relative to the reference areas.

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[54] Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

To assess the potential effects of Vineyard Northeast, modeling of MFs from HVDC and HVAC cables was completed (see Appendix II-O).[55] Model results provided estimates of the magnitude and extent of MFs from a range of loads and burial depths during operation and for cables that are either buried at a depth of 1.5 m (5 ft) or surface-laid. Surface laid cables are assumed to have 0.5 m (1.6 ft) thick cable protection covering. Modeling demonstrated that MFs at the seafloor from the buried cables decline with distance, with a maximum MF directly above the centerline that decreases rapidly with distance (see Tables 4.6-5, 4.6-6, and Appendix II-O). Tables 4.6-5 and 4.6-6 show the rapid drop-off in MF levels with increased lateral distance from the HVAC cables or HVDC cable bundles for each of the modeling scenarios. More specifically, the analysis shows > 95 to > 99% reductions in MF levels at lateral distances of ±25 ft (±7.6 m) from the centerlines of HVAC cables or HVDC cable bundles; and at lateral distances of ±25 ft (±7.6 m), there is a negligible difference in MF levels for the buried versus the surface-laid cables. Based on the results, MFs are likely only able to be sensed, if at all, directly over the buried cable centerline. Therefore, any effects from EMF are expected to be localized with only behavioral impacts, if any at all, for most finfish and invertebrate species.

Table 4.6-5 Summary of Modeled Magnetic Fields for HVDC Offshore Export Cables, as Deviations from Earth's Steady DC Magnetic Field

Cable Voltage	Installation Scenario[2]	DC Magnetic Field[1] Deviation (mG)[3]			
		Maximum (above cables)	± 10 ft	± 25 ft	± 50 ft
±320 kV	Buried	-268 to 271	-49.9 to 51.8	-11.5 to 11.5	-2.9 to 2.9
	Surface-laid	-266 to 2,039	-72.4 to 72.5	-11.5 to 11.5	-2.8 to 2.8
±525 kV	Buried	-296 to 300	-55.4 to 57.8	-12.9 to 12.9	-3.3 to 3.3
	Surface-laid	-268 to 2,207	-81.0 to 81.2	-12.9 to 12.9	-3.2 to 3.2

Notes:

1. MFs are presented as the deviation from the Earth's steady DC magnetic field of 508 mG and are maximum positive and negative deviations across modeling cases that include two representative cable orientations (north-south and east-west) and both possible current flow direction scenarios for each representative cable orientation. Negative values are the maximum reductions below the Earth's steady DC magnetic field of 508 mG.
2. MFs at the seabed are reported for buried cables. Surface-laid cables are assumed to have 0.5-m (1.6-ft) thick cable protection covering. For these scenarios, MFs are reported at the top of the cable protection, specifically at 0.65 m (2.14 ft) for the ±320-kV cables, and 0.67 m (2.20 ft) for the ±525-kV cables.
3. Horizontal distance is measured from the center of the cable bundle.

[55] Modeling was focused on export cables because inter-array cables are expected to have lower currents and MFs. Inter-link cables are expected to have similar or lower MFs.

Table 4.6-6 Summary of Modeled Magnetic Fields for HVAC Offshore Export Cables

Cable Voltage	Installation Scenario[1]	AC Magnetic Field (mG)[2]			
		Maximum	± 10 ft	± 25 ft	± 50 ft
230 kV, 3-phase	Buried	191	43.6	9	2.8
	Surface-laid	1,243	54	9.3	2.8
345 kV, 3-phase	Buried	214	49.6	10.2	3.1
	Surface-laid	1,354	61.6	10.7	3.2

Notes:
1. MFs at the seabed are reported for buried cables. Surface-laid cables are assumed to have 0.5-m (1.6-ft) thick cable protection covering. For these scenarios, MFs are reported on top of the cable protection, specifically at 0.79 m (2.58 ft) for 220-kV cables, and 0.82 m (2.68 ft) for 345-kV cables.
2. Horizontal distance is measured from the center of the cable bundle.
3. The offshore export cable MF modeling assumes straight-laid phase-conductor cable cores, as opposed to the actual helical or "twisted" phase-conductor cores. A helical design achieves a considerable degree of magnetic field cancellation; hence the modeled MF levels are expected to be overestimates of actual MF levels.

4.6.2.5 Noise

Temporary to long-term increases in noise may occur in the Lease Area and OECCs from the installation, operation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, and foundations. The intensity and duration of noises is expected to vary based on activity. Temporary construction noise is expected to include both repetitive, high-intensity (impulsive) sounds produced by pile driving, and continuous (non-impulsive), lower-frequency sounds produced by vessel propulsion, drilling, vibratory installation of monopiles, and cable pre-installation/installation activities. Noise will also be produced during UXO detonation (if UXO denotation is needed). Long-term operational noise is expected to be continuous (non-impulsive) noise from WTGs and vessel traffic. Additional continuous noise may also be produced temporarily during cable maintenance or aircraft activities.

Effects of Sound on Finfish and Invertebrates

Direct effects on finfish and invertebrates from noise can include behavioral changes, stress responses, injury, and mortality. Severity of impacts from noise during construction, maintenance activities, or decommissioning would vary based on the duration and intensity of sound and biology (e.g., auditory system and swim bladder presence) of the fish. Impulsive sounds can lead to mortality, ruptured gas bladders and damage to surrounding organs, damage to auditory processes, and altered behavior in some fish species (Popper and Hastings 2009; Casper et al. 2012; Riefolo et al. 2016). Continuous noise typically has lower sound pressure levels but can result in avoidance behavior that interferes with feeding and breeding, alter schooling behaviors and migration patterns, and can mask important environmental auditory cues (CBD 2012; Barber 2017). In general, the presence of a swim bladder makes a fish more susceptible to injury from sounds because loud, usually impulsive, noises (i.e., impact pile driving, explosions) can cause swim bladders to vibrate with enough force to inflict damage to tissues and organs around the bladder (Halvorsen et al. 2011; Casper et al. 2012).

Risk of injury occurs at the lowest noise levels in fishes with swim bladders connected to the inner ear, such as Atlantic herring and Atlantic cod. Least sound sensitive fish species which do not have a swim bladder include both flatfishes and elasmobranchs (Thomsen et al. 2006; Popper et al. 2014). Noise could also affect the functionality and sensitivity of the sensory systems of marine invertebrates, but most studies on these effects have been performed *ex situ*, making it difficult to control and assess the acoustic conditions and typically only measure and report on the pressure component of sound. Additionally, most crustacean species lack swim bladders and are considered less sensitive to sound; however, understanding of the impact of sound and vibration on invertebrates is limited by a dearth of data (Edmonds et al. 2016).

Popper et al. (2014) determined injury and mortality thresholds for three groups of fishes from impact pile driving (see Table 4.6-7 for values). The three groups include fishes with swim bladders whose hearing does not involve the swim bladder or other gas volumes (e.g., tuna [*Thunnus* sp.] or Atlantic salmon), fishes whose hearing does involve 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 (Popper et al. 2014; Carroll et al. 2017). NMFS published "interim guidance" thresholds for peak onset of injury or behavior regardless of source type, fish size, or hearing type, and a cumulative Sound Exposure Level (SEL) onset of injury or mortality for fish less than and greater than 2 grams (0.07 ounces) (Oestman et al. 2009) (see Table 4.6-7 and Table 4.6-8).

Table 4.6-7 Acoustic Thresholds Used to Evaluate Impacts to Fish Exposed to Impact Pile Driving Sound

Faunal Group	Impairment				Behavior
	Recoverable Injury		Temporary Threshold Shift	Masking	
	L_{PK}	$L_{E,24hr}$	$L_{E,24hr}$		
Fishes without swim bladder	>213	>216	>>186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fishes with swim bladder not involved in hearing	>207	203	>186	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fishes with swim bladder involved in hearing	>207	203	186	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate

Notes:
1. Adapted from American National Standards Institute (ANSI) -accredited Popper et al. 2014; all thresholds are unweighted. Recoverable injury thresholds were modeled for this study.
2. L_{PK} = peak sound pressure (dB re 1 μPa); $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 $\mu Pa^2 \cdot s$).
3. N = near (tens of meters), I = intermediate (hundreds of meters), and F = far (thousands of meters).
4. >> = much greater than.

Table 4.6-8 General Interim Acoustic Thresholds for Fish Currently Used or Recommended by NMFS and BOEM for Impact Pile Driving

Fish Group	Injury[1,2]		Behavior[3]
	L_{PK}	$L_{E,24hr}$	L_p
Fish ≥2 g	206[4,5]	187[4,5]	150[5]
Fish <2 g		183[4,5]	
Fish without swim bladder[6]	213	216	-
Fish with swim bladder not involved in hearing[6]	207	210	-
Fish with swim bladder involved in hearing[6]	207	207	-

Notes:

1. All thresholds are unweighted.
2. L_{PK} = peak sound pressure (decibels [dB] re 1 μPa); $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 μPa^2·s).
3. L_p = root mean square sound pressure (dB re 1 μPa).
4. NMFS recommended criteria adopted from the Fisheries Hydroacoustic Working Group (Oestman et al. 2009).
5. References in the NMFS Greater Atlantic Regional Fisheries Office (NMFS GARFO 2020) tool: Andersson et al. (2007), Mueller-Blenkle et al. (2010), Purser and Radford (2011), Wysocki et al. (2007).
6. Popper et al. 2014.

Foundation Installation

Foundation installation is expected to require impact pile driving and may also require the use of a vibratory hammer and/or drilling. Potential effects from each of these activities are described below. Results of the acoustic modeling for foundation installation activities, provided in Appendix II-E, were used to calculate modeled distances to potential fish injury and behavioral thresholds.

Impact Pile Driving

Impact pile driving would result in temporary, transient, repetitive, and discontinuous high intensity impulsive noise during construction. Field measurements of pile driving show that source, or near-source, levels are typically in the range of 210 to 250 decibels (dB) re 1 μPa (McHugh 2005; Tougaard et al. 2009a; Bailey et al. 2010) and frequency is predominantly <1 kilohertz (kHz) (Robinson et al. 2007; Tougaard et al. 2009b), although they can extend to higher frequencies (MacGillivray 2018), including at least 100 kHz (Tougaard et al. 2009b).

Sound thresholds derived from Popper et al. (2014) indicate that pile driving sound above 207 dB peak can lead to mortality of the most sensitive fish species, such as Atlantic herring, while noise above 186 dB can lead to impairment. Longfin squid, an invertebrate, had no physical harm but exhibited a startle response to recorded pile driving sound played at 190–194 dB but habituated quickly and startle responses typically diminished within the first eight strikes, but the response returned when the squid were tested again 24 hours later (Jones et al. 2020). In their more recent study, when playing pile driving noise to mating squid, Jones et al. (2023) found no significant effects on the occurrence rates of agnostic behaviors, mate guarding, mating, and egg laying, when compared to silent control trials. From this study, Jones et al.

(2023) conclude that while there can be some disturbance to some non-reproductive behaviors, the results of their study show that species with limited opportunity to reproduce can tolerate intense stressors to secure reproductive success. The effects of impulsive sound on fish eggs and larvae have also been studied in the context of offshore pile driving. Common sole (*Solea solea*) larvae exposed to impulsive stimuli up to a SEL of 206 dB re 1 $\mu Pa^2 \cdot s$ (corresponding to 100 strikes at a distance of 100 m [328 ft]) had no statistically significant differences in mortality (Bolle et al. 2012). Published exposure guidelines for fish eggs and larvae based on pile driving data proposed a precautionary threshold for mortality of fish eggs and larvae of greater than 207 dB re 1 μPa PK, which was noted by the publisher to likely be conservative (Popper et al. 2014).

There are no studies available on the potential effects of pile driving sounds on plankton and no established acoustic thresholds for plankton. Although use of air guns is not a proposed action, they provide insight on potential effects from impulsive sound. The results from air gun studies on plankton are mixed, varying from no significant effects on mortality (Parry et al. 2002) to a maximum horizontal effect-range of 1.2 km (0.65 nautical mile [NM]) in which decreases in zooplankton abundance with mortality in adult and larval zooplankton increased two- to three-fold when compared to controls (McCauley et al. 2017). The Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Richardson et al. 2017) simulated the large-scale impact of a seismic survey on zooplankton on the Northwest Shelf of Western Australia using the mortality rate found by McCauley et al. (2017). The major findings of the CSIRO study were that seismic activity had substantial impacts on zooplankton populations on a local scale within or close to the survey area; however, on a regional scale, the impacts were minimal and not discernible over the entire Northwest Shelf Bioregion. The study found that the zooplankton biomass recovered to pre-seismic levels inside the survey area, and within 15 km (8 NM) of the area, within three days following the completion of the survey. This relatively quick recovery was due to the fast growth rates of zooplankton as well as the dispersal and mixing of zooplankton from both inside and outside of the impacted region (Richardson et al. 2017). Another study found that the potential effects of seismic pulses of 221 dB re 1 $\mu Pa^2 \cdot s$ to zooplankton are limited to within approximately 10 m (33 ft) from the seismic source with immediate mortality rates of up to 30% of copepods when compared to controls (Fields et al. 2019).

There has also been a suite of air gun studies examining a variety of invertebrate life stages. New Zealand scallop (*Pecten novaezelandiae*) larvae exposed to extended periods of air gun signals during their ontogeny had increases in abnormality and mortality rates (Aguilar de Soto et al. 2013). Blue mussel clearance (i.e., filtration rate) increased with pile driving noise, likely in response to increased metabolic demands triggered by stress (Spiga et al. 2016). High-intensity, low-frequency sound exposure to crustaceans and mollusks do not appear to result in immediate mass mortality events (Edmonds et al. 2016; Day et al. 2016; Carroll et al. 2017) but may have longer-term effects (Day et al. 2016). Specifically, tail tonicity (i.e., extension) and righting behavior, reflexes used in lobster fishery industries in grading animals for their likelihood of survival, were assessed in southern rock lobster (*Jasus edwardsii*) and significant responses to righting responses were observed after exposure to air gun sounds. André et al. (2011) and Solé et al. (2013) provide evidence of acoustic trauma in four cephalopod species [common cuttlefish (*Sepia officinalis*), common octopus (*Octopus vulgaris*), European squid (*Loligo vulgaris*), and southern shortfin squid (*Illex condietii*)], which they exposed (underwater) for two hours to low-frequency sweeps between 50–400 hertz (Hz) (1 second duration) generated by an in-air speaker. The measured level at the animals' position was 157 dB re 1 μPa with peak levels (unspecified) up to 175 dB re 1 μPa. Both studies reported permanent and substantial morphological and structural alterations of the sensory hair cells of the statocysts following noise exposure, with no indication of recovery. In a more recent experiment, Solé et al. (2017) exposed common cuttlefish to tonal sweeps between 100–400 Hz in a controlled exposure experiment in open water. Their results showed a clear statistical relationship between the cellular damage detected in the sensory cells of the individuals exposed to the sound sweeps and their distance from the sound source. The maximal particle motion level was 0.7 ms^{-2} (2.3 ft^{-2}) observed at 1 m (3.3 ft) depth, the pressure reached levels of 139–142 dB re 1 μPa^2. The reported sound pressure levels were only slightly higher than the hearing threshold determined for longfin squid measured by Mooney et al. (2010). The maximum particle motion (reported in terms of particle acceleration) reported by Solé et al. (2017) is in the same order of magnitude as the behaviorally thresholds measured at 100 Hz by Packard et al. (1990) using a standing wave acoustic tube.

In general, the impacts from pile driving will depend on an individual's proximity to the source, intensity of noise, and sensitivity to sound. However, Vineyard Northeast plans to implement mitigation actions including a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing mobile species to move out of the activity area before the full-power pile driving begins. In addition, the Proponent will use a noise abatement system to reduce sound levels by a target of approximately 10 dB and will adhere to an anticipated time of year restriction on pile driving between January 1 and April 30 to protect North Atlantic right whales (NARW) (see Section 4.7), which may also confer protection to fish that occur within the Offshore Development Area during that timeframe. In addition, while there have been no recorded catches of Atlantic sturgeon within the Lease Area by commercial fisheries in the analyzed period between 1989 and 2000, for commercial data or by research surveys up through 2007 (Stein et al. 2004; Dunton et al. 2010), this species is known to move offshore into water depths of 20-50 m (66–164 ft) during the winter and early spring (December to March); therefore, the anticipated time of year restriction may also benefit Atlantic sturgeon in the unlikely event that any are present within the Lease Area during the winter and early spring months.

To assess the impacts of noise during construction, acoustic modeling of pile driving (see Appendix II-E) was completed assuming broadband noise attenuation levels of 10, 12, and 15 dB in relation to thresholds of mortality and recoverable injury for fishes with different hearing structures (based on thresholds in Popper et al. 2014). Model results provided estimates of the magnitude and extent of noise from a range of noise attenuation levels during construction. The severity and duration of the impacts from the acoustic modelling were characterized for each component based on existing studies and literature. The characteristics and potential effects of noise from other offshore components were assessed based on existing studies and literature. Impacts to marine species were conservatively assessed based on 10 dB of noise attenuation. Sound with peak sound pressure (dB re 1 μPa) up to 200 dB was predicted to occur for typical piles. Applying the thresholds for potential injury for fish (Oestman et al. 2009) with 10 dB attenuation levels, Tables 4.6-9 and 4.6-10 show the maximum radial distance to PK sound levels associated with 4.25 m (14 ft) jacket foundation piles and 14 m (46 ft) monopile foundation piles. Radial distances from the piling source to regulatory-defined thresholds for SEL are also shown in Tables 4.6-9 and 4.6-10. These estimates do not consider animals avoiding loud sounds (aversion) or implementation of mitigation measures other than sound attenuation using a noise abatement system. Popper et al. (2014) does not define quantitative acoustic thresholds for behavioral response in fish. NMFS GARFO (2016) uses a 150 dB SPL behavioral threshold for all fish. The maximum range to the threshold defining potential injury across all foundation types is 40 km (22 NM) with 10 dB attenuation (for fish of less than 2 g in winter and considering the post-piling installation of 8 pin piles of 4.25 m [14 ft] diameter). NMFS GARFO (2020) defines a broad behavioral criterion for all fish, which corresponds to a maximum range to threshold of 15.74 km (8.5 NM), considering the installation of 14 m monopiles at an approximate impact pile driving energy of 6,600 kJ. However, impairment from pile driving noise is less likely to occur during construction because a soft-start technique will be employed, and mobile fishes and invertebrates will be able to leave the area before full strength pile driving occurs.

Table 4.6-9 Summary Acoustic Model Radial Distances (in m) for Post-Piled Jacket Pin Piles to Thresholds Used to Evaluate Potential Impacts to Fish from Impact Pile Driving Sound

Faunal group	Metric	Threshold	Attenuation level (dB)			
			0	10	12	15
Fish without swim bladder	L_{PK}	>213	146	20	-	-
	L_E	>216	3,624	1,018	730	462
Fish with swim bladder not involved in hearing	L_{PK}	>207	356	100	63	28
	L_E	203	12,516	4,875	4,012	2,823
Fish with swim bladder involved in hearing	L_{PK}	>207	356	100	63	28
	L_E	203	12,516	4,875	4,012	2,823
Fish ≥ 2 g	L_{PK}	206	484	108	89	45
	L_E	187	84,740	23,231	18,218	13,739
Fish < 2 g	L_{PK}	206	484	108	89	45
	L_E	183	85,311	39,560	29,395	20,584
All fish (behavioral disturbance)	L_p	150	80,699	16,864	13,727	9,824

Notes:

1. Radial distances ($R_{95\%}$) for auditory injury threshold for fish exposed to impulsive sound are in meters.
2. Numbers represent the maximum radial distance estimated at each of the two modeling sites across summer/winter seasons and all piling energy levels, for varying levels of attenuation.
3. L_{PK} = peak sound pressure (dB re 1 μPa).
4. $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 μPa^2·s).
5. L_p = root mean square sound pressure (dB re 1 μPa).

Table 4.6-10 Summary Acoustic Model Radial Distances (in m) for WTG Monopiles to Thresholds Used to Evaluate Potential Impacts to Fish from Impact Pile Driving Sound

Faunal group	Metric	Threshold	Attenuation level (dB)			
			0	10	12	15
Fish without swim bladder	L_{PK}	>213	179	28	-	-
	L_E	>216	1,875	412	313	172
Fish with swim bladder not involved in hearing	L_{PK}	>207	539	108	89	28
	L_E	203	6,463	2,666	2,140	1,474
Fish with swim bladder involved in hearing	L_{PK}	>207	539	108	89	28
	L_E	203	6,463	2,666	2,140	1,474
Fish ≥2 g	L_{PK}	206	573	128	100	60
	L_E	187	21,386	9,957	8,668	6,964
Fish <2 g	L_{PK}	206	573	128	100	60
	L_E	183	30,250	13,468	11,727	9,218
All fish (behavioral disturbance)	L_p	150	41,176	15,740	13,604	1,086

Notes:
1. Radial distances ($R_{95\%}$) for auditory injury threshold for fish exposed to impulsive sound are in meters.
2. Numbers represent the maximum radial distance estimated at each of the two modeling sites across summer/winter seasons and all piling energy levels, for varying levels of attenuation.
3. L_{PK} = peak sound pressure (dB re 1 µPa).
4. $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 $\mu Pa^2 \cdot s$).
5. L_p = root mean square sound pressure (dB re 1 µPa).

Vibratory Pile Setting

A vibratory hammer or other tool could be used to install the monopile through surficial sediments in a controlled fashion to avoid the potential for a "pile run," where the pile could drop quickly through the looser surficial sediments and destabilize the installation vessel, risking the integrity of the vessel and safety of the crew. Once the pile has penetrated the surficial sediments and is stable, an impact hammer would be used for the remainder of the installation. During vibratory pile driving, piles are driven into the substrate due to longitudinal vibration motion at the hammer's operational frequency and corresponding amplitude. This causes the soil to liquefy, allowing the pile to penetrate into the seabed. Sounds generated by vibratory pile setting are non-impulsive, which are known to be less damaging than impulsive sounds to marine fauna (Tsouvalas et al. 2016; Zykov et al. 2016; Molnar et al. 2020).

There are few data on the effects of vibratory pile driving on fish. Further, generalizations can be difficult because sound affects species differently, particularly with regards to the presence or absence of a swim bladder and its proximity to the ear. Nedwell et al. (2003) detected no changes in activity level or startle response in brown trout, a species without specialized hearing structures, when exposed to vibratory piling at close ranges (<50 m). There are no direct data available on the behavioral response to continuous noise in fish species with more specialized hearing. The masking of communicative signals, as well as signals produced by predators and prey, may be the most likely behavioral impact to fish (Popper and Hawkins 2019). However, the effect is expected to be short term (Popper et al. 2014). Additionally, high risks of any behavioral impacts from continuous sound sources (e.g., vibratory pile driving) are likely to only occur at close range to the source (Popper et al. 2014).

There are no data linking continuous noise to mortality or permanent injury in fish (Popper et al. 2014). Continuous noise has been linked to temporary threshold shift (TTS) in some fish species; however, exposure times to these sounds were at least 12 hours (Amoser and Ladich 2003; Smith et al. 2006).

There is a lack of data involving the effects of vibratory pile installations on invertebrates. Among marine invertebrates, some can detect particle motion and are sensitive to noise (Popper et al. 2014; André et al. 2016; Jézéquel et al. 2023). Invertebrates generally do not possess air-filled spaces like lungs, middle ears, or swim bladders; thus, they have been considered less susceptible than fish to noise and vibration. Invertebrates display measurable behavioral responses to noise, such as interruptions to feeding and resource gathering, startle responses, and escape behaviors (Mooney et al. 2010; Roberts et al. 2015).

To assess the impacts of underwater sound to fish, vibratory pile setting followed by impact pile driving scenarios were modeled (see Appendix II-E) with 10, 12, and 15 dB attenuation levels. Tables 4.6-11 and 4.6-12 show the maximum radial distance to PK and SEL associated with 4.25 m (14 ft) jacket foundation piles and 14 m (46 ft) monopile foundation piles, respectively.

Table 4.6-11 Summary Acoustic Model Radial Distances (in m) for 14 m WTG Monopiles to Thresholds Used to Evaluate Potential Impacts to Fish from Vibratory Pile Setting Followed by Impact Pile Driving Sound

Faunal group	Metric	Threshold	Attenuation level (dB)			
			0	10	12	15
Fish without swim bladder	L_{PK}	>213	179	28	0	0
	L_{E}	>216	1,984	467	328	184
Fish with swim bladder not involved in hearing	L_{PK}	>207	539	108	89	28
	L_{E}	203	6,671	2,774	2,259	1,565
Fish with swim bladder involved in hearing	L_{PK}	>207	539	108	89	28
	L_{E}	203	6,671	2,774	2,259	1,565
Fish ≥2 g	L_{PK}	206	573	128	100	60
	L_{E}	187	22,211	10,372	8,915	7,223

Table 4.6-11 Summary Acoustic Model Radial Distances (in m) for 14 m WTG Monopiles to Thresholds Used to Evaluate Potential Impacts to Fish from Vibratory Pile Setting Followed by Impact Pile Driving Sound (Continued)

Faunal group	Metric	Threshold	Attenuation level (dB)			
			0	10	12	15
Fish <2 g	L_{PK}	206	573	128	100	60
	L_E	183	31,492	13,888	12,095	9,491
All fish (behavioral disturbance)	L_p	150	41,176	15,740	13,604	10,860

Notes:
1. Radial distances ($R_{95\%}$) for auditory injury threshold for fish exposed to impulsive sound are in meters.
2. Numbers represent the maximum radial distance estimated at each of the two modeling sites across summer/winter seasons and all piling energy levels, for varying levels of attenuation.
3. L_{PK} = peak sound pressure (dB re 1 μPa).
4. $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 μPa^2·s).
5. L_p = root mean square sound pressure (dB re 1 μPa).

Table 4.6-12 Summary Acoustic Model Radial Distances (in m) for 4.25 m Jacket Pin Piles to Thresholds Used to Evaluate Potential Impacts to Fish from Vibratory Pile Setting Followed by Impact Pile Driving Sound

Faunal group	Metric	Threshold	Attenuation Level (dB)			
			0	10	12	15
Fish without swim bladder	L_{PK}	>213	130	0	0	0
	L_E	>216	3,680	1,040	740	470
Fish with swim bladder not involved in hearing	L_{PK}	>207	290	60	50	0
	L_E	203	12,660	4,940	4,070	2,860
Fish with swim bladder involved in hearing	L_{PK}	>207	290	60	50	0
	L_E	203	12,660	4,940	4,070	2,860
Fish ≥2 g	L_{PK}	206	330	90	60	20
	L_E	187	84,750	23,470	18,380	13,890
Fish <2 g	L_{PK}	206	330	90	60	20
	L_E	183	85,310	40,030	29,700	20,830
All fish (behavioral disturbance)	L_p	150	50,590	13,730	11,120	8,060

Notes:
1. Radial distances ($R_{95\%}$) for auditory injury threshold for fish exposed to impulsive sound are in meters.
2. Numbers represent the maximum radial distance estimated at each of the two modeling sites across summer/winter seasons and all piling energy levels, for varying levels of attenuation.
3. L_{PK} = peak sound pressure (dB re 1 μPa).
4. $L_{E,24hr}$ = 24 hr cumulative sound exposure level (dB re 1 μPa^2·s).
5. L_p = root mean square sound pressure (dB re 1 μPa)

Drilling

During the construction phase of Vineyard Northeast, there may be instances when large sub-surface boulders or hard sediment layers are encountered during pile driving, requiring drilling operations to pass through these barriers. Vineyard Northeast estimates that foundations could potentially require up to 6 hours of drilling per day in addition to pile driving operations for the installation of wind turbines. To assess the impacts of underwater sound produced by drilling activities, modeled distances to potential fish injury and behavioral thresholds were calculated. The maximum acoustic radial distances results are shown in Table 4.6-13 with the full set of modeling results provided in Appendix I of Appendix II-E.

During drilling activities, a drill head produces vibrations that propagate as sound through the sediment and water column (Hall and Francine 1991; Nguyen 1996; Willis et al. 2010). Most measurements of offshore drilling sounds have been made for oil exploration and production drilling. The sound levels associated with those drilling operations have been documented to be within the hearing range of fish injury and behavioral thresholds (Popper et al. 2014). Underwater sound emitted by project construction drilling activities is not expected to produce injury to marine fauna but is likely to be audible and could elicit temporary behavioral responses.

It is unclear whether the sound emitted by marine drilling activities is likely to impact the behavior of fish. McCauley (1998) determined that any effects to fish from sounds produced by marine drilling activity would likely be temporary behavioral changes within a few hundred meters of the source. For instance, measured source levels during drilling operations reached 120 dB at 3–5 km (2–3 mi), which may have caused fish avoidance (McCauley 1998). The available literature suggests that continuous sound produced by drilling operations may mask acoustic signals of fish that convey important environmental information (McCauley 1994; Popper et al. 2014). Recordings of planktivorous fish choruses showed that the fish were still active during drilling operations off the coast of the Timor Sea; however, it is likely that partial masking of their calls would have occurred (McCauley 1998).

There are no data to support a clear link between anthropogenic sound and permanent injury or mortality in fish, particularly with non-impulsive sound sources (Popper and Hawkins 2019). Continuous sound has been linked to temporary threshold shift (TTS) in some species of fish; however, exposure times to these sounds were at least 12 hours (Amoser and Ladich 2003; Smith et al. 2006). The sounds emitted by marine drilling operations for wind farm construction are expected to be short-term and intermittent. Acoustic masking to fish from drilling could occur during the short-term drill events.

There are very few data on the effect of sound from drilling on marine invertebrates. Solé et al. (2022) reported a decreased survival rate in cephalopod (cuttlefish) larvae exposed to drilling sound levels (167 dB re 1 μPa^2). Importantly, levels below 163 dB re 1 μPa^2 did not elicit severe damage. Evidence from research on the levels of particle motion associated with behavioral responses in blue mussels indicates that the threshold of sensitivity in this species falls within vibration levels measured near blasting, pile driving, and impact drilling (Roberts et al. 2015). Studies have indicated reception of vibration in bivalves and an associated behavioral response, which included closing syphons and, in more active mollusks, moving away from the substrate (Mosher 1972; Ellers 1995; Kastelein 2008).

Drilling activities produce non-impulsive sounds that may cause hearing damage or behavioral responses in marine mammals, sea turtles, and fish. Distances to potential injury and behavioral disruption of marine animals are computed here by propagating measured drilling source levels in the construction area and then comparing the resulting sound fields to regulatory thresholds. The modeled ensonified areas are combined with the planned drilling schedules and predicted species densities to estimate the number of marine mammals and sea turtles that will be exposed above thresholds for injury and behavioral response.

Table 4.6-13 Summary Acoustic Model Radial Distances (in m) to Thresholds Used to Evaluate Potential Impacts to Fish from Drilling

Faunal group	Metric	Threshold	Maximum Rmax (m)
Fish without swim bladder	L_E	>216	<20 m[1]
Fish with swim bladder not involved in hearing	L_E	203	81
Fish with swim bladder involved in hearing	L_E	203	81
Fish ≥2 g	L_E	187	1,468
Fish <2 g	L_E	183	2,476
All fish (behavioral disturbance)	L_p	150	455

Note:
1. <20 m refers to ranges that were below the modeling resolution.

Unexploded Ordnances

Acoustic modeling also assessed the effects of detonation of unexploded ordnance (UXO) and/or discarded military munitions (DMM). As described in Section 3.10.2 of COP Volume I, if potential UXO and/or DMM are discovered in the Lease Area or OECCs, the Proponent will prioritize avoidance of UXO/DMM wherever possible by micro-siting structures and cables around the object. Where avoidance is not possible (e.g., due to layout restrictions, presence of archaeological resources, etc.), UXO/DMM will be relocated or otherwise disposed of (e.g., via deflagration [burning without detonating], detonation, or dismantling the UXO/DMM to extract explosive components). The exact number and type of UXO/DMM that may be present, and which subset of those UXO/DMM cannot be avoided by micro-siting, are unknown at this time (further evaluation is ongoing). For the purposes of impact analyses, the Proponent conservatively assumes that up to two UXO in the Lease Area, four UXO in the Massachusetts

OECC, and four UXO in the Connecticut OECC may need to be detonated in place (each detonation would occur on different days). The potential acoustic impacts of UXO/DMM detonation on finfish are further assessed in Appendix J of Appendix II-E.

Underwater explosive detonations generate impulsive sound waves with high pressure levels that could cause disturbance and/or injury to marine fauna. An explosion produces hot gases that create a large oscillating sphere and a shock wave (Chapman 1985). The extreme increase in pressure followed by a decrease to below ambient pressure caused by an explosive shock wave can cause injury to soft tissues, membranes, and cavities filled with air (Keevin and Hempen 1997). However, these sound-producing events produce a short signal duration, and the extent of impact will depend on the proximity of the receiver to the detonation.

Injury to fish from exposures to explosion are called barotrauma injuries. Rapid changes in gas volume and rapid changes in the solubility of gas in the blood and tissues cause barotrauma injuries. When pressure increases, solubility increases and vice versa. Injury mechanisms include bubble formation in fluids/tissues (i.e., decompression sickness), and rapidly expanding gas-filled bodies (i.e., swim bladder) that push against surrounding tissues, thereby damaging surrounding tissues (Carlson 2012; Halvorsen 2012).

Effects of detonation pressure exposures to fish have been assessed according to the Lpk limits for onset of mortality or injury leading to mortality due to explosives, as recommended by the American National Standards Institute (ANSI) expert working group (Popper et al. 2014).

Currently, there is no available information describing the effect of sound on invertebrates related to UXO detonation. Particle motion changes may cause behavioral response, injury, mortality, sensory damage, and physiological changes (Fitzgibbon et al. 2017; McCauley et al. 2017). Vibration caused by anthropogenic sound, such as UXO detonation, can propagate to the seabed (Roberts and Elliott 2017). Researchers have reported substrate-borne vibrations from anthropogenic sound can alter invertebrate behavior (Roberts et al. 2015; 2016).

To assess the impacts of underwater sound during UXO detonation, acoustic modeling was completed for two charge sizes at six separate modeling sites with different depths (see Appendix J of Appendix II-E) assuming 10 dB broadband noise attenuation levels. Table 4.6-14 shows the maximum acoustic radial distance to PK sound level thresholds for all fish.

Table 4.6-14 Summary Acoustic Model Radial Distances (in m) to Thresholds Used to Evaluate Potential Impacts to Fish from Unexploded Ordnance (UXO)

Faunal group	Metric	Threshold	Attenuation level (dB)	
			0	10
All fishes	L_{PK}	>229	852.1	292.2

Notes:
1. Radial distances ($R_{95\%}$) for auditory injury threshold for fish exposed to impulsive sound are in meters.
2. Numbers represent the maximum radial distance estimated.
3. L_{PK} = peak sound pressure (dB re 1 μPa).

Vessel Noise

Vessel traffic associated with construction, operation, and decommissioning would result in temporary, transient, and continuous non-impulsive noise primarily originating from the vessel propulsion system. Sound emission from vessels, especially from vessels using dynamic positioning, depends on vessel operational state and is strongly weather-dependent. Zykov et al. (2013) and McPherson et al. (2019) report a maximum broadband source level of 192 dB re 1 μPa for numerous vessels with varying propulsion power using dynamic positioning. Vessel noise can present a chronic impact for fish species (Popper 2003), whose communication is mainly based on low-frequency sound signals (Ladich and Myrberg 2006; Myrberg and Lugli 2006). Continuous noise greater than or equal to 158 dB root-mean-square (rms) for 12 hours can lead to behavioral disturbance, while noise above 170 dB rms for 48 hours can lead to injury (Popper et al. 2014; Hawkins and Popper 2017). Vessel noise can also cause avoidance behavior that interferes with feeding and breeding, alter schooling behaviors and migration patterns, and mask important environmental auditory cues (CBD 2012; Barber 2017). Recent studies have shown that vessel noise can induce endocrine stress response (Wysocki et al. 2006); diminish hearing ability; and mask intra-specific relevant signals in exposed fish species (Scholik and Yan 2002; Amoser et al. 2004; Vasconcelos et al. 2007; Codarin et al. 2009). Masking communication is of concern because although fishes are generally not loud (120 dB re 1 μPa [at 1 m (3.3 ft)], with the loudest on the order of 160 dB re 1 μPa), species make unique noises that allow for individual identification (Normandeau Associates 2012). In addition, vessel noise has the capacity to provoke short-term changes in the spatial position and group structure of pelagic fish in the water column (Buerkle 1973; Olsen et al. 1983; Schwarz and Greer 1984; Soria et al. 1996; Vabø et al. 2002; Handegard et al. 2003; Mitson and Knudsen 2003; Ona et al. 2007; Sarà et al. 2007). Fish can respond to approaching vessels by diving towards the seafloor or by moving horizontally out of a vessel's path (Ona et al. 2007; Berthe and Lecchini 2016). Nedelec et al. (2014) investigated the response of reef-associated fish by exposing them in their natural environment to playback of motorboat sounds. They found that juvenile fish increased hiding and ventilation rate after a short-term boat sound playback, but responses diminished after long-term playback, indicating habituation to sound exposure over longer durations. These results were corroborated by Holmes et al. (2017) who also observed short-term behavioral changes in juvenile reef fish after exposure to boat noise as well as desensitization over longer exposure periods. Therefore, areas of high vessel traffic may result in habituation by localized fishes. As stated in the BOEM Environmental Assessment and the Alternative Energy Programmatic Environmental Impact Statement that were prepared for the assessment and designation of wind energy areas by BOEM, regular vessel traffic occurs throughout this area; thus, implying that biological resources in the area are presumably habituated to this noise (BOEM 2007; BOEM 2014).

Operational Sounds

Operation of WTGs would result in variable, mostly continuous (i.e., during power generation) non-impulsive noise. Underwater noise level is related to WTG power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg and Westerberg 2005). Operational noise from WTGs is low frequency (60–300 Hz) and at relatively low sound pressure levels near the foundation (100–151 dB re 1 μPa) and decreases to ambient within 1 km (0.6 mi) (Tougaard et al. 2009a, 2009b; Lindeboom et al. 2011; Dow Piniak et al. 2012; HDR 2019).

At high wind speeds, Wahlberg and Westerberg (2005) estimated permanent avoidance by fish would only occur within a range of 4 m (13 ft) of a WTG. In a study on fish near the Svante wind farm in Sweden, Atlantic cod and roach (*Rutilus rutilus*) catch rates were significantly higher near WTGs when rotors were stopped, which could indicate fish attraction to WTG structures and avoidance to generated noise (Westerberg 2000 as cited in Thomsen et al. 2006). Alternatively, no avoidance behavior was detected, and fish densities increased around WTG foundations of the Lillgrund offshore wind farm in Sweden (Bergström et al. 2013). In addition, ambient noise can influence how fish detect other sounds and a change in background noise could alter how fish perceive and react to biological noise stimuli (Popper and Fay 1993). Ambient noise within the 70.8–224 Hz frequency band in the MA WEA and RI/MA WEA was measured to be between 96 dB and 103 dB 50% of the time with greater sound levels 10% of the time (Kraus et al. 2016).

Underwater sound radiated from operating WTGs is low-frequency and low level (Nedwell and Edwards 2004). At distances of 14 to 20 m (46 to 66 ft) from operational WTGs in Europe, underwater sound pressure levels ranged from 109 dB to 127 dB re 1μPa (Tougaard et al. 2009). Pangerc et al. (2016) recorded sound levels at ~50 m (164 ft) from two individual 3.6 megawatt (MW) WTGs monopile foundations over a 21-day operating period. Miller and Potty (2017) measured an SPL of 100 dB re 1 μPa within 50 m of five General Electric Haliade 150–6 MW wind turbines with a peak signal frequency of 72 Hz. At the Block Island Wind Farm off Rhode Island, sound levels were found to be 112–120 dB re 1 μPa near the WTG when wind speeds were 2–12 m/s (4-23 knots) and the WTG sound levels declined to ambient within 1 km (0.6 mi) from the WTG (Elliott et al. 2019). Tougaard et al. (2009) found that sound level from three different WTG types in European waters was only measurable above ambient sound levels at frequencies below 500 Hz, and Thomsen et al. (2016) suggest that at approximately 500 m (1,640 ft) from operating WTGs, sound levels are expected to approach ambient levels.

Two recent meta-papers (Tougaard et al. 2020; Stöber and Thomsen 2021) assessed WTG operational sounds by extracting sound levels measured at various distances from operating WTGs from currently available reports. Both studies found sounds to generally be higher for higher powered WTGs; thus, distances to a given sound threshold are likely to be greater for higher powered WTGs. However, as Stöber and Thomsen (2021) point out, direct drive technology could reduce these distances substantially. Importantly, no measurements exist for these larger turbine sizes and few measurements have been made for direct drive turbines so the uncertainty in these estimates is large.

Overall, current literature indicates noise generated from the operation of wind farms is minor and does not cause injury or lead to permanent avoidance at distances greater than 1 km (0.6 mi) (Wahlberg and Westerberg 2005; Stenberg et al. 2015), with potential to have minimal effects at much closer distances up to within a few meters of the WTG (Bergström et al. 2013) such as masking auditory sensitivity and communication of fishes within a few tens of meters of WTGs (Zhang et al. 2021).

Subsea Cables

Previous impact assessment studies for various cable projects have concluded that sound related to subsea cable installation or cable operation is not a significant issue (Nedwell et al. 2003; Austin et al. 2005). This was based on the prediction that anticipated sound levels would not exceed existing ambient sound levels in the area, although background sound level measurements were often not presented (Meißner et al. 2006). Subsea cables are expected to produce low-frequency tonal vibration sound in the water, since Coulomb forces between the conductors cause the HVAC lines to vibrate at twice the frequency of the current (direct current cables do not produce a similar tonal sound because the current is not alternating). Anticipated SPLs arising from the vibration of alternating current cables during operation are significantly lower than SPLs that may occur during cable installation (Meißner et al. 2006) and may be undetectable in the ambient soundscape of the Offshore Development Area, especially after consideration of the 1.5–2.5 m (5–8 ft)[56] target burial depth beneath the stable seafloor.

4.6.2.6 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent’s proposed measures to avoid, minimize, and mitigate potential effects to finfish and invertebrates during Vineyard Northeast are summarized below:

- Offshore export cable installation will avoid sensitive habitats including eelgrass and hard/complex bottom, where feasible.

[56] Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

- The Proponent will require the cable installation contractor to prioritize the least environmentally impactful cable installation alternative(s) that are practicable for each segment of cable.

- For vessels other than cable laying vessels (which must maintain tension on anchor lines), where it is considered impossible or impracticable to avoid a sensitive seafloor habitat when anchoring, the use of mid-line anchor buoys will be considered (where feasible and considered safe) as a potential measure to reduce impacts from anchor line sweep.

- At the landfall sites, HDD is expected to be used to avoid or minimize disturbance to coastal habitats by drilling underneath them.

- The target cable burial depth is 1.5–2.5 m (5–8 ft) beneath the stable seafloor,[57] which will reduce effects of EMFs. In areas where seafloor type or cable crossings potentially prohibit cable burial, cable protection would serve as a similar barrier to exposure.

- The Proponent's goal is to minimize the use of cable protection to the greatest extent possible through a careful route assessment and the selection of the most appropriate cable burial tool for each segment of the cable route.

- The Proponent will apply a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing mobile species to move out of the activity area before the full-power pile driving begins.

- A noise abatement system will be used to reduce sound levels by a target of approximately 10 dB during pile driving.

- The Proponent does not intend to conduct pile driving between January 1 and April 30 when higher numbers of NARW are expected to be present in the Offshore Development Area. This will reduce the potential impacts to NARW and other species with similar seasonal presence in the region, including Atlantic cod and other soniferous species during their potential spawning seasons.

- A benthic habitat monitoring plan framework has been developed (see Appendix II-R) to monitor recovery after construction in areas with sensitive habitats where similar post-construction monitoring has not already been conducted for other projects (such as along the OECCs).

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57 Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

- A fisheries monitoring plan will be developed to monitor key indicators before and after construction; such monitoring may be part of regional monitoring efforts.

- WTGs and ESPs will also be widely spaced, leaving a large portion of the Lease Area undisturbed by WTG and ESP installation.

4.7 Marine Mammals

This section addresses the potential impacts of Vineyard Northeast on marine mammals in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the proposed measures to avoid, minimize, and mitigate potential effects to marine mammals during the construction, operation, and decommissioning of Vineyard Northeast.

Appendix II-E provides detailed results of the acoustic and exposure modeling conducted for Vineyard Northeast.

4.7.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. The Lease Area is 536 square kilometers (km^2) (132,370 acres) in size with water depths ranging from approximately 32 to 64 meters (m) (105 to 210 feet [ft]) and is located approximately 46 km (29 miles [mi]) from Nantucket. The Massachusetts OECC travels northwest from the northern portion of Lease Area OCS-A 0522 towards the landfall site in Massachusetts. The Connecticut OECC travels west from the southern portion of Lease Area OCS-A 0522 towards the potential landfall sites in Connecticut.

Given the regional nature of marine mammal species distribution, species that are present within the Massachusetts Wind Energy Area (MA WEA), and the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) are also considered likely to be present within the Offshore Development Area including the entirety of Lease Area OCS-A 0522 as well as the two OECCs. Marine mammal species that occur within the United States (US) Atlantic Exclusive Economic Zone (EEZ) are discussed generally with an evaluation of their likely occurrence in and near the MA and RI/MA WEAs, while species more likely to be present in the vicinity of Vineyard Northeast activities are described in detail.

Descriptions of marine mammals, their distribution and abundance, and endangered species density maps are based on information provided by a number of different sources. Examples of primary data sources referenced throughout this COP include:

- **Marine Mammal Stock Assessment Reports (SARs):** National Marine Fisheries Service (NMFS) Marine Mammal Stock Assessment Reports for marine mammals that occur within the US Atlantic EEZ as required under the 1994 amendments to the Marine Mammal Protection Act (MMPA) (Hayes et al. 2018, 2019, 2020, 2021).

- **The Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles:** Seasonality and occurrence reported in and discussed below were mainly derived from the Northeast Large Pelagic Survey Collaborative (NLPSC) aerial surveys of the RI/MA WEAs during 2011–2015 (Kraus et al. 2016).

- **Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales: Summary Report Campaign 5, 2018-2019:** Oceanographic surveys to assess the physical and biological characteristics of waters used by right whales within the MA and MA/RI WEAs conducted by the New England Aquarium (NEAq) and Woods Hole Oceanographic Institution (WHOI), in coordination with the Provincetown Center for Coastal Studies. This report includes the sighting data, analyses of effort corrected data, and maps of sightings per unit effort (SPUE), sighting rates, and calculations of density and abundance (O'Brien et al. 2020a).

- **Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales: Interim Report Campaign 6A, 2020:** Report summarizing the results from a subset of the ongoing Campaign 6 surveys conducted in the MA and RI/MA WEAs between March and October 2020, funded by the Bureau of Ocean and Energy Management (BOEM). Summaries of survey effort, sighting maps, analyses of effort-corrected data, including sighting rates and calculations of density and abundance (O'Brien et al. 2020b).

- **Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales: Final Report Campaign 6B, 2020–2021:** Report summarizing the results from a subset of the ongoing Campaign 6 surveys conducted by the NEAq within the MA and RI/MA WEAs between fall 2020 and fall 2021 (O'Brien et al. 2022).

- **Atlantic Marine Assessment Program for Protected Species (AMAPPS):** NMFS Northeast Fisheries Science Center's (NEFSC's) AMAPPS shipboard and aerial observations, biological and oceanographic sampling, satellite-telemetry, and passive acoustic monitoring (PAM) conducted in all four seasons. AMAPPS surveys took place from 2010–2014 and 2014–2019 (Phase 2) (NEFSC and Southeast Fisheries Science Center [SEFSC] 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

- **Duke University Habitat-based Cetacean Density Models for the US Atlantic:** The original Duke University Habitat-based Cetacean Density Models were published in 2016 for 26 cetacean species and three cetacean species guilds for US waters of the North Atlantic and northern Gulf of Mexico (Roberts et al. 2016). The models have been updated for the Atlantic (East Coast [EC] models) using the same methods but incorporating additional data. Habitat-based density modeling (Roberts et al. 2016) using the latest 2022 models (Roberts et al. 2022) have been released; however, the full publication has not yet been released.

- **Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and nearby waters:** An analysis of existing data for the Rhode Island Ocean Special Area Management (Kenney and Vigness-Raposa 2010).
- **Site-Specific Digital Aerial Surveys:** 32 site-specific high-resolution digital aerial surveys focused on the Lease Area were conducted by APEM Inc. between June 2019 and July 2021 to collect spatial and temporal distribution and abundance data on wildlife.
- **Protected Species Observer (PSO) Sighting Data:** Opportunistic PSO sightings data from geophysical and geotechnical surveys (G&G surveys) undertaken across Lease Area OCS-A 0522.
- **New York Bight Aerial Surveys:** Three years of monthly aerial surveys in the New York Bight from 2017–2020 (Zoidis et al. 2021).
- Published scientific literature relating to relevant marine mammals.

4.7.1.1 Marine Mammals that May Occur in the Offshore Development Area

There are 38 marine mammal species comprising 39 stocks in the Western North Atlantic Outer Continental Shelf (OCS) Region that are protected under the MMPA and whose ranges include the Northeastern US region where the Offshore Development Area will be located (BOEM 2013, 2014b). This includes two different stocks of the common bottlenose dolphin (offshore and migratory coastal) as well as four different species of beaked whale that are often pooled together when estimating abundance. The marine mammal assemblage comprises cetaceans (whales, dolphins, and porpoises) and pinnipeds (seals). There are 35 cetacean species, including 29 members of the suborder Odontoceti (toothed whales, dolphins, and porpoises) and six of the suborder Mysticeti (baleen whales) within the region. There are four phocid species (true seals) that are known to occur in the region, including harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), harp seals (*Pagophilus groenlandica*), and hooded seals (*Cystophora cristata*) (Hayes et al. 2020).

Five of the species known to occur in the Western North Atlantic are listed under the Endangered Species Act (ESA); these include the fin whale (*Balaenoptera physalus*) (endangered), sei whale (*Balaenoptera borealis*) (endangered), blue whale (*Balaenoptera musculus)* (endangered), North Atlantic right whale (*Eubalaena glacialis*) (endangered) and sperm whale (*Physeter macrocephalus*) (endangered). These five species, the blue whale, fin whale, sei whale, North Atlantic right whale (NARW), and sperm whale are expected to occur in the Offshore Development Area and are considered affected species. The blue whale is uncommon in the Offshore Development Area; however, blue whale vocalizations and sighting data in the region demonstrate the possibility for the species to be present in the Offshore Development Area. The following sections provide further information regarding species behavior and expected occurrence in the Offshore Development Area.

The protection status, habitat, seasonality in the Offshore Development Area, stock identification, and abundance estimates of each marine mammal species with geographic ranges that include the Northeastern US region are provided in Table 4.7-1. Table 4.7-1 evaluates the potential occurrence of marine mammals in the Offshore Development Area based on five categories defined as follows:

- Common – Occurring consistently in moderate to large numbers.
- Uncommon – Occurring in low numbers or on an irregular basis.
- Rare – Range includes the Offshore Development Area, but due to habitat preferences and distribution information, species are not expected to occur in the Offshore Development Area although records may exist for adjacent waters.

Of the 38 marine mammal species comprising 39 stocks within geographic ranges that include the western North Atlantic OCS, 21 are considered to be "rare" in the Offshore Development Area based on sighting and distribution data (see Table 4.7-1). These are the dwarf and pygmy sperm whales (*Kogia sima* and *K. breviceps*), northern bottlenose whale (*Hyperoodon ampullatus*), Cuvier's beaked whale (*Ziphius cavirostris*), four species of Mesoplodont beaked whales (*Mesoplodon densitostris, M. europaeus, M. mirus, and M. bidens*), killer whale (*Orcinus orca*), false killer whale (*Pseudorca crassidens*), pygmy killer whale (*Feresa attenuate*), melon-headed whale (*Peponocephala electra*), Fraser's dolphin (*Lagenodelphis hosei*), white-beaked dolphin (*Lagenorhynchus albirotris*), pantropical spotted dolphin (*Stenella attenuate*), Clymene dolphin (*Stenella clymene*), striped dolphin (*Stenella coeruleoalba*), spinner dolphin (*Stenella longirostris*), rough-toothed dolphin (*Steno bredanensis*), common bottlenose dolphin (*Tursiops truncatus*) northern migratory coastal stock, and the hooded seal (*Cystophora cristata*) (Kenney and Vigness-Raposa 2010; Kraus et al. 2016; Roberts et al. 2016; Hayes et al. 2019, 2020; Roberts et al. 2022). Of these species considered to be "rare," eight are not expected to occur within the Offshore Development Area including Clymene dolphin, Fraser's dolphin, rough-toothed dolphin, spinner dolphin, northern bottlenose whale, false killer whale, melon-headed whale, and pygmy killer whale. Due to these species' unexpected occurrence within the Offshore Development Area, they have been excluded from Table 4.7-1.

Table 4.7-1 Marine Mammals that Could be Present in the Offshore Development Area

Common Name (Species Name) and Stock	ESA/MMPA Status[1]	Habitat[2]	Occurrence in the MA and RI/MA WEAs[3]	Seasonality in MA and RI/MA WEAs[4]	Abundance (NMFS best available)[5]
Mysticetes					
Blue whale *(Balaenoptera musculus)* Western North Atlantic Stock	Endangered/Strategic	Pelagic and coastal	Uncommon	Mainly winter, but rare year-round	402
Fin whale *(Balaenoptera physalus)* Western North Atlantic Stock	Endangered/ Strategic	Slope, pelagic	Common	Year-round, but mainly spring and summer	6,802
Humpback whale *(Megaptera novaeangliae)* Gulf of Maine Stock	Not Listed/Not Strategic	Mainly nearshore and banks	Common	Year-round, but mainly spring and summer	1,396
Minke whale *(Balaenoptera acutorostrata)* Canadian East Coast Stock	Not Listed/Not Strategic	Coastal, shelf	Common	Spring, summer, and fall (March to September)	21,968
North Atlantic right whale (*Eubalaena glacialis*) Western North Atlantic Stock	Endangered/ Strategic	Coastal, shelf, offshore	Common	Winter and spring (December to May)	338
Sei whale (*Balaenoptera borealis*) Nova Scotia Stock	Endangered/ Strategic	Mostly pelagic	Common	Spring and summer (March to June)	6,292

Table 4.7-1 Marine Mammals that Could be Present in the Offshore Development Area (Continued)

Common Name (Species Name) and Stock	ESA/MMPA Status[1]	Habitat[2]	Occurrence in the MA and RI/MA WEAs[3]	Seasonality in MA and RI/MA WEAs[4]	Abundance (NMFS best available)[5]
Odontocetes					
Dwarf sperm whale (*Kogia sima*) Western North Atlantic Stock	Not Listed/Not Strategic	Deep, shelf, slope	Rare	NA	7,750[6]
Pygmy sperm whale (*Kogia breviceps*) Western North Atlantic Stock	Not Listed/Not Strategic	Pelagic	Rare	NA	7,750[6]
Sperm whale (Physeter *macrocephalus)* North Atlantic Stock	Endangered/ Strategic	Pelagic, steep topography	Uncommon	Mainly summer and fall	4,349
Atlantic spotted dolphin *(Stenella frontalis)* Western North Atlantic Stock	Not Listed/Not Strategic	Continental shelf, slope	Uncommon	NA	39,921
Atlantic white-sided dolphin *(Lagenorhynchus acutus)* Western North Atlantic Stock	Not Listed/Not Strategic	Offshore, slope	Common	Year-round	93,233
Common bottlenose dolphin *(Tursiops truncatus)* Western North Atlantic Offshore Stock[7]	Not Listed/Not Strategic	Coastal, shelf, deep	Common	Year-round	62,851

Table 4.7-1 Marine Mammals that Could be Present in the Offshore Development Area (Continued)

Common Name (Species Name) and Stock	ESA/MMPA Status[1]	Habitat[2]	Occurrence in the MA and RI/MA WEAs[3]	Seasonality in MA and RI/MA WEAs[4]	Abundance (NMFS best available)[5]
Odontocetes (Continued)					
Killer whale *(Orcinus orca)* Western North Atlantic Stock	Not Listed/Not Strategic	Offshore and mid-ocean	Rare	NA	Unknown
Pantropical spotted dolphin (*Stenella attenuata*) Western North Atlantic Stock	Not Listed/Not Strategic	Pelagic	Rare	NA	6,593
Pilot whale, long-finned (*Globicephalus melas*) Western North Atlantic Stock	Not Listed/Not Strategic	Continental shelf edge, high relief	Uncommon	Year-round	39,215
Pilot whale, short-finned (*Globicephalus macrorhynchus*) Western North Atlantic Stock	Not Listed/Not Strategic	Pelagic, high relief	Uncommon	NA	28,924
Risso's dolphin *(Grampus griseus)* Western North Atlantic Stock	Not Listed/Not Strategic	Shelf, slope	Uncommon	Year-round	35,215
Striped dolphin (*Stenella coeruleoalba*) Western North Atlantic Stock	Not Listed/Not Strategic	Off continental shelf	Rare	NA	67,036

Table 4.7-1 Marine Mammals that Could be Present in the Offshore Development Area (Continued)

Common Name (Species Name) and Stock	ESA/MMPA Status[1]	Habitat[2]	Occurrence in the MA and RI/MA WEAs[3]	Seasonality in MA and RI/MA WEAs[4]	Abundance (NMFS best available)[5]
Odontocetes (Continued)					
Short-beaked common dolphin *(Delphinus delphis delphis)* Western North Atlantic Stock	Not Listed/Not Strategic	Shelf, pelagic	Common	Year-round, but more abundant in summer	172,974
White-beaked dolphin *(Lagenorhynchus albirostris)* Western North Atlantic Stock	Not Listed/Not Strategic	Off continental shelf	Rare	NA	536,016
Cuvier's beaked whale (*Ziphius cavirostris*) Western North Atlantic Stock	Not Listed/Not Strategic	Pelagic	Rare	NA	5,744
Mesoplodont beaked whales[8] *(Mesoplodon densitostris, M. europaeus, M. mirus, and M. bidens)* Western North Atlantic Stock	Not Listed/Not Strategic	Slope, offshore	Rare	NA	10,107[8]
Harbor porpoise (*Phocoena phocoena*) Gulf of Maine/Bay of Fundy Stock	Not Listed/Not Strategic	Shelf	Common	Year-round, but less abundant in summer	95,543

Table 4.7-1 Marine Mammals that Could be Present in the Offshore Development Area (Continued)

Common Name (Species Name) and Stock	ESA/MMPA Status[1]	Habitat[2]	Occurrence in the MA and RI/MA WEAs[3]	Seasonality in MA and RI/MA WEAs[4]	Abundance (NMFS best available)[5]
Pinnipeds					
Gray seal *(Halichoerus grypus)* Western North Atlantic Stock	Not Listed/Not Strategic	Nearshore, shelf	Common	Year-round	27,300
Harbor seal *(Phoca vitulina)* Western North Atlantic Stock	Not Listed/Not Strategic	Coastal	Common	Year-round, but rare in summer	61,336
Harp seal *(Pagophilus groenlandicus)* Western North Atlantic Stock	Not Listed/Not Strategic	Nearshore	Uncommon	Winter and spring	7.6 M
Hooded seal *(Crysophora cristata)* Western North Atlantic Stock	Not Listed/Not Strategic	Off continental shelf	Rare	NA	Unknown

Notes:
NA= Not applicable and/or insufficient data available to determine seasonal occurrence in the Offshore Development Area.
1. Listing status under the US ESA, NMFS (Hayes et al. 2019, 2020), and MMPA.
2. Habitat descriptions from the 2019 Marine Mammal SARs (Hayes et al. 2019).
3. Occurrence in the MA WEA is mainly derived from Hayes et al. (Hayes et al. 2019), Kenney and Vigness-Raposa (Kenney and Vigness-Raposa 2010), Kraus et al. (Kraus et al. 2016), and Roberts et al. (Roberts et al. 2016; Roberts et al. 2022).
4. Seasonality in the MA and RI/MA WEAs was mainly derived from Kraus et al. (Kraus et al. 2016) and Kenney and Vigness-Raposa (Kenney and Vigness-Raposa 2010).
5. "Best Available" abundance estimate is from the 2019 Marine Mammal SARs, published by NMFS on the Federal Register on 27 November 2019 (84 FR 65353); the 2020 Marine Mammal SARs (Hayes et al. 2020); the 2021 Marine Mammal SARs (Hayes et al. 2022); and the Draft 2022 Marine Mammal SARs (Hayes 2023).
6. This estimate includes both dwarf and pygmy whales. Source: Hayes et al. (2022)
7. Common bottlenose dolphins occurring in the MA WEA likely belong to the Western North Atlantic Offshore Stock. It is possible that some could belong to the Western North Atlantic Northern Migratory Coastal Stock (listed as depleted under the MMPA), but the northernmost range of that stock is south of the Lease Area.
8. Mesoplodont beaked whale abundance estimate accounts for all undifferentiated beaked whale species within the Western Atlantic (Hayes et al. 2019).

4.7.1.2 Mysticetes

4.7.1.2.1 Blue Whale (Balaenoptera musculus musculus)

The blue whale is the largest cetacean, although its size range overlaps with that of fin and sei whales. Most adults are 23 to 27 m (75 to 90 ft in length) (Jefferson et al. 2008). Blue whales feed almost exclusively on krill (Kenney and Vigness-Raposa 2010).

Blue whales are considered low-frequency cetaceans in terms of their classification in the acoustic categories assigned by NMFS for the purposes of assessment of the potential for harassment or injury arising from exposure to anthropogenic noise sources, a group whose hearing is estimated to range from 7 hertz (Hz) to 35 kilohertz (kHz) (NMFS 2018b). Peak frequencies of blue whale vocalizations range from roughly 10 to 120 Hz; an analysis of calls recorded since the 1960s indicates that the tonal frequency of blue whale calls has decreased over the past several decades (McDonald et al. 2009).

Status

The blue whale is listed as endangered under the ESA and the Massachusetts Endangered Species Act (MA ESA). The Western North Atlantic stock of blue whales is considered strategic and depleted under the MMPA. Human induced threats to blue whales include entanglement in fishing gear, ship-strikes, pollution, and disruptions of pelagic food webs in response to changes in ocean temperatures and circulation processes (Hayes et al. 2020). There is no designated critical habitat for this species within the Offshore Development Area (Hayes et al. 2020).

Distribution

Blue whales are found in all oceans, including at least two distinct populations inhabiting the eastern and western North Atlantic Ocean (Sears et al. 2005). Although blue whales spend most of their time in deep open ocean waters, there are summertime feeding aggregations of Western North Atlantic blue whales in the Gulf of St. Lawrence, where animals target krill swarms in accessible shallow waters (McQuinn et al. 2016). Data from animals tagged in the St. Lawrence estuary indicate that blue whales use other summer feeding grounds off Nova Scotia and Newfoundland and also feed sporadically during the winter in the Mid-Atlantic Bight, occasionally venturing to waters along or shoreward of the continental shelf break (Lesage et al. 2017; Lesage et al. 2018). Tagging studies show blue whale movements from the Gulf of St. Lawrence to North Carolina, including both on- and off-shelf waters, extending into deeper waters around the New England seamounts (Lesage et al. 2017; Davis et al. 2020). Acoustic detections of blue whales have occurred in deep waters north of the West Indies and east of the US EEZ, indicating that their southern range limit is unknown (Clark 1995; Nieukirk et al. 2004; Davis et al. 2020).

Recent deployment of passive acoustic devices in the New York Bight yielded detections of blue whales about 37 km (20 nautical miles [NM]) southeast of the entrance to New York Harbor during the months of January, February, and March (Muirhead et al. 2018). Blue whale vocalizations have also been detected in the Offshore Development Area during acoustic surveys (Kraus et al. 2016). However, the blue whale vocalizations could have originated at large distances from the receivers, meaning the detections in or near the Offshore Development Area do not necessarily mean blue whale presence within the Offshore Development Area. A single sighting on an individual blue whale was observed approximately 78 km (48.5 mi) east of the Offshore Development Area during the AMAPPS surveys in 2016 (Palka 2017). More recently, during three years of monthly area surveys in the New York Bight from 2017–2020, Zoidis et al. (2021) reported three sightings of five individuals.

Abundance

The current minimum estimate of the Western North Atlantic population, based on photo-identification efforts in the St. Lawrence estuary and the Northwestern Gulf of St. Lawrence, is 402 animals (Sears and Calambokidis 2002; Ramp and Sears 2013; Hayes et al. 2020). This work led to a suggestion that between 400–600 individuals may be found in the Western North Atlantic (Hayes et al. 2020).

4.7.1.2.2 Fin Whale (Balaenoptera physalus)

Fin whales are the second largest species of baleen whale in the Northern Hemisphere (NMFS 2021b), with a maximum length of about 22.8 m (75 ft). These whales have a sleek, streamlined body with a V-shaped head that makes them fast swimmers. This species has a distinctive coloration pattern: the dorsal and lateral sides of the body are black or dark brownish-gray, and the ventral surface is white. The lower jaw is dark on the left side and white on the right side. Fin whales feed on krill (Euphausiacea), small schooling fish (e.g., herring [*Clupea harengus*], capelin [*Mallotus villosus*], sand lance [Ammodytidae spp.]), and squid (*Teuthida* spp.) by lunging into schools of prey with their mouths open (Kenney and Vigness-Raposa 2010).

Fin whales produce characteristic vocalizations that can be distinguished during PAM surveys (BOEM 2013; Erbe et al. 2017). The most commonly observed calls are the "20-Hz signals," a short down sweep falling from 30 to 15 Hz over a one-second period. Fin whales can also produce higher frequency sounds up to 310 Hz, and sound levels (SLs) as high as 195 decibels (dB) relative to one microPascal (re 1 µPa) @ 1 m (3.28 ft) root mean square sound pressure level (SPL_{rms}) have been reported, making it one of the most powerful biological sounds in the ocean (Erbe et al. 2017). Anatomical modeling based on fin whale ear morphology suggests their greatest hearing sensitivity is between 20 Hz and 20 kHz (Cranford and Krysl 2015; Southall et al. 2019).

Status

Fin whales are listed as endangered under the ESA and the MA ESA and are listed as Vulnerable by the International Union for Conservation of Nature (IUCN) Red List (Hayes et al. 2020; IUCN 2020). This stock is listed as strategic and depleted under the MMPA due to its endangered status (Hayes et al. 2020). Potential Biological Removal (PBR) for the western North Atlantic fin whale is 11 (Hayes et al. 2020). PBR is defined as the product of minimum population size, one-half the maximum net productivity rate and recovery factor for endangered, depleted, threatened, or stocks of unknown status relative to the optimal sustainable population (OSP) (Hayes et al. 2020). Annual human-caused mortality and serious injury for the period between 2015 and 2019 was estimated to be 1.8 per year (Hayes et al. 2021). This estimate includes incidental fishery interactions (i.e., bycatch/entanglement) and vessel collisions, but does not include other threats to fin whales such as contaminants found within their habitat and potential climate-related shifts in distribution of prey species (Hayes et al. 2020).

Distribution

Fin whales have a wide distribution and can be found in the Atlantic and Pacific Oceans in both the Northern and Southern Hemisphere (Hayes et al. 2020). The population is divided by ocean basins; however, these boundaries are arbitrary as they are based on historical whaling patterns rather than biological evidence (Hayes et al. 2020). Fin whales off the eastern US, Nova Scotia, and the southeastern coast of Newfoundland are believed to constitute a single stock under the present International Whaling Commission (IWC) management scheme (Donovan 1991), which has been called the Western North Atlantic stock.

Fin whales transit between summer feeding grounds in the high latitudes and the wintering, calving, or mating habitats in low latitudes or offshore. However, acoustic records indicate that fin whale populations may be less migratory than other mysticetes whose populations make distinct annual migrations (Watkins et al. 2000). Fin whales typically feed in New England waters on fishes (e.g., sea lance, capelin, herring), krill, copepods, and squid in deeper waters near the edge of the continental shelf (90 to 180 m [295 to 591 ft]) but will migrate towards coastal areas following prey distribution. However, fin whales' habitat use has shifted in the southern Gulf of Maine, most likely due to changes in the abundance of sand lance and herring, both of which are prey for the fin whale (Vigness-Raposa et al. 2010). While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas remain largely unknown (Hayes et al. 2020). The Offshore Development Area is flanked by two Biologically Important Areas (BIAs) for feeding for fin whales—the area to the northeast in the Southern Gulf of Maine is considered a BIA year-round, while the area to the southwest off the tip of Long Island is a BIA from March to October (LaBrecque et al. 2015).

Kraus et al. (2016) suggest that, compared to other baleen whale species, fin whales have a high multi-seasonal relative abundance in the MA WEA and RI/MA WEA and surrounding areas. Fin whales were observed during spring and summer of the 2011–2015 NLPSC aerial survey. This species was observed primarily in the offshore (southern) regions of the MA and RI/MA WEAs and during spring and was found closer to shore (northern areas) during the summer months (Kraus et al. 2016). Calves were observed three times and feeding was observed nine times during the Kraus et al. (2016) study. Although fin whales were largely absent from visual surveys in the MA and RI/MA WEAs and in the fall and winter months (Kraus et al. 2016), acoustic data indicated that this species was present in the MA and RI/MA WEAs during all months of the year. Fin whales were acoustically detected in the MA WEA on 87% of study days (889/1,020 days). Acoustic detection data indicated a lack of seasonal trends in fin whale abundance with slightly less detections from April to July (Kraus et al. 2016). Because the detection range for fin whale vocalizations is more than 200 km (108 NM), detected signals may have originated from areas far outside of the MA and RI/MA WEAs; however, arrival patterns of many fin whale vocalizations indicated that received signals likely originated from within the Kraus et al. (2016) study area. Fin whales were observed in the MA WEA and nearby waters during spring and summer of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). Between May and December 2019 and March and April 2022, there were eight and five sightings of fin whales, respectively, recorded during high resolution geophysical (HRG) surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

During more recent surveys conducted in the MA and RI/MA WEAs, there were 32 sightings of 53 individual fin whales between October 2018 and August 2019 (O'Brien et al. 2020a). Most of these sightings occurred in late spring and early summer (May–June) (O'Brien et al. 2020a). Fin whales were observed clustering in the southern and eastern parts of the MA and RI/MA WEAs during the surveys (O'Brien et al. 2020a). Between March and October 2020, fin whales were only observed during summer months within the MA and RI/MA WEAs (O'Brien et al. 2020b). The most recent surveys conducted in the MA and RI/MA WEAs observed 18 sightings of 27 individual fin whales between September 2020 and October 2021 (O'Brien et al. 2022). A map of fin whale average seasonal density from Roberts et al. (2016; 2022) is presented in Figure 4.7-1.

Abundance

The best abundance estimate available for the Western North Atlantic stock is 6,802 based on data from NMFS shipboard and aerial surveys and the 2016 NEFSC and Department of Fisheries and Oceans Canada (DFO) surveys (Hayes et al. 2020) A population trend analysis does not currently exist for this species because of insufficient data; however, based on photographic identification, the gross annual reproduction rate is 8% with a mean calving interval of 2.7 years (Agler et al. 1993; Hayes et al. 2020).

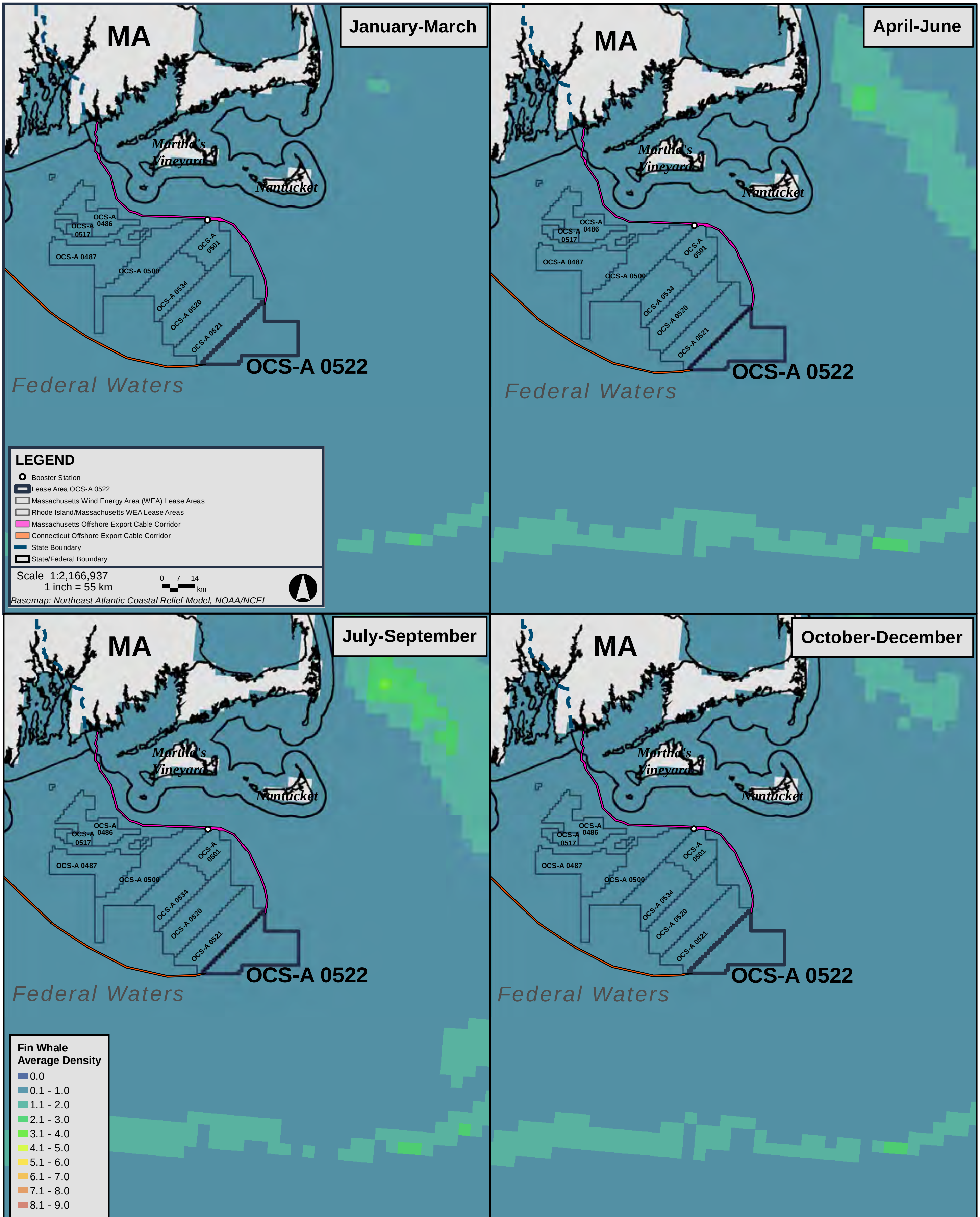

Figure 4.7-1
Map of Fin Whale Average Seasonal Density from Roberts et al. (2016; 2022)

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4.7.1.2.3 Humpback Whale (*Megaptera novaengilae*)

Female humpback whales are larger than males and can reach lengths of up to 18 m (60 ft) (NMFS 2021e). Humpback whale body coloration is primarily dark gray, but individuals have a variable amount of white on their pectoral fins, belly, and flukes. These distinct coloration patterns are used by scientists to identify individuals. These baleen whales feed on small prey often found in large concentrations, including krill and fish such as herring and sand lance (Kenney and Vigness-Raposa 2010). Humpback whales use unique behaviors, including bubble nets, bubble clouds, and flicking of their flukes and fins, to herd and capture prey (NMFS 1991).

During migration and breeding seasons, male humpback whales are often recorded producing vocalizations arranged into repetitive sequences termed "songs" that can last for hours or even days. These songs have been well studied in the literature to document changes over time and geographic differences. Generally, the frequencies produced during these songs range from 20 Hz to over 24 kHz. Most of the energy is focused between 50 and 1,000 Hz and reported SLs range from 151 to 189 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). Other calls produced by humpbacks, both male and female, include pulses, moans, and grunts used for foraging and communication. These calls are lower frequency (under 2 kHz) with SLs ranging from 162 to 190 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Thompson et al. 1986; Erbe et al. 2017). Anatomical modeling based on humpback whale ear morphology indicates that their best hearing sensitivity is between 18 Hz and 15 kHz (Ketten et al. 2014; Southall et al. 2019).

Status

NMFS revised the listing status for humpback whales under the ESA in 2016 (81 FR 62260 2016). Globally, there are 14 distinct population segments (DPSs) recognized for humpback whales, four of which are listed as endangered. The Gulf of Maine stock (formerly known as the Western North Atlantic stock) which occurs in the Offshore Development Area is considered non-strategic under the MMPA and does not coincide with any ESA-listed DPS (Hayes et al. 2020). This stock is considered non-strategic because the detected level of US fishery-caused mortality and serious injury derived from the available records do not exceed the calculated PBR of 22, with a set recovery factor at 0.5 (Hayes et al. 2020). Because the observed mortality is estimated to be only 20% of all mortality, total annual mortality may be 60-70 animals in this stock (Hayes et al. 2020). If anthropogenic causes are responsible for as little as 31% of potential total mortality, this stock could be over PBR. While detected mortalities yield an estimated minimum fraction anthropogenic mortality at 0.85, additional research is being done before apportioning mortality to anthropogenic versus natural causes for undetected mortalities and making a potential change to the MMPA status of this stock.

An Unusual Mortality Event (UME) was declared for this species in January 2016, which as of March 2023 has caused 188 stranded humpback whales with 35 of those occurring off Massachusetts (Hayes et al. 2020; NMFS 2023a). Stranding investigations have concluded that 40% of the stranded humpback whales show signs of interaction with vessels and entanglement in commercial fishing gear (NMFS 2023a). A BIA for humpback whales for feeding has been designated northeast of the Offshore Development Area in the Gulf of Maine, Stellwagen Bank, and the Great South Channel from March through December (LaBrecque et al. 2015). Major threats to humpback whales include vessel strikes, entanglement, and climate-related shifts in prey distribution (Hayes et al. 2020).

Distribution

The humpback whale can be found worldwide in all major oceans from the equator to sub-polar latitudes. In the summer, humpbacks are found in higher latitudes feeding in the Gulf of Maine and Gulf of Alaska. During the winter months, humpbacks migrate to calving grounds in subtropical or tropical waters, such as the Dominican Republic in the Atlantic and Hawaiian Islands in the Pacific (Hayes et al. 2020). Humpback whales from the North Atlantic feed, mate, and calve in the West Indies (Hayes et al. 2020). In the summer, humpback whales in the Western North Atlantic are typically observed in the Gulf of Maine and along the Scotian Shelf; there have also been numerous winter sightings in the southeastern US (Hayes et al. 2020). Feeding behavior has also been observed in New England off Long Island, New York, and NMFS survey data suggests a potential increase in humpback whale abundance off New Jersey and New York (Hayes et al. 2020). There were 46 sightings of humpback whales in the New York-New Jersey Harbor Estuary documented between 2011 and 2016 (Brown et al. 2017). Between May and December 2019 and March and April 2022, there were three and 25 sightings of humpback whales, respectively, recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed humpback whales in the MA and RI/MA WEAs, and surrounding areas during all seasons of the 2011–2015 NLPSC aerial surveys. Humpback whales were observed most often during the spring and summer months, with a peak from April to June. Calves were observed 10 times and feeding was observed 10 times during the Kraus et al. (2016) study. That study also observed one instance of courtship behavior. Although humpback whales were only rarely seen during fall and winter surveys, acoustic data indicate that this species may be present within the MA WEA year-round, with the highest rates of acoustic detections in winter and spring (Kraus et al. 2016). Humpback whales were acoustically detected in the MA WEA on 56% of acoustic survey days (566/1,020 days). Acoustic detections do not differentiate between individuals, so detections on multiple days could be the same or different individuals. The mean detection range for humpback whales using PAM was 30–36 km (16-19 NM), with a mean radius of 36 km (19 NM) for the PAM system. Kraus et al. (2016) estimated that 63% of acoustic detections of humpback whales represented whales within their study area. Humpback whales were observed in the MA WEA and nearby waters during the spring and summer of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

Similar trends were observed during more recent surveys conducted in the MA and RI/MA WEAs between October 2018 and August 2019 to those observed during the 2011–2015 NLPSC aerial surveys (O'Brien et al. 2020a). There was a total of 30 humpback whale sightings of 32 individuals observed in the MA and RI/MA WEAs including both on- and off-effort sightings (O'Brien et al. 2020a). Humpback whales were present during all seasons with peak sightings and the greatest relative abundance in spring and summer. The majority of sightings were on the eastern side of the MA and RI/MA WEAs, regardless of time of year (O'Brien et al. 2020a). From March to October 2020, humpback whales were the most frequently sighted cetacean during surveys conducted in the MA and RI/MA WEAs, although not the most abundant, accounting for 22% of all sightings (O'Brien et al. 2020b). Over the survey period, there were 22 sightings of 44 individual humpback whales. During the 2020 survey, sightings were also concentrated more on the eastern side of the MA and RI/MA WEAs, and just outside the WEAs in the Nantucket Shoals area. During the most recent surveys conducted in the MA and RI/MA WEAs from September 2020 and October 2021, there were 66 sightings of 97 individuals observed (O'Brien et al. 2022). Humpback whales were sighted across the entire study area; however, seasonal distribution patterns were observed. During fall seasons, humpback whales were observed most prevalently in Nantucket Shoals; during spring and summer months, humpback whales were spread more evenly across the MA and RI/MA WEAs (O'Brien et al. 2022). A map of humpback whale average seasonal density from Roberts et al. (2016, 2022) is presented in Figure 4.7-2.

<u>Abundance</u>

The best available abundance estimate of the Gulf of Maine stock is 1,396 individuals, derived from modeled sighting histories constructed using photo-identification data collected through October 2016 (Hayes et al. 2020). Available data indicate that this stock is characterized by a positive population trend, with an estimated increase in abundance of 2.8% per year (Hayes et al. 2020).

4.7.1.2.4 Minke Whale (Balaenoptera acustorostrata)

Minke whales are a baleen whale species reaching 10 m (35 ft) in length. The minke whale is common and widely distributed within the US Atlantic EEZ and is the third most abundant great whale (any of the larger marine mammals of the order Cetacea) in the EEZ (CeTAP 1982). A prominent morphological feature of the minke whale is the large, pointed median ridge on top of the rostrum. The body is dark gray to black with a pale belly, and frequently shows pale areas on the sides that may extend up onto the back. The flippers are smooth and taper to a point, and the middle third of each flipper has a conspicuous bright white band that can be distinguished during visual surveys (Kenney and Vigness-Raposa 2010). Its diet is comprised primarily of crustaceans, schooling fish, and copepods. Minke whales generally travel in small groups (one to three individuals), but larger groups have been observed on feeding grounds (NMFS 2021g).

In the North Atlantic, minke whales commonly produce pulse trains lasting 10 –70 seconds with a frequency range between 10 and 800 Hz. SLs for this call type have been reported between 159 and 176 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). Some minke whales also

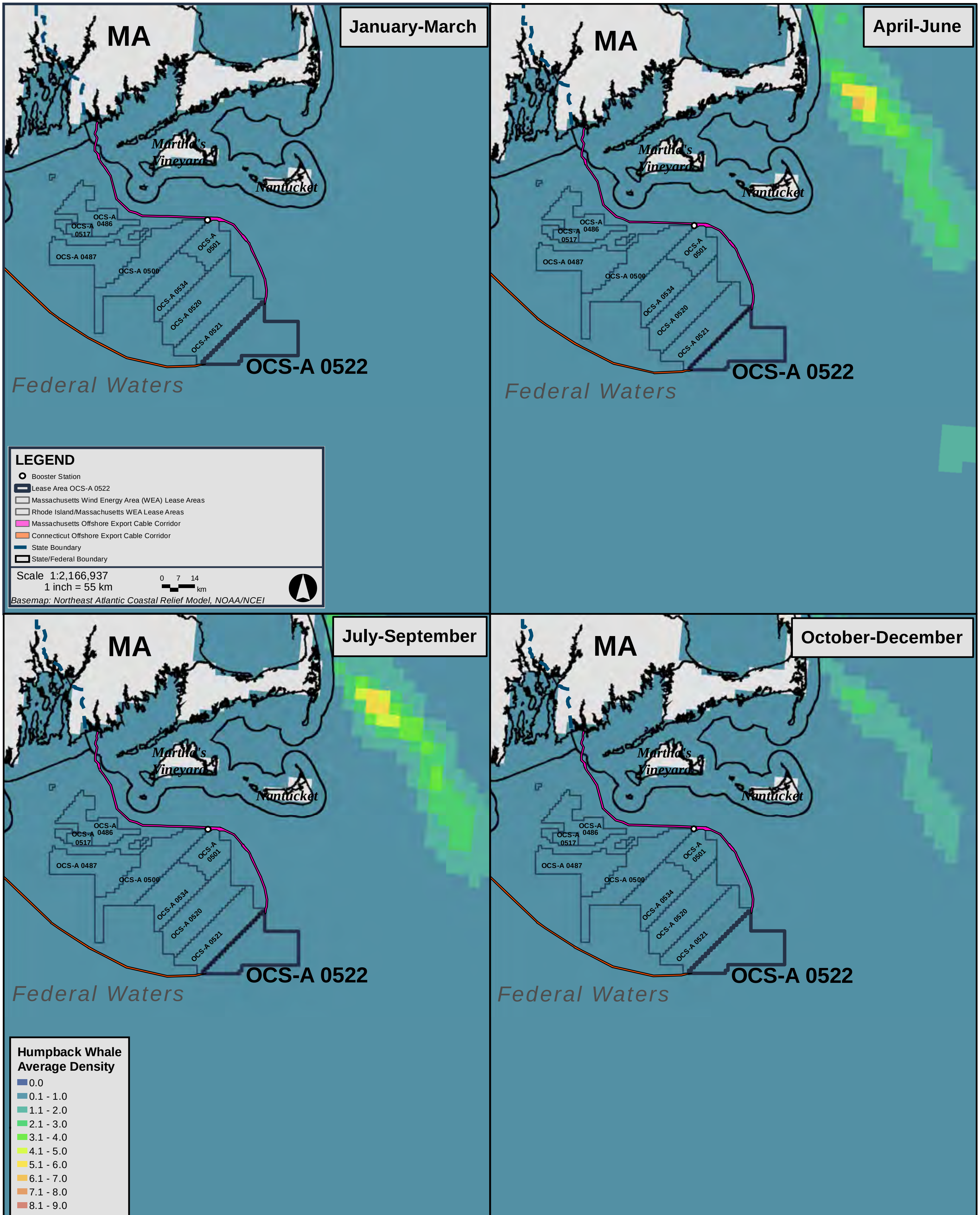

Figure 4.7-2
Map of Humpback Whale Average Seasonal Density from Roberts et al. (2016; 2022)

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produce a unique "boing" sound which is a train of rapid pulses often described as an initial pulse followed by an undulating tonal (Rankin and Barlow 2005; Erbe et al. 2017). The "boing" ranges from one to five kHz with an SLs of approximately 150 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Rankin and Barlow 2005; Erbe et al. 2017). Auditory sensitivity for this species based on anatomical modeling of minke whale ear morphology is best between 10 Hz and 34 kHz (Ketten et al. 2014; Southall et al. 2019).

Status

Minke whales are not listed under the ESA or classified as strategic under the MMPA. They are listed as Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The estimated annual human-caused mortality and serious injury from 2014 to 2018 was 10.55 per year attributed to fishery interactions, vessel strikes, and non-fishery entanglement in both the US and Canada (Hayes et al. 2020), and a UME was declared for this species in January 2017, which is ongoing (NMFS 2023b). As of March 2023, a total of 140 strandings have been reported, with 49 of those occurring off Massachusetts (NMFS 2022b). The PBR for this stock is estimated to be 170 (Hayes et al. 2020). A BIA for minke whales for feeding has been designated east of the Offshore Development Area from March through November (LaBrecque et al. 2015). Minke whales may also be vulnerable to climate-related changes in prey distribution, although the extent of this effect on minke whales remains uncertain (Hayes et al. 2020).

Distribution

Minke whales prefer the colder waters in northern and southern latitudes, but they can be found in every ocean in the world. Available data suggest that minke whales are distributed in shallower waters along the continental shelf between the spring and fall and are located in deeper oceanic waters between the winter and spring (Hayes et al. 2020). They are most abundant in New England waters in the spring, summer, and early fall (Hayes et al. 2020). Acoustic detections show that minke whales migrate sound in mid-October to early November and return from wintering grounds starting in March through early April (Risch et al. 2014). Between May and December 2019 and March and April 2022, there were six and seven sightings of minke whales, respectively, recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed minke whales in the MA and RI/MA WEAs and surrounding areas primarily from May to June during the 2011–2015 NLPSC aerial survey. This species demonstrated a distinct seasonal habitat usage pattern that was consistent throughout the study. Minke whales were not observed between October and February, but acoustic data indicate the presence of this species in the winter months. Calves were observed twice, and feeding was also observed twice during the Kraus et al. (2016) study. Minke whales were acoustically detected in the MA WEA on 28% of project days (291/1,020 days). Minke whale acoustic presence data also exhibited a distinct seasonal pattern; acoustic presence was lowest in the months of December and January, steadily increased beginning in February, peaked in

April, and exhibited a gradual decrease throughout the summer months (Kraus et al. 2016). Acoustic detection range for this species was small enough that over 99% of detections were limited to within the Kraus et al. (2016) study area. Minke whales were observed several times in the MA WEA and nearby waters during spring and summer of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During recent surveys conducted in the MA and RI/MA WEAs, there were 98 sightings of 115 individual minke whales between October 2018 and August 2019 (O'Brien et al. 2020a). The majority of these sightings occurred during the spring and summer (April and June). Only two sightings occurred during the winter, and none during the fall. Between March and October 2020, minke whales were sighted during all months within the MA and RI/MA WEAs except March and October (O'Brien et al. 2020b). During the most recent surveys conducted in the MA and RI/MA WEAs, there were 24 sightings of 24 individuals observed between September 2020 and October 2021 (O'Brien et al. 2022). A map of minke whale average seasonal density from Roberts et al. (2016, 2022) is presented in Figure 4.7-3.

Abundance

The best available current global abundance estimates for the common minke whale, compiled by the IUCN Red List, is around 200,000 (Graham and Cooke 2008). The most recent population estimate for the Canadian East Coast stock which occurs in the Offshore Development Area is 21,968 minke whales, derived from surveys conducted by NMFS and the DFO Canada between Labrador and central Virginia (Hayes et al. 2020). There are no current population trends or net productivity rates for this species due to insufficient data.

4.7.1.2.5 North Atlantic Right Whale (Eubalaena glacialis)

NARWs are among the rarest of all marine mammal species in the Atlantic Ocean. They average approximately 15 m (50 ft) in length (NMFS 2021h). They have stocky, black bodies with no dorsal fin, and bumpy, coarse patches of skin on their heads called callosities. NARWs feed mostly on zooplankton and copepods belonging to the *Calanus* and *Pseudocalanus* genera (Hayes et al. 2020). NARWs are slow-moving grazers that feed on dense concentrations of prey at or below the water's surface, as well as at depth (NMFS 2021h). Research suggests that NARWs must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are a primary characteristic of the spring, summer, and fall NARW habitats (Kenney et al. 1995). NARWs are usually observed in groups of less than 12 individuals, and most often as single individuals or pairs. Larger groups may be observed in feeding or breeding areas (Jefferson et al. 2008).

NARW vocalizations most frequently observed during PAM studies include upsweeps rising from 30 to 450 Hz, often referred to as "upcalls," and broadband (30 to 8,400 Hz) pulses, or "gunshots," with SLs between 172 and 187 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). However, recent studies have shown that mother-calf pairs reduce the amplitude of their calls

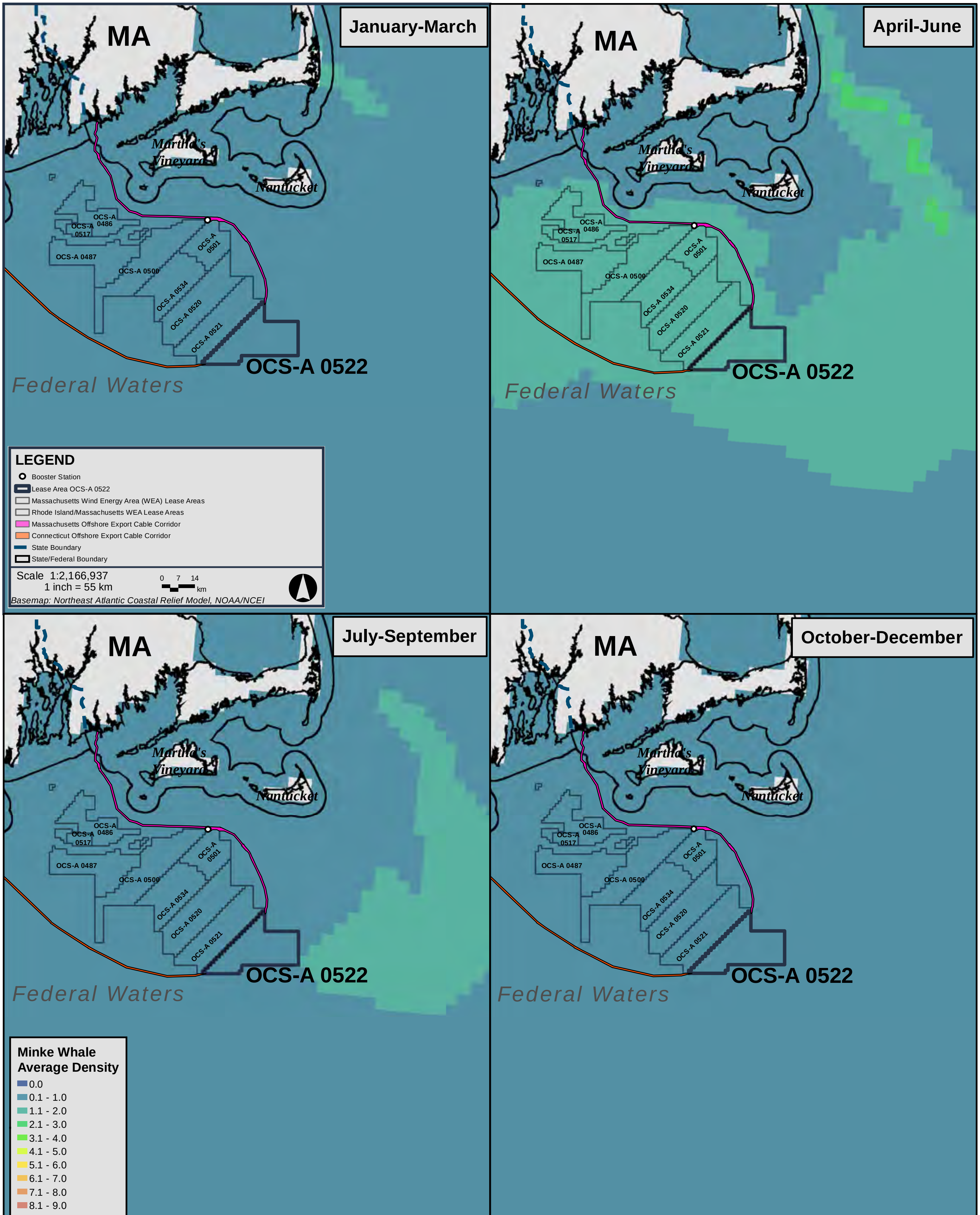

Figure 4.7-3
Map of Minke Whale Average Seasonal Density from Roberts et al. (2016; 2022)

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in the calving grounds, possibly to avoid detection by predators (Parks et al. 2019). Modeling conducted using right whale ear morphology suggests that the best hearing sensitivity for this species is between 16 Hz and 25 kHz (Ketten et al. 2014; Southall et al. 2019).

Status

The NARW is listed as endangered under the ESA and MA ESA and are listed as critically endangered by the IUCN Red List (Hayes et al. 2020; IUCN 2020). NARWs are considered to be the most critically endangered large whales in the world (Hayes et al. 2019). The average annual human-related mortality/injury rate exceeds that of the calculated PBR of 0.7, classifying this population as strategic and depleted under the MMPA (Hayes et al. 2021). Estimated human-caused mortality and serious injury between 2016 and 2020 was 8.1 whales per year (Hayes et al. 2023). Pettis et al. (2017) uses the hierarchical Bayesian, state-space model to estimate NARW abundance, which can also be used to estimate total mortality (Hayes et al. 2023). The estimated rate of total mortality using this modeling approach is 31.2 animals per year, or 156 animals total, for the period of 2015 – 2019 (Pettis et al. 2021). That annual rate of total mortality is 4.1 times higher than the 7.7 detected mortality and serious injury value reported for the same period in the previous stock assessment report (Hayes et al. 2023). To apportion the estimated total NARW mortality by cause, the proportion of observed mortalities and serious injuries from entanglement compared to those from vessel collision for the period of 2016 – 2020 were used (Hayes et al. 2023). During this period, 71% of the observed mortalities and serious injuries were the result of entanglement and 29% were from vessel collisions (Hayes et al. 2023).

To protect this species from ship strikes, NMFS designated Seasonal Management Areas (SMAs) in US waters in 2008 (NMFS 2008). All vessels greater than 19.8 m (65 ft) in overall length must operate at speeds of 18.4 km/hour (10 knots) or less within these areas during specific time periods. The Block Island Sound SMA overlaps with the southern portion of the MA WEA and is active between November 1 and April 30 each year. The Great South Channel SMA lies to the northeast of the MA WEA and is active April 1 to July 31. In addition, the rule provides for the establishment of Dynamic Management Areas (DMAs) when and where NARWs are sighted outside SMAs. DMAs are generally in effect for two weeks and the 18.4 km/hour (10 knots) or less speed restriction is voluntary.

NMFS has designated two critical habitat areas for the NARW under the ESA: the Gulf of Maine/Georges Bank region and the southeast calving grounds from North Carolina to Florida (NMFS 2016). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the NARW (Brown et al. 2009). The Offshore Development Area is encompassed by a NARW BIA for migration from March to April and from November to December (LaBrecque et al. 2015). The NARW BIA for migration includes the MA and RI/MA WEAs and beyond to the continental slope, extending northward to offshore of Provincetown, MA and southward to halfway down the Florida coast (LaBrecque et al. 2015).

Distribution

The NARW is a migratory species that travels from high-latitude feeding waters to low-latitude calving and breeding grounds (Whitt et al. 2013). The Western Atlantic stock of NARWs ranges primarily from calving grounds in coastal waters of the southeastern US to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al. 2020). These whales undertake a seasonal migration from their northeast feeding grounds (generally spring, summer, and fall habitats) south along the US east coast to their calving grounds in the waters of the southeastern US (Kenney and Vigness-Raposa 2010).

NARWs are considered to be comprised of two separate stocks: Eastern and Western Atlantic stocks. The Eastern North Atlantic stock was largely extirpated by historical whaling (Aguilar 1986). NARWs in US waters belong to the Western Atlantic stock. Since 2010, NARWs have been declining in and around once key habitats in the Gulf of Maine and the Bay of Fundy (Davies et al. 2015; Davis et al. 2017), while sightings have increased in other areas including Cape Cod Bay, Massachusetts Bay, the Mid-Atlantic Bight, and the Gulf of St. Lawrence (Whitt et al. 2013; Davis et al. 2017; Mayo et al. 2018; Davies and Brillant 2019; Ganley et al. 2019; Charif et al. 2020). An eight-year analysis of NARW sightings within southern New England (SNE) shows that the NARW distribution has been shifting (Quintana-Rizzo et al. 2021). The SNE study area (shores of Martha's Vineyard and Nantucket to and covering all the offshore wind lease sites of Massachusetts and Rhode Island) recorded sightings of NARWs in almost all months of the year, with the highest sighting rates between December and May, when close to a quarter of the population may be present at any given time (Quintana-Rizzo et al. 2021). Between January 2021 to present, there have been 68 sightings of NARW within the Nantucket Shoals (O'Brien et al. 2020a, 2020b, 2022).

The winter distribution of NARWs is largely unknown; however, in January 2021, during HRG surveys within the Lease Area and the OECCs, four NARW sightings were recorded (see Section 5.3 of Appendix II-B). Some evidence provided through acoustic monitoring suggests that not all individuals of the population participate in annual migrations, with a continuous presence of NARWs occupying their entire habitat rage throughout the year, particularly north of Cape Hatteras (Davis et al. 2017). These data also recognize changes in population distribution throughout the NARW habitat range that could be due to environmental or anthropogenic effects, a response to short-term changes in the environment, or a longer-term shift in the NARW distribution cycle (Davis et al. 2017). A climate-driven shift in the Gulf of Maine/western Scotian Shelf region occurred in 2010 and impacted the foraging environment, habitat use, and demography of the NARW population (Meyer-Gutbrod et al. 2021). In 2010, the number of NARWs returning to the traditional summertime foraging grounds in the eastern Gulf of Maine/Bay of Fundy region began to decline rapidly (Davies et al. 2019; Davies and Brillant 2019; Record et al. 2019). Despite considerable survey effort, the location of most of the population during the 2010-2014 foraging seasons are largely unknown; however, sporadic sightings and acoustic detections in Canadian waters suggest a dispersed distribution (Davies et al. 2019) and a significant increase in the presence of whales in the southern Gulf of St. Lawrence beginning in 2015 (Simard et al. 2019).

Surveys demonstrate the existence of seven areas where NARWs congregate seasonally: the coastal waters of the southeastern US, the Great South Channel, Jordan Basin, Georges Basin along the northeastern edge of Georges Bank, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Roseway Basin on the Scotian Shelf (Hayes et al. 2018). NMFS has designated two critical habitat areas for the NARW under the ESA: the Gulf of Maine/Georges Bank region, and the southeast calving grounds from North Carolina to Florida (DoC 2016). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the NARW (Brown et al. 2009).

Kraus et al. (2016) observed NARWs in the MA and RI/MA WEAs and surrounding waters in winter and spring during the 2011–2015 NLPSC aerial survey and observed 11 instances of courtship behavior. The greatest SPUE in the MA and RI/MA WEAs was in March. Seventy-seven unique individual NARWs were observed in the MA and RI/MA WEAs over the duration of the NLPSC surveys (Kraus et al. 2016). No calves were observed. Kraus et al. (2016) acoustically detected NARWs with PAM within the MA WEA on 43% of project days (443/1,020 days) and during all months of the year. Acoustic detections do not differentiate between individuals, so detections on multiple days could be the same or different individuals. NARWs exhibited notable seasonal variability in acoustic presence, with maximum occurrence in the winter and spring (January through March), and minimum occurrence in summer (July, August, and September). The mean detection range for NARWs using PAM was 15–24 km (8-13 NM), with a mean radius of 21 km (11 NM) for the PAM system within the study area. Between March and April 2022, there were two sightings of NARWs recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B). During more recent surveys conducted in the MA and RI/MA WEAs there were 112 sightings of 164 individual NARWs during directed surveys between October 2018 and August 2019 (O'Brien et al. 2020a). In contrast with the aerial surveys conducted by Kraus et al. (2016), NARWs were observed in the MA and RI/MA WEAs during every season, in nine of eleven months, with the highest number of sightings in January. NARWs were recorded predominantly on the eastern side of the survey area. The distribution was observed to change seasonally with NARWs moving north from the southern portion of Nantucket Shoals in winter to an area 18.52 km (10 NM) south of Nantucket in April. The aggregation was then observed to move south again back to Nantucket Shoals in late July persisting in the area until the end of the survey period in August (O'Brien et al. 2020a). Between March and October 2022, there were 10 sightings of 15 individual NARWs (O'Brien et al. 2020b). Sighting rates were higher in the fall than summer, and the feeding aggregation observed in previous years during the summer were absent (O'Brien et al. 2020b). During the most recent surveys conducted in the MA and RI/MA WEAs between September 2020 and October 2021, there were 90 sightings of 169 NARWs (O'Brien et al. 2022). NARWs were sighted over the Nantucket Shoals during all seasons except for spring. During spring months, NARWs were aggregated in or near the MA and RI/MA WEAs (O'Brien et al. 2022).

Roberts et al. (2021) predicted the highest density of NARWs in the MA WEA and adjacent waters occurs in April, and Kraus et al. (2016) reported greatest levels of SPUE of NARWs in the WEA in March. The NLPSC aerial surveys report no sightings of NARWs for the months of May through October and reported only four sightings in December across all survey years (Kraus et al. 2016). NARWs were observed in the MA WEA and nearby waters during the winter, spring, and summer of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). Sightings of this species in the Offshore Development Area are possible at any time of year. A map of NARW average seasonal density from Roberts et al. (2016, 2022) is presented in Figure 4.7-4.

Abundance

The Western North Atlantic population size was estimated to be 338 individuals in the most recent draft 2022 SAR, which used data from the photo-identification database maintained by the NEAq that were available in October 2019 (Hayes et al. 2023). However, the Right Whale Consortium 2020 Report Card estimates the NARW population to be 336 individuals (Pettis et al. 2021). A population trend analysis conducted on the abundance estimates from 1990 to 2011 suggest an increase at about 2.8% per year from an initial abundance estimate of 270 individuals in 1998 to 481 in 2011, but there was a 100% chance the abundance declined from 2011 to 2020 when the final estimate was 338 individuals (Hayes et al. 2023). Based on the abundance estimates between 2011 and 2019, there was an overall abundance decline of 29.7% (derived from 2011 and 2020 median point estimates) (Hayes et al. 2023). Modeling conducted by Pace et al. (2021) showed a decline in annual abundance after 2011, which has likely continued as evidenced by the decrease in the abundance estimate from 368 in 2022 (Hayes et al. 2022) to 338 in 2023 (Hayes et al. 2023). Highly variable data exists regarding the productivity of this stock. Over time, there have been periodic swings of per capita birth rates (Hayes et al. 2023). Net productivity rates do not exist as the Western North Atlantic stock lacks any definitive population trend (Hayes et al. 2020).

4.7.1.2.6 Sei Whale (Balaenoptera borealis)

Sei whales are baleen whales that can reach lengths of about 12–18 m (40–60 ft) (NMFS 2021j). This species has a long, sleek body that is dark bluish gray to black in color and pale underneath (NMFS 2021j). Their diet is comprised primarily of plankton, schooling fish, and cephalopods. Sei whales generally travel in small groups (two to five individuals), but larger groups are observed on feeding grounds (NMFS 2021j).

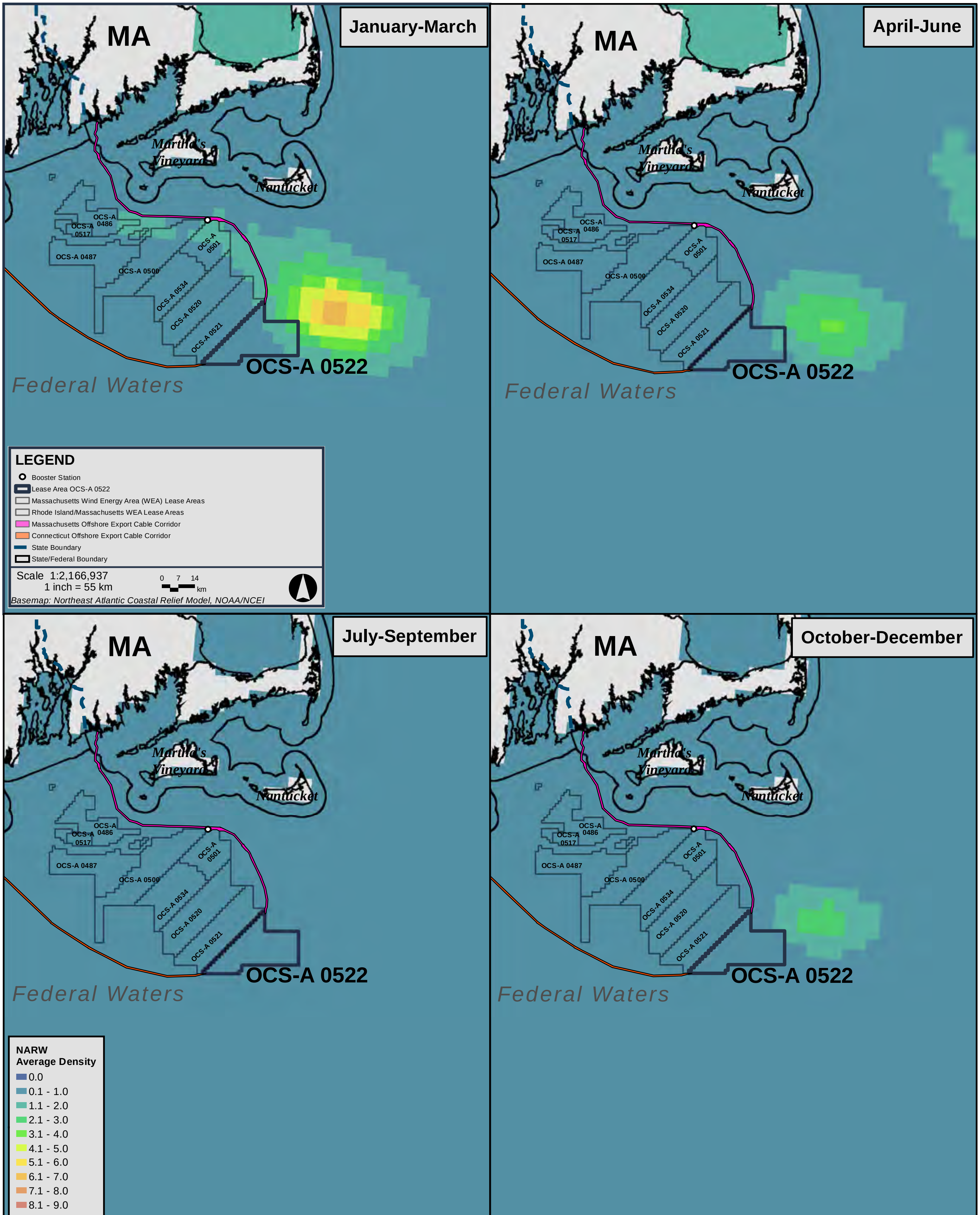

Figure 4.7-4
Map of NARW Average Seasonal Density from Roberts et al. (2016; 2022)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Although uncertainties still exist with distinguishing sei whale vocalizations during PAM surveys, they are known to produce short duration (0.7 to 2.2 seconds) upsweeps and downsweeps between 20 and 600 Hz. SLs for these calls can range from 147 to 183 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). No auditory sensitivity data are available for this species (Southall et al. 2019).

Status

Sei whales are listed as endangered under the ESA and MA ESA and by the IUCN Red List (Hayes et al. 2020; IUCN 2020). This stock is listed as strategic and depleted under the MMPA due to its endangered status (Hayes et al. 2020). Annual human-caused mortality and serious injury from 2015 to 2019 was estimated to be 0.8 per year (Hayes et al. 2021). The PBR for this stock is 6.2 (Hayes et al. 2020). Like fin whales, major threats to sei whales include fishery interactions, vessel collisions, contaminants, and climate-related shifts in prey species (Hayes et al. 2020). There are no critical habitat areas designated for the sei whale under the ESA. A BIA for feeding for sei whales occurs east of the Offshore Development Area from May through November (LaBrecque et al. 2015).

Distribution

Sei whales occur in all the world's oceans and migrate between feeding grounds in temperate and sub-polar regions to wintering grounds in lower latitudes (Kenney and Vigness-Raposa 2010; Hayes et al. 2020). In the Western North Atlantic, most of the population is concentrated in northerly waters along the Scotian Shelf. Sei whales are observed in the spring and summer, utilizing the northern portions of the US Atlantic EEZ as feeding grounds, including the Gulf of Maine and Georges Bank. The highest concentration is observed during the spring along the eastern margin of Georges Bank and in the Northeast Channel area along the southwestern edge of Georges Bank. PAM conducted along the Atlantic Continental Shelf and Slope in 2004-2014 detected sei whales calls from south of Cape Hatteras to the Davis Strait with evidence of distinct seasonal and geographic patterns. Davis et al. (2020) detected peak call occurrence in northern latitudes during summer indicating feeding grounds ranging from SNE through the Scotian Shelf. Sei whales were recorded in the southeast on Blake's Plateau in the winter months, but only on the offshore recorders indicating a more pelagic distribution in this region. Persistent year-round detections in SNE and the New York Bight highlight this as an important region for the species (Hayes et al. 2021). In general, sei whales are observed offshore with periodic incursions into more shallow waters for foraging (Hayes et al. 2020). Between March and April 2022, there were two sightings of sei whales recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed sei whales in the MA and RI/MA WEAs and surrounding areas only between the months of March and June during the 2011–2015 NLPSC aerial survey. The number of sei whale observations was less than half that of other baleen whale species in the two seasons in which sei whales were observed (spring and summer). This species demonstrated a distinct seasonal habitat use pattern that was consistent throughout the study. Calves were observed three times and feeding was observed four times during the Kraus et al. (2016) study. Sei whales were not observed in the MA WEA and nearby waters during the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). However, there were observations during the 2016 and 2017 summer surveys that were identified as being either a fin or sei whale.

During recent surveys conducted in the MA and RI/MA WEAs, there were 28 sightings of 55 individual sei whales observed between October 2018 and August, all of which occurred in May and June (O'Brien et al. 2020a). Observations of sei whales were made in the southern portion of the survey area outside the MA and RI/MA WEAs (O'Brien et al. 2020a). No sei whales were observed during the 2020 surveys conducted within the MA and RI/MA WEAs (O'Brien et al. 2020b). During the most recent surveys conducted in the MA and RI/MA WEAs, there was one sighting of one individual sei whale between September 2020 and October 2021 (O'Brien et al. 2022). Based on the observed sightings from Kraus et al. (2016) and O'Brien et al. (2020a, 2020b, 2022), sei whales are expected to be present much less than the other baleen whales.

Abundance

Prior to 1999, sei whales in the Western North Atlantic were considered a single stock. Following the suggestion of the Scientific Committee of the IWC, two separate stocks were identified for this species: a Nova Scotia stock and a Labrador Sea stock. Only the Nova Scotia stock can be found in US waters, and the current abundance estimate for this population is 6,292 derived from recent surveys conducted between Halifax, Nova Scotia and Florida (Hayes et al. 2020). Population trends are not available for this stock because of insufficient data (Hayes et al. 2020).

4.7.1.3 Odontocetes

4.7.1.3.1 Atlantic Spotted Dolphin (Stenella frontalis)

There are two species of spotted dolphins in the Atlantic Ocean, the Atlantic spotted dolphin (*Stenella frontalis*) and the pantropical spotted dolphin (*Stenella attenuata*) (Perrin et al. 1987). In addition, two forms of the Atlantic spotted dolphin exist: one that is large and heavily spotted and usually inhabits the continental shelf, and the other is smaller in size with less spots and occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Fulling and Fertl 2003; Mullin and Fulling 2003; Viricel and Rosel 2014). Where they co-occur, the offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate (Hayes et al. 2021). Atlantic spotted dolphins in the western Atlantic belong to the Western North Atlantic stock (Hayes et al. 2021). The Atlantic spotted dolphin diet consists of a wide variety of fish and squid, as well as benthic invertebrates (Herzing 1997). They form groups of varying sizes, usually less than 50 individuals, but can be seen travelling in groups of more than 200. In shallower waters, group size is typically five to 15 individuals.

Atlantic spotted dolphins are in the mid-frequency functional hearing group (Southall et al. 2007). They have an auditory bandwidth of 150 Hz to 160 kHz with vocalizations typically ranging from 100 Hz to 130 kHz (DoN 2008). Because calls produced by many delphinid species are highly variable and overlap in frequency characteristics, they are challenging to identify to individual species during acoustic studies (Oswald et al. 2007).

Status

The Atlantic spotted dolphin is not listed under the ESA and is not considered strategic under the MMPA. There have been no recent UMEs declared for the Atlantic spotted dolphin. No fishing-related mortality of spotted dolphin was reported for 1998 through 2003 (Yeung 1999, 2001; Garrison 2003; Garrison and Richards 2004). From 2007 through 2011, the estimated mean annual fishery-related mortality and serious injury for this species was 42 Atlantic spotted dolphins (Hayes et al. 2017). More recent observer data are not available. The commercial fisheries that interact or potentially interact with the Atlantic spotted dolphin are the pelagic longline fishery and the shrimp trawl fishery (Hayes et al. 2017). From 2013 – 2017, 21 Atlantic spotted dolphins were reported stranded between North Carolina and Florida (Hayes et al. 2020). It could not be determined whether there was evidence of human interaction for nine of these strandings, and for 12 dolphins, no evidence of human interaction was detected (Hayes et al. 2020). However, stranding data likely underestimates the extent of fishery-related mortality (and serious injury) because not all of the marine mammals that die or are seriously injured are reported.

Distribution

The Atlantic spotted dolphin prefers tropical to warm temperate waters along the continental shelf 10 to 200 m (33 to 650 ft) deep to slope waters greater than 500 m (1,640 ft) deep. It has been suggested that the species may move inshore seasonally during the spring, but data to support this theory are limited (Caldwell and Caldwell 1966; Fritts et al. 1983). They occur in the US Atlantic waters year-round, ranging from the Mid-Atlantic south through the Caribbean and the Gulf of Mexico (Hayes et al. 2021). This species inhabits inshore waters and along the continental shelf edge and slope, with sightings concentrated north of Cape Hatteras.

Kraus et al (2016) suggest that Atlantic spotted dolphins occur infrequently in the MA and RI/MA WEAs and surrounding areas. Effort-weighted average sighting rates for this species could not be calculated because most small cetaceans sighted during the study could not be identified to species due to their size. However, during a 2020 G&G survey in or adjacent to the Offshore Development Area, there were observations of Atlantic spotted dolphins during summer months (Vineyard Wind 2020). It is possible that the NLPSC surveys may have underestimated the abundance of Atlantic spotted dolphins, as the study was designed for large cetaceans.

Abundance

The best available abundance estimate for Atlantic spotted dolphins is 39,921 from 2016 surveys (Hayes et al. 2020). Distinction between the two Atlantic spotted dolphin ecotypes has not regularly been made during surveys (Hayes et al. 2020).

4.7.1.3.2 Atlantic White-Sided Dolphin (Langenorhynchus acutus)

The Atlantic white-sided dolphin is robust and attains a body length of approximately 2.8 m (9 ft) (Jefferson et al. 2008). It is characterized by a strongly "keeled" tail stock and distinctive, white-sided color pattern (BOEM 2014a). They feed mostly on small schooling fishes, shrimps, and squids, and are often observed feeding in mixed-species groups with pilot whales and other dolphin species (Jefferson et al. 2008; Cipriano 2018). Behaviorally, this species is highly social, but not as demonstrative as some other common dolphins. They typically form pods of around 30 to 150 individuals but have also been seen in very large pods of 500 to 2,000 individuals (Hayes et al. 2020). It is common to find these pods associated with the presence of other white-beaked dolphins, pilot whales, fin whales, and humpback whales.

Like most dolphin species, Atlantic white-sided dolphins produce clicks, buzzes, calls, and whistles. Their clicks are broadband sounds ranging from 30 to 40 kHz that can contain frequencies over 100 kHz and are often produced during foraging and for orientation within the water column. Buzzes and calls are not as well studied, and they may be used for socialization as well as foraging. Whistles are primarily for social communication and group cohesion and are characterized by a down sweep followed by an upsweep with an approximate starting frequency of 20 kHz and ending frequency of 17 kHz (Hamran 2014). No hearing sensitivity data are currently available for this species (Southall et al. 2019).

Status

Atlantic white-sided dolphins are not listed under the ESA or considered a strategic stock under the MMPA. They are classified as Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The PBR for this stock is 544 and the annual rate of human-caused mortality and serious injury from 2015 to 2019 was estimated to be 27 dolphins (Hayes et al. 2021). This estimate is based on observed fishery interactions, but Atlantic white-sided dolphins are also threatened by contaminants in their habitat, and climate-related shifts in prey distribution (Hayes et al. 2021). There is no designated critical habitat for this stock in the Offshore Development Area.

Distribution

Atlantic white-sided dolphins migrate between the temperate and polar waters of the north Atlantic Ocean, but usually maintain migration routes over outer shelf or slope waters. This is the most abundant dolphin in the Gulf of Maine and the Gulf of St. Lawrence; they are rarely seen off the coast of Nova Scotia (Kenney and Vigness-Raposa 2010). The species occurs year-round between central West Greenland to North Carolina primarily in continental shelf waters to the 100-m (328-ft) depth contour (Hayes et al. 2020). There are seasonal shifts in the distribution of the Atlantic white-sided dolphins off the northeastern US coast, with low abundance in winter between Georges Basin and Jeffrey's Ledge and very high abundance in the Gulf of Maine during spring. During summer, Atlantic white-sided dolphins are most abundant between Cape Cod and the lower Bay of Fundy. And during fall, the distribution of the species is similar to that in summer, with less overall abundance (DoN (U.S. Department of the Navy) 2005). Between May and December 2019, there was one sighting of Atlantic white-sided dolphins recorded during HRG surveys conducted within the area surrounding Lease Area OCS-A 0522 and the OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) suggest that Atlantic white-sided dolphins occur infrequently in the MA and RI/MA WEAs and surrounding areas. Effort-weighted average sighting rates for Atlantic white-sided dolphins could not be calculated because this species was only observed on eight occasions throughout the duration of the study (October 2011 through June 2015). No Atlantic white-sided dolphins were observed during winter, and this species was only sighted twice in the fall and three times in the spring and summer. It is possible that the NLPSC survey may have underestimated the abundance of Atlantic white-sided dolphins because this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species. Atlantic white-sided dolphins were seen during the spring and summer in the MA WEA and nearby waters during the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During recent surveys conducted in the MA and RI/MA WEAs, no Atlantic white-sided dolphins were observed between October 2018 and August 2019 (O'Brien et al. 2020a). Atlantic white-sided dolphins were only observed between the months of April and July, and only on the western side of the survey area (O'Brien et al. 2020a). During the most recent surveys conducted in the MA and RI/MA WEAs, there was one sighting of 15 individual Atlantic white-sided dolphins (O'Brien et al. 2020b).

Abundance

The best abundance estimate currently available for the Western North Atlantic stock is 93,233 based on surveys conducted between Labrador to Florida (Hayes et al. 2020). A trend analysis is not currently available for this stock due to insufficient data (Hayes et al. 2020).

4.7.1.3.3 Common Bottlenose Dolphin (Tursiops truncatus truncatus)

Common bottlenose dolphins are one of the most well-known and widely distributed species of marine mammals. These dolphins reach 2–4 m (6–12.5 ft) in length (NMFS 2021a). The snout is stocky and set off from the head by a crease. They are typically light to dark grey in color with a white underside (Jefferson et al. 1993). Bottlenose dolphins are commonly found in groups of two to 15 individuals, though aggregations in the hundreds are occasionally observed (NMFS 2021a). They are considered generalist feeders and consume a wide variety of organisms, including fish, squid, shrimp, and other crustaceans (Jefferson et al. 2008).

Whistles produced by bottlenose dolphins can vary over geographic regions, and newborns are thought to develop "signature whistles" within the first few months of their lives that are used for intraspecific communication. Whistles generally range in frequency from 300 Hz to 39 kHz with SLs between 114 and 163 dB re 1 µPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). Bottlenose dolphins also make burst-pulse sounds and echolocation clicks, which can range from a few kHz to over 150 kHz. As these sounds are used for locating and capturing prey, they are directional calls; the recorded frequency and sound level can vary depending on whether the sound was received head-on or at an angle relative to the vocalizing dolphin. SLs for burst-pulses and clicks range between 193 and 228 dB re 1 µPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). There are sufficient available data for bottlenose dolphin hearing sensitivity using both behavioral and auditory evoked potential (AEP) methods as well as anatomical modeling studies, which show hearing for the species is most sensitive between approximately 400 Hz and 169 kHz (Southall et al. 2019).

Status

Common bottlenose dolphins are not listed under the ESA and are classified as Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The PBR for this stock is 519, and the average annual human-cause mortality and serious injury from 2013 to 2017 was estimated to be 28, attributed to fishery interactions (Hayes et al. 2020). Because annual mortality does not exceed PBR, this stock is not classified as strategic under the MMPA. In addition to fisheries, threats to common bottlenose dolphins include non-fishery related human interaction; anthropogenic noise; offshore development; contaminants in their habitat; and climate-related changes in prey distribution (Hayes et al. 2020). There is no designated critical habitat for either stock in the Offshore Development Area.

Distribution

In the Western North Atlantic, there are two morphologically and genetically distinct common bottlenose morphotypes, the Western North Atlantic Northern Migratory Coastal stock and the Western North Atlantic offshore stock. The offshore stock is primarily distributed along the outer shelf and slope from Georges Bank to Florida during spring and summer and has been observed in the Gulf of Maine during late summer and fall (Hayes et al. 2020), whereas the northern migratory coastal stock is distributed along the coast between southern Long Island, New York, and Florida (Hayes et al. 2018). Given their distribution, only the offshore stock is likely to occur in the Offshore Development Area. The Western North Atlantic offshore stock is distributed primarily along the OCS and continental slope, from Georges Bank to Cape Hatteras during spring and summer. Between May and December 2019 and March and April

2022, there were nine and two sightings of bottlenose dolphins, respectively, recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed common bottlenose dolphins during all seasons within the MA and RI/MA WEAs in the 2011–2015 NLPSC aerial survey. This was the second most commonly observed small cetacean species and exhibited little seasonal variability in abundance. One sighting of common bottlenose dolphins in the Kraus et al. (2016) study included calves, and one sighting involved mating behavior. It is possible that the NLPSC survey may have underestimated the abundance of common bottlenose dolphins because this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al. 2016). Common bottlenose dolphins were observed in the MA WEA and nearby waters during spring, summer, and fall of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During the recent surveys conducted in the MA and RI/MA WEAs, bottlenose dolphins were the second most abundant small cetacean, accounting for 15% of sightings between October 2018 and August 2019 (O'Brien et al. 2020a). Bottlenose dolphins were only observed between April and July but were sighted throughout the MA and RI/MA WEAs. During the most recent surveys conducted in the MA and RI/MA WEAs, similar trends were observed with bottlenose dolphins occurring predominantly during summer months between March – October 2020 (O'Brien et al. 2020b). Bottlenose dolphins were sighted only within the southern end of the MA and RI/MA WEAs during the 2020 study (O'Brien et al. 2020b).

Abundance

The best abundance estimate for the Western North Atlantic offshore stock is 62,851 based on recent surveys between the lower Bay of Fundy and Florida (Hayes et al. 2020). A population trend analysis for this stock was conducted using abundance estimates from 2004, 2011, and 2016, and showed no statistically significant trend (Hayes et al. 2020).

4.7.1.3.4 Common Dolphin (Delphinus delphis delphis)

Two common dolphin species were previously recognized: the long-beaked common dolphin (*Delphinus capensis*) and the short-beaked common dolphin (*Delphinus delphis*). However, Cunha et al. (2015) summarized the relevant data and analyses along with additional molecular data and analysis and recommended that the long-beaked common dolphin not be further recognized in the Atlantic Ocean. Short-beaked common dolphins can reach 2.7 m (9 ft) in length and have a distinct color pattern with a white ventral patch, yellow or tan flank, and dark gray dorsal "cape" (NMFS 2021k). This species feeds on schooling fish and squid found near the surface at night (NMFS 2021k). They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NMFS 1993). This highly social and energetic species usually travels in large pods consisting of 50 to >1,000 individuals (Cañadas and Hammond 2008). The common dolphin can frequently be seen performing acrobatics and interacting with large vessels and other marine mammals.

Common dolphin clicks are broadband sounds between 17 and 45 kHz with peak energy between 23 and 67 kHz. Burst-pulse sounds are typically between 2 and 14 kHz while the key frequencies of common dolphin whistles are between 3 and 24 kHz (Erbe et al. 2017). No hearing sensitivity data are available for this species (Southall et al. 2019).

Status

The common dolphin is not listed under the ESA and is classified as Least Concern by the IUCN Red List (Hayes et al. 2020; IUCN 2020). Historically, this species was hunted in large numbers for food and oil. Currently, they continue to suffer incidental mortality from vessel collisions and Eastern North American fishing activities within the Atlantic, most prominently yellowfin tuna (*Thunnus albacares*) nets, driftnets, and bottom-set gillnets (Kraus et al. 2016; Hayes et al. 2020). The common dolphin faces anthropogenic threats because of its utilization of nearshore habitat and highly social nature, but it is not considered a strategic stock under the MMPA because the average annual human-caused mortality and serious injury does not exceed the calculated PBR of 1,452 for this stock (Hayes et al. 2020). The annual estimated human-caused mortality and serious injury for 2015 to 2019 was 390.4, which included fishery-interactions and research takes (Hayes et al. 2021). Other threats to this species include contaminants in their habitat and climate-related changes in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this stock in the Offshore Development Area.

Distribution

Common dolphins in the US Atlantic EEZ belong to the Western North Atlantic stock, generally occurring from Cape Hatteras, North Carolina to the Scotian Shelf (Hayes et al. 2018). Common dolphins are a highly seasonal, migratory species. In the US Atlantic EEZ this species is distributed along the continental shelf between the 200–2,000 m (650–6,561.6 ft) isobaths and is associated with Gulf Stream features (CeTAP 1982; Payne and Selzer 1989; Hamazaki 2002; Hayes et al. 2018). Common dolphins occur from Cape Hatteras northeast to Georges Bank (35° to 42°N) during mid-January to May and move as far north as the Scotian Shelf from mid-summer to fall (Payne and Selzer 1989; Hayes et al. 2020). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs when water temperatures exceed 11° Celsius (C) (51.8° Fahrenheit [F]) (Sergeant et al. 1970; Gowans and Whitehead 1995). Breeding usually takes place between June and September and females have an estimated calving interval of two to three years (Hayes et al. 2018). Between May and December 2019 and March and April 2022, there were 39 and six sightings of common dolphins, respectively, recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) suggested that common dolphins occur year-round in the MA and RI/MA WEAs and surrounding areas based on data from the 2011–2015 NLPSC aerial survey. They were the most frequently observed small cetacean species within the Kraus et al. (2016) study area. Common dolphins were observed in the MA and RI/MA WEAs in all seasons but were most frequently observed during the summer months; observations of this species peaked between June and August. Two sightings of common dolphins in the Kraus et al. (2016) study included calves, two sightings involved feeding behavior, and three sightings involved mating behavior. Sighting data indicate that common dolphin distribution tended to be farther offshore during the winter months than during spring, summer, and fall. It is possible that the NLPSC survey may have underestimated the abundance of common dolphins, because this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al. 2016). Common dolphins were observed in the MA WEA and nearby waters during all seasons of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During the recent surveys conducted in the MA and RI/MA WEAs, common dolphins were observed in all seasons and throughout the MA and RI/MA WEAs from October 2018 and August 2019; however, they were absent in the months of March and August (O'Brien et al. 2020a). The largest aggregations of common dolphins were observed on the southern edge of the MA and RI/MA WEAs during both surveys (O'Brien et al. 2020a, 2020b).

Abundance

The best population estimate in the US Atlantic EEZ for the Western North Atlantic common dolphin is 70,184 (Hayes et al. 2018) while Roberts et al. (2016) habitat-based density models provide an abundance estimate of 86,098 common dolphins in the US Atlantic EEZ. The current best abundance estimate for the entire Western North Atlantic stock is 172,974 based on recent surveys conducted between Newfoundland and Florida (Hayes et al. 2020). A trend analysis was not conducted for this stock because of the imprecise abundance estimate and long survey intervals (Hayes et al. 2020).

4.7.1.3.5 Harbor Porpoise (Phocoena phocoena)

This species is among the smallest of the toothed whales and is the only porpoise species found in northeastern US waters. A distinguishing physical characteristic is the dark stripe that extends from the flipper to the eye. The rest of its body has common porpoise features; a dark gray back, light gray sides, and small, rounded flippers (Jefferson et al. 1993). It reaches a maximum length of 1.8 m (6 ft) and feeds on a wide variety of small fish and cephalopods (Reeves and Read 2003; Kenney and Vigness-Raposa 2010). Most harbor porpoises are observed in small groups, usually between five and six individuals, although they aggregate into larger groups for feeding or migration (Jefferson et al. 2008).

Harbor porpoises produce high frequency clicks with a peak frequency between 129 and 145 kHz and an estimated SLs that ranges from 166 to 194 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Villadsgaard et al. 2007). Available data estimating auditory sensitivity for this species suggest that they are most receptive to noise between 300 Hz and 160 kHz (Southall et al. 2019).

Status

This species is not listed under the ESA and is considered non-strategic under the MMPA (Hayes et al. 2020). Harbor porpoise is listed as Least Concern by the IUCN Red List (IUCN 2020). The PBR for this stock is 851, and the estimated human-caused annual mortality and serious injury from 2015 to 2019 was 164 harbor porpoises per year (Hayes et al. 2021). This species faces major anthropogenic impacts because of its nearshore habitat. Historically, Greenland populations were hunted in large numbers for food and oil. Currently, they continue to suffer incidental mortality from Western North Atlantic fishing activities such as gillnets and bottom trawls (Hayes et al. 2020). Harbor porpoises also face threats from contaminants in their habitat, vessel traffic, habitat alteration due to offshore development, and climate-related shifts in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this species near the Offshore Development Area.

Distribution

The harbor porpoise is mainly a temperate, inshore species that prefers to inhabit shallow, coastal waters of the North Atlantic, North Pacific, and Black Sea. Harbor porpoises mostly occur in shallow shelf and coastal waters. In the summer, they tend to congregate in the northern Gulf of Maine, southern Bay of Fundy, and around the southern tip of Nova Scotia (Hayes et al. 2020). In the fall and spring, harbor porpoises are widely distributed from New Jersey to Maine (Hayes et al. 2020). In the winter, intermediate densities can be found from New Jersey to North Carolina, with lower densities from New York to New Brunswick, Canada (Kenney and Vigness-Raposa 2010). In cooler months, harbor porpoises have been observed from the coastline to deeper waters (>1,800 m [5,906 ft]), although the majority of sightings are over the continental shelf (Hayes et al. 2020).

Kraus et al. (2016) indicate that harbor porpoises occur within the MA and RI/MA WEAs in fall, winter, and spring. Harbor porpoises were observed in groups ranging in size from three to 15 individuals and were primarily observed in the Kraus et al. (2016) study area from November through May, with very few sightings during June through September. It is possible that the NLPSC survey may have underestimated the abundance of harbor porpoise because this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al. 2016). Harbor porpoises were observed in the MA WEA and nearby waters during spring and fall of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During more recent studies conducted in the MA and RI/MA WEAs, harbor porpoises accounted for 15% of small cetacean sightings, and were seen in all seasons except fall from October 2018– August 2019 (O'Brien et al. 2020a). They were distributed farther north in the MA and RI/MA WEAs than the other small cetacean species. The most recent surveys recorded two sightings of single harbor porpoises between March and October 2020 during the summer months (O'Brien et al. 2020b).

Abundance

The best available abundance estimate for the Gulf of Maine/Bay of Fundy stock occurring in the Offshore Development Area is 95,543 based on combined survey data from NMFS and the DFO Canada between the Gulf of St. Lawrence/Bay of Fundy/Scotian Shelf and central Virginia (Hayes et al. 2020). A population trend analysis is not available because data are insufficient for this species (Hayes et al. 2019).

4.7.1.3.6 Long-finned Pilot Whale (Globicephala melas)

Two species of pilot whale occur within the Western North Atlantic: the long-finned pilot whale and the short-finned pilot whale. These species are difficult to differentiate at sea and cannot be reliably distinguished during most surveys (Rone et al. 2012; Hayes et al. 2017). Both short-finned and long-finned pilot whales are similar in coloration and body shape. Pilot whales have bulbous heads, are dark gray, brown, or black in color, and can reach approximately 7.3 m (25 ft) in length (NMFS 2021f). However, long-finned pilot whales can be distinguished by their long flippers, which are 18 to 27% of the body length with a pointed tip and angled leading edge (Jefferson et al. 1993). These whales form large, relatively stable aggregations that appear to be maternally determined (ACS 2018). Pilot whales feed primarily on squid, although they also eat small to medium-sized fish and octopus when available (NMFS 2021f).

Like dolphin species, long-finned pilot whales can produce whistles and burst-pulses used for foraging and communication. Whistles typically range in frequency from one to 11 kHz while burst-pulses cover a broader frequency range from 100 Hz to 22 kHz (Erbe et al. 2017). AEP measurements conducted by Pacini et al. (2010) indicate that the hearing sensitivity for this species ranges from <4 kHz to 89 kHz.

Status

Long-finned pilot whales are not listed as threatened or endangered under the ESA or the MA ESA and both species are classified as Least Concern by the IUCN Red List (Hayes et al. 2020; IUCN 2020). Long-finned pilot whales are not listed under the ESA and are classified as Least Concern by the IUCN Red List (Hayes et al. 2020; IUCN 2020). Long-finned pilot whales have a propensity to mass strand in US waters, although the role of human activity in these strandings remains unknown (Hayes et al. 2020). The PBR for this stock is 306, and the annual human-caused mortality and serious injury was estimated to be nine whales between 2015 and 2019

(Hayes et al. 2021). Threats to this population include entanglement in fishing gear, contaminants, climate-related shifts in prey distribution, and anthropogenic noise (Hayes et al. 2020). There is no designated critical habitat for this stock in the Offshore Development Area.

Distribution

Because it is difficult to differentiate between the two pilot whale species in the field, sightings are usually reported to genus level only (CeTAP 1982; Hayes et al. 2020). However, short-finned pilot whales are a southern or tropical species and pilot whale sightings above approximately 42° North (N) are most likely long-finned pilot whales. Short-finned pilot whale occurrence in the Offshore Development Area is considered rare (CeTAP 1982; Hayes et al. 2020). Long-finned pilot whales are distributed along the continental shelf waters off the northeastern US in the winter and early spring. By late spring, pilot whales migrate into more northern waters including Georges Bank and the Gulf of Maine and will remain there until fall (Hayes et al. 2020). The two species' ranges overlap spatially along the shelf break between the southern flank of Georges Bank and New Jersey (Rone et al. 2012; Hayes et al. 2019). Between March and April 2022, there were nine sightings of pilot whales recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed pilot whales infrequently in the MA and RI/MA WEAs and surrounding areas during the 2011–2015 NLPSC aerial survey. Effort-weighted average sighting rates for pilot whales could not be calculated. No pilot whales were observed during the fall or winter, and these species were only observed 11 times in the spring and three times in the summer. Two of these sightings included calves. It is possible that the NLPSC survey may have underestimated the abundance of pilot whales, as this survey was designed to target large cetaceans and most small cetaceans were not identified to species (Kraus et al. 2016). No pilot whales were observed in the MA WEA and nearby waters during the 2010–2017 AMAPPS surveys from 2010¬2017 (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During more recent surveys conducted in the MA and MA/RI WEAs between April and July 2018–2019, pilot whales were observed only in the area south of Nantucket Shoals (O'Brien et al. 2020a). Due to the small number of sightings, no inferences can be made about the distribution of pilot whales in the survey area. During the 2020 surveys conducted in the MA and MA/RI WEAs, no pilot whales were sighted (O'Brien et al. 2020b).

Abundance

The best available estimate of long-finned pilot whales in the Western North Atlantic is 39,215 based on recent surveys covering waters between Labrador and central Virginia (Hayes et al. 2020). A trend analysis has not been conducted for this stock due to the relatively imprecise abundance estimates (Hayes et al. 2020).

4.7.1.3.7 Risso's Dolphin (Grampus griseus)

The Risso's dolphin attains a body length of approximately 2.6–4 m (8.5–13 ft) (NMFS 2021i). Unlike most other dolphins, Risso's dolphins have blunt heads without distinct beaks. Coloration for this species ranges from dark to light grey. Adult Risso's dolphins are typically covered in white scratches and spots that can be used to identify the species in field surveys (Jefferson et al. 1993). The Risso's dolphin forms groups ranging from 10 to 30 individuals and primarily feed on squid, but also fish such as anchovies (Engraulidae), krill, and other cephalopods (NMFS 2021i).

Whistles for this species have frequencies ranging from around 4 kHz to over 22 kHz with estimated SLs between 163 and 210 dB re 1 μPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). Studies using both behavioral and AEP methods have been conducted for this species, which show greatest auditory sensitivity between <4 kHz to >100 kHz (Nachtigal et al. 1995; Nachtigal et al. 2005).

Status

Risso's dolphins are not listed as threatened or endangered under the ESA and are classified as a species of Least Concern on the IUCN Red List (Hayes et al. 2020; IUCN 2020). The PBR for this stock is 301, and the annual human-caused mortality and injury for 2015 to 2019 was estimated to be 34 (Hayes et al. 2021). This stock is not classified as strategic under the MMPA because mortality does not exceed the calculated PBR. Threats to this stock include fishery interactions, non-fishery related human interaction, contaminants in their habitat, and climate-related shifts in prey distribution (Hayes et al. 2020). There is no designated critical habitat for this stock in the Offshore Development Area.

Distribution

Risso's dolphins in the US Atlantic EEZ are part of the Western North Atlantic Stock. The Western North Atlantic stock of Risso's dolphins inhabits waters from Florida to eastern Newfoundland (Leatherwood et al. 1976; Baird and Stacey 1991). Off the northeastern US coast, Risso's dolphins are primarily concentrated along the continental shelf edge, but they can also be found swimming in shallower waters to the mid-shelf (Hayes et al. 2020). During spring, summer, and fall, Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank (CeTAP 1982; Payne et al. 1984). During the winter, the distribution extends outward into oceanic waters (Payne et al. 1984). The stock may contain multiple demographically independent populations that should themselves be stocks because the current stock spans multiple eco-regions (Longhurst 1998; Spalding et al. 2007).

Kraus et al. (2016) results from the 2011–2015 NLPSC aerial survey suggest that Risso's dolphins occur infrequently in the MA and RI/MA WEAs and surrounding areas. Effort-weighted average sighting rates for Risso's dolphins could not be calculated. No Risso's dolphins were observed during summer, fall, or winter, and this species was only observed twice in the spring. It is possible that the NLPSC survey may have underestimated the abundance of Risso's dolphins, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species. Risso's dolphins were observed in the MA WEA and nearby waters during spring and summer of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). In the most recently conducted surveys within the MA and RI/MA WEAs, no Risso's dolphins were observed (O'Brien et al. 2020a, 2020b).

Abundance

The best abundance estimate in the Western North Atlantic is 35,215 based on the 2016 NEFSC and DFO surveys (Hayes et al. 2021). A trend analysis was not conducted on this species, because there are insufficient data to generate this information.

4.7.1.3.8 Sperm Whale (Physeter macrocephalus)

The sperm whale is the largest of all toothed whales; males can reach 16 m (52 ft) in length and weigh over 40,823 kilograms ("kg" [45 US tons]), and females can attain lengths of up to 11 m (36 ft) and weigh over 13,607 kg (15 tons) (Whitehead 2009). Sperm whales have extremely large heads, which account for 25–35% of the total length of the animal. This species tends to be uniformly dark gray in color, though lighter spots may be present on the ventral surface. Sperm whales frequently dive to depths of 400 m (1,300 ft) in search of their prey, which includes large squid, fishes, octopus, sharks, and skates (Whitehead 2009). This species can remain submerged for over an hour and reach depths as great as 1,000 m (3,280 ft). Sperm whales form stable social groups and exhibit a geographic social structure; females and juveniles form mixed groups and primarily reside in tropical and subtropical waters, whereas males are more solitary and wide-ranging and occur at higher latitudes (Whitehead 2002; Whitehead 2003).

Unlike mysticete whales that produce various types of calls used solely for communication, sperm whales produce clicks that are used for echolocation and foraging as well as communication (Erbe et al. 2017). Sperm whale clicks have been grouped into five classes based on the click rate, or number of clicks per second; these include "squeals," "creaks," "usual clicks," "slow clicks," and "codas." In general, these clicks are broadband sounds ranging from 100 Hz to 30 kHz with peak energy centered around 15 kHz. Depending on the class, SLs for sperm whale calls range between approximately 166 and 236 dB re 1 µPa @ 1 m (3.28 ft) SPL_{rms} (Erbe et al. 2017). Hearing sensitivity data for this species are currently unavailable (Southall et al. 2019).

Status

The Western North Atlantic stock is considered strategic under the MMPA due to its listing as endangered under the ESA, and the global population is listed as Vulnerable on the IUCN Red List (Hayes et al. 2020; IUCN 2020). Between 2013 and 2017, 12 sperm whale strandings were documented along the US east coast, but none of the strandings showed evidence of human interactions (Hayes et al. 2020). A moratorium on sperm whale hunting was adopted in 1986 and currently no hunting is allowed for any purposes in the North Atlantic. Occasionally, sperm whales will become entangled in fishing gear or be struck by ships off the east coast of the US. However, this rate of mortality is not believed to have biologically significant impacts. The current PBR for this stock is 6.9, and because the total estimated human-caused mortality and serious injury is <10% of this calculated PBR, it is considered insignificant (Hayes et al. 2020). Other threats to sperm whales include contaminants, climate-related changes in prey distribution, and anthropogenic noise, although the severity of these threats on sperm whales is currently unknown (Hayes et al. 2020). There is no designated critical habitat for this population in the Offshore Development Area.

Distribution

Sperm whales can be found throughout the world's oceans. They can be found near the edge of the ice pack in both hemispheres and are also common along the equator. The North Atlantic stock is distributed mainly along the continental shelf-edge, over the continental slope, and mid-ocean regions, where they prefer water depths of 600 m (1,969 ft) or more and are less common in waters <300 m (984 ft) deep (Waring et al. 2015; Hayes et al. 2020). In the winter, sperm whales are observed east and northeast of Cape Hatteras. In the spring, sperm whales are more widely distributed throughout the Mid-Atlantic Bight and southern portions of George's Bank (Hayes et al. 2020). In the summer, sperm whale distribution is similar to the spring, but they are more widespread in Georges Bank and the northeast Channel region and are also observed inshore of the 100-m (328-ft) isobath south of New England (Hayes et al. 2020). Sperm whale occurrence on the continental shelf in areas south of New England is at its highest in the fall (Hayes et al. 2020).

Kraus et al. (2016) observed sperm whales four times in the MA and RI/MA WEAs and surrounding areas in the summer and fall during the 2011–2015 NLPSC aerial survey. Sperm whales, traveling individually or in groups of three or four, were observed three times in August and September of 2012, and once in June of 2015 (Kraus et al. 2016). Effort-weighted average sighting rates could not be calculated. The frequency of sperm whale clicks exceeded the maximum frequency of PAM equipment used in the Kraus et al. (2016) study, so no acoustic data are available for this species from that study. Sperm whales were observed only once in the MA WEA and nearby waters during the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). This occurred during a summer shipboard survey in 2016.

During more recent surveys conducted within the MA and RI/MA WEAs, two groups of sperm whales were observed in June and July of 2019 (O'Brien et al. 2020a). On June 12th, a group of four whales was sighted, and a group of two whales was sighted on July 15th. Both groups were observed in relatively shallow water close to shore, with the June 12th sighting 18.5 km (10 NM) south of Nantucket Island and the July 15th sighting 24 km (13 NM) southwest of the island. Both groups were observed diving and milling at the surface (O'Brien et al. 2020a). No observations of sperm whales were recorded during the most recent survey conducted in the MA and RI/MA WEAs between March and October 2020 (O'Brien et al. 2020b). A map of sperm whale maximum seasonal density from Roberts et al. (2016; 2022) is presented in Figure 4.7-5.

Abundance

The IWC recognizes only one stock of sperm whales for the North Atlantic, and Reeves and Whitehead (1997) and Dufault et al. (1999) suggest that sperm whale populations lack clear geographic structure. The best and most recent abundance estimate based on 2016 surveys conducted between the lower Bay of Fundy and Florida is 4,349 (Hayes et al. 2020). No population trend analysis is available for this stock.

4.7.1.4 Pinnipeds

Two species of pinnipeds occur in the Atlantic Ocean near the Offshore Development Area: the gray seal and harbor seal. Both pinniped species are likely to occur in the region year-round.

The Draft 2021 SAR mentions an increase of sightings and stranding data for harp seals off of the east coast of the US from Maine to New Jersey (Hayes et al. 2021). However, assessment of the Ocean Biodiversity Information System (OBIS 2021) database found only records of stranding for the harp seal. Although the presence of stranded animals indicates some level of occurrence in the regions, it does not necessarily reflect the likely encounter of free-ranging animals in the Offshore Development Area.

4.7.1.4.1 Gray Seal (Halichoerus grypus atlantica)

Gray seals are the second most common pinniped in the US Atlantic EEZ (Jefferson et al. 2008). This species inhabits temperate and sub-arctic waters and lives on remote, exposed islands, shoals, and unstable sandbars (Jefferson et al. 2008). Gray seals are large, reaching 2–3 m (7.5–10 ft) in length, and have a silver-gray coat with scattered dark spots (NMFS 2021c). These seals are generally gregarious and live in loose colonies while breeding (Jefferson et al. 2008). Though they spend most of their time in coastal waters, gray seals can dive to depths of 300 m (984 ft), and frequently forage on the outer shelf (Hammill et al. 2001; Jefferson et al. 2008). These opportunistic feeders primarily consume fish, crustaceans, squid, and octopus (Bonner et al. 1971; Reeves 1992; Jefferson et al. 2008). They often co-occur with harbor seals because their habitat and feeding preferences overlap (NMFS 2021c).

Two types of underwater vocalizations have been recorded for male and female gray seals; clicks and hums. Clicks are produced in a rapid series resulting in a buzzing noise with a frequency range between 500 Hz and 12 kHz. Hums, which is described as being similar to that of a dog crying in its sleep, are lower frequency calls, with most of the energy <1 kHz (Schusterman et al. 1970). AEP studies indicate that hearing sensitivity for this species is greatest between 140 Hz and 100 kHz (Southall et al. 2019).

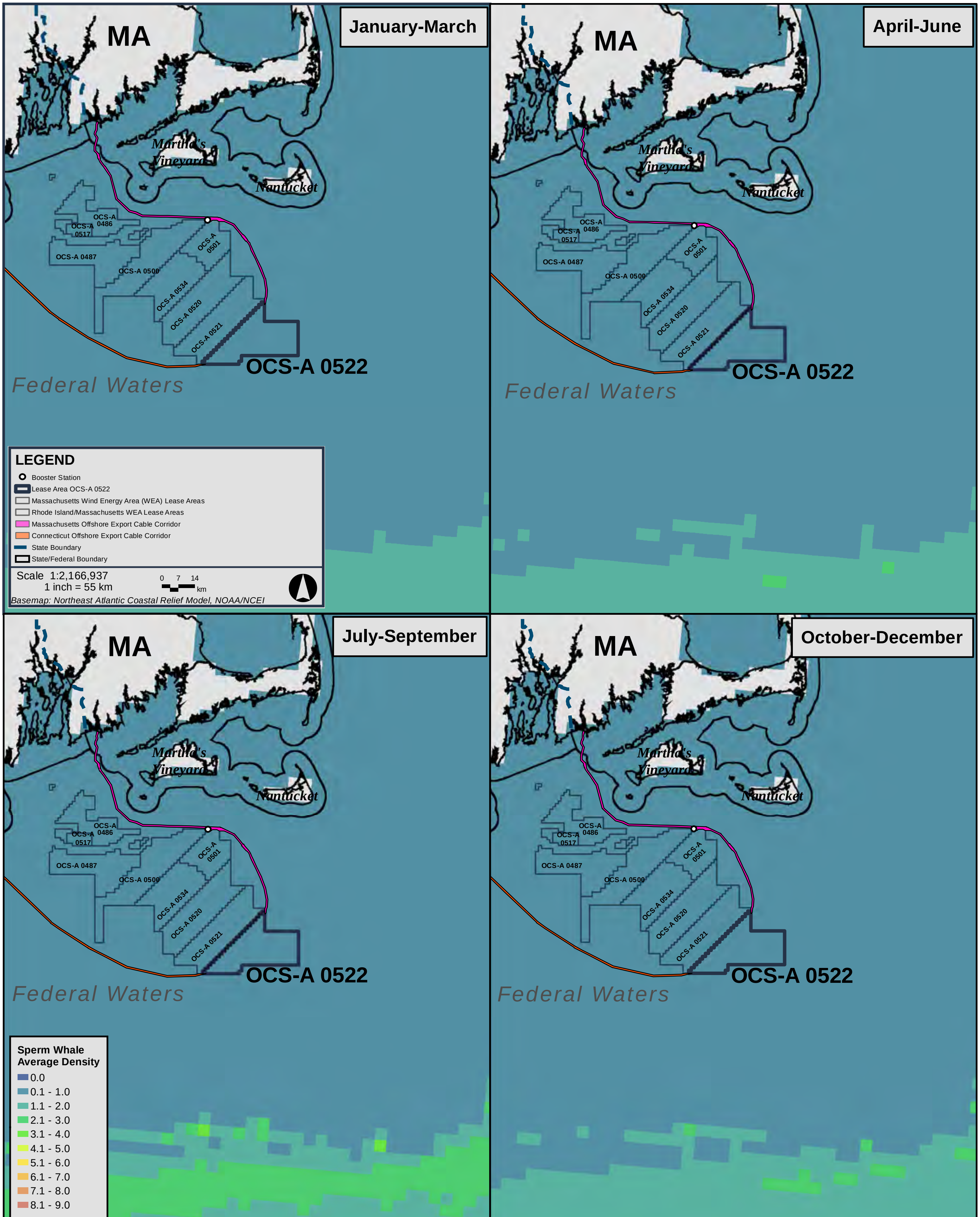

Figure 4.7-5
Map of Sperm Whale Average Seasonal Density from Roberts et al. (2016; 2022)

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Status

This species is not listed under the ESA or the MA ESA and is considered non-strategic under the MMPA because anthropogenic mortality does not exceed PBR (Hayes et al. 2020). Gray seals are listed as Least Concern by the IUCN Red List (IUCN 2020). The PBR for this population is 1,458, and the annual human-caused mortality and serious injury between 2015 and 2019 was estimated to be 4,453 in both the US and Canada (Hayes et al. 2021). Like harbor seals, the gray seal was commercially and recreationally hunted until 1972. Mortality is currently attributed to fishery interactions, non-fishery related human interactions and hunting, research activities, Canadian commercial harvest, and removals of nuisance animals in Canada (Hayes et al. 2020). Other threats to this population include disease, predation, and natural phenomena like storms (Hayes et al. 2020). There is no designated critical habitat for this species in the Offshore Development Area.

Distribution

The eastern Canadian population of gray seals ranges from New Jersey to Labrador and is centered at Sable Island, Nova Scotia (Davies 1957; Mansfield 1966; Richardson and Rough 1993; Hammill et al. 2001). There are three breeding concentrations in eastern Canada: Sable Island, the Gulf of St. Lawrence, and along the east coast of Nova Scotia (Lavigueur and Hammill 1993). In US waters, gray seals currently pup at four established colonies from late December to mid-February: Muskeget and Monomoy Islands in Massachusetts, and Green and Seal Islands in Maine (Center for Coastal Studies 2017; Hayes et al. 2018). Pupping was also observed in the early 1980s on small islands in Nantucket-Vineyard Sound and more recently at Nomans Island (Hayes et al. 2018). Following the breeding season, gray seals may spend several weeks ashore in the late spring and early summer while undergoing a yearly molt. Between May and December 2019 and March and April 2022, there were two and 58 sightings of gray seals, respectively, recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed gray seals in the MA and RI/MA WEAs and surrounding areas during the 2011–2015 NLPSC aerial survey, but this survey was designed to target large cetaceans so locations and numbers of seal observations were not included in the study report. Gray seals were regularly observed in the MA WEA and nearby waters during all seasons of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). Gray seals tagged near Cape Cod during Phase I of AMAPPS showed strong site fidelity to Cape Cod throughout the summer and fall then movement south and east toward Nantucket beginning in mid-December (Palka et al. 2017). One pup tagged in January spent most of the month that the tag was active in the MA WEA.

During more recent surveys conducted in the MA and RI/MA WEAs, a total of 77 sightings were made of 3,963 unidentified individual seals between October 2018 and August 2019 (O'Brien et al. 2020a). Between March and October 2020, three unidentified seals were sighted within the MA and RI/MA WEAs (O'Brien et al. 2020b).

Abundance

Estimates of the entire Western North Atlantic gray seal population are not available. Some estimates are available for portions of the stock, although recent genetic evidence suggests that all Western North Atlantic gray seals may actually comprise a single stock (Hayes et al. 2020). The best available current abundance estimate for the Canadian gray seal stock is 424,300 and the current US population estimate is 27,300 (Hayes et al. 2021). The population of gray seals is likely increasing in the US Atlantic EEZ; recent data show approximately 28,000 to 40,000 gray seals were observed in southeastern Massachusetts in 2015 (Hayes et al. 2020). A population trend is not currently available for this stock, although the observed increase in the number of pups born in US pupping colonies between 1991 and 2019 is currently being evaluated (Hayes et al. 2020).

4.7.1.4.2 Harbor Seal (Phoca vitulina vitulina)

The harbor seal is one of the smaller pinnipeds, and adults are often light to dark grey or brown with a paler belly and dark spots covering the head and body (Jefferson et al. 1993; Kenney and Vigness-Raposa 2010). This species is approximately 2 m (6 ft) in length (NMFS 2021d). Harbor seals complete both shallow and deep dives during hunting, depending on the availability of prey (Tollit et al. 1997). Harbor seals consume a variety of prey, including fish, shellfish, and crustaceans (Bigg 1981; Reeves 1992; Burns 2002; Jefferson et al. 2008). They commonly occur in coastal waters and on coastal islands, ledges, and sandbars (Jefferson et al. 2008).

Male harbor seals have been documented producing an underwater roar call which is used for competition with other males and attracting mates. These are relatively short calls with a duration of about two seconds and a peak frequency between one and two kHz (Van Parijs et al. 2003). Behavioral audiometric studies for this species estimate peak hearing sensitivity between 100 Hz and 79 kHz (Southall et al. 2019).

Status

Harbor seals are not listed under the ESA or MA ESA, are listed as Least Concern by the IUCN Red List and are considered non-strategic because anthropogenic mortality does not exceed PBR (Hayes et al. 2020; IUCN 2020). The PBR for this population is 1,729 and the annual human-caused mortality and serious injury from 2015 to 2019 was estimated to be 399 seals per year (Hayes et al. 2021). This mortality and serious injury was attributed to fishery interactions, non-fishery related human interactions, and research activities (Hayes et al. 2020). Until 1972, harbor seals were commercially and recreationally hunted. Currently, only Alaska natives can hunt harbor seals for sustenance and the creation of authentic handicrafts. Other threats to harbor seals include disease and predation (Hayes et al. 2020). There is no designated critical habitat for this species in the Offshore Development Area.

Distribution

The harbor seal is found throughout coastal waters of the Atlantic Ocean and adjoining seas above 30°N and is the most abundant pinniped in the US Atlantic EEZ (Hayes et al. 2018). Harbor seals, also known as common seals, are one of the most widely distributed seal species in the Northern Hemisphere. They can be found inhabiting coastal and inshore waters from temperate to polar latitudes. Harbor seals occur seasonally along the coast during winter months from southern New England to New Jersey, typically from September through late May (Kenney and Vigness-Raposa 2010; Hayes et al. 2020). In recent years, this species has been seen regularly as far south as North Carolina, and regular seasonal haul-out sites of up to 40–60 animals have been documented on the eastern shore of Virginia and the Chesapeake Bay (Jones and Rees 2020). During the summer, most harbor seals can be found north of New York, within the coastal waters of central and northern Maine, as well as the Bay of Fundy (US Department of the Navy [DoN] 2005; Hayes et al. 2020). Genetic variability from different geographic populations has led to five subspecies being recognized. Peak breeding and pupping times range from February to early September, and breeding occurs in open water (Temte 1994). Between May and December 2019 and March and April 2022, there were three and four sightings of harbor seals, respectively, recorded during HRG surveys conducted within the area surrounding the Lease Area and OECCs (see Section 5.3 of Appendix II-B).

Kraus et al. (2016) observed harbor seals in the MA and RI/MA WEAs and surrounding areas during the 2011–2015 NLPSC aerial survey, but this survey was designed to target large cetaceans so locations and numbers of seal observations were not included in the study report. Harbor seals have five major haul-out sites in and near the MA and RI/MA WEAs: Monomoy Island, the northwestern side of Nantucket Island, Nomans Land, the north side of Gosnold Island, and the southeastern side of Naushon Island (Payne and Selzer 1989). Payne and Selzer (1989) conducted aerial surveys and found that for haul-out sites in Massachusetts and New Hampshire, Monomoy Island had approximately twice as many seals as any of the 13 other sites in the study (maximum count of 1,672 in March of 1986). Harbor seals were observed in the MA WEA and nearby waters during spring, summer, and fall of the 2010–2017 AMAPPS surveys (NEFSC and SEFSC 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

During more recent surveys conducted in the MA and RI/MA WEAs, a total of 77 sightings were made of 3,963 unidentified individual seals between October 2018 and August 2019 (O'Brien et al. 2020a). Between March and October 2020, three unidentified seals were sighted within the MA and RI/MA WEAs (O'Brien et al. 2020b). Based on the known distribution in the MA and RI/MA WEAs and surrounding areas, it is likely that some harbor seals were included in the unidentified seal sightings.

Abundance

The best available abundance estimate for harbor seals in the Western North Atlantic is 61,336, with global population estimates reaching 610,000 to 640,000 (Bjørge et al. 2010; Hayes et al. 2020; IUCN 2020; Hayes et al. 2021). Estimates of abundance are based on surveys conducted during the pupping season, when most of the population is assumed to be congregated along the Maine coast. Abundance estimates do not reflect the portion of the stock that might pup in Canadian waters (Hayes et al. 2021). Trend in population from 1993 to 2018 was estimated for non-pups and pups using a Bayesian hierarchical model to account for missing data both within and between survey years. The estimated mean change in non-pup harbor seal abundance per year was a positive from 2001 to 2004, but close to zero or negative between 2005 and 2018 (Hayes et al. 2021). After 2005, mean change in pup abundance was steady or declining until 2018 but these changes were not significant (Hayes et al. 2021).

4.7.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect marine mammals during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 4.7-2. This section provides an assessment of Vineyard Northeast's activities that have the potential to behaviorally or physically disturb or harm marine mammal species expected to occur within the Offshore Development Area.

Table 4.7-2 Impact Producing Factors for Marine Mammals

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Noise		•	
Vessel Activity			
Habitat Modification			
Marine Debris		•	
Entanglement and Entrapment	•	•	•
Electromagnetic Fields		•	
Reduction in Prey Availability	•	•	•
Suspended Sediments and Deposition	•	•	•
Artificial Light	•	•	•

Potential effects to marine mammals were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

4.7.2.1 Noise

The ability to hear and transmit sound is vital for marine mammals to perform basic life functions, such as navigating, communicating, foraging, and avoiding predators. Marine mammals use sound to gather and understand information about their environment, including detection of prey, predators, and conspecifics, and environmental conditions, such as wind, waves, and rain, as well as anthropogenic sounds (Richardson et al. 1995). Increased levels of unwanted or disturbing sounds, defined as noise, may affect marine mammals in one or more of the following ways: masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment ([temporary threshold shift [TTS] or permanent threshold shift

[PTS]), or non-auditory physical or physiological effects (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007). The distances to which a sound travels through the water and remains audible depends on existing environmental conditions and propagation characteristics (e.g., sea floor topography, stratification, and ambient noise levels) and characteristics of the sound, such as SLs and frequency (Richardson et al. 1995). The level of impact on marine mammals will vary depending on many factors, including but not limited to: the species and its sensitivity to the received sounds; life stage; orientation and distance between the marine mammal and the activity; the intensity and duration of the activity; and environmental conditions affecting sound propagation.

Marine mammals could be impacted from increased levels of underwater sound associated with various construction activities including impact pile driving, vibratory pile driving, drilling, unexploded ordinance (UXO) detonation, HRG surveys, vessel movements, cable installation, and aircrafts. Activities that produce sounds during O&M will be more limited and primarily related to vessel traffic, infrequent HRG surveys, and in some cases operating wind turbine generators (WTGs). The Proponent will implement several mitigation measures to reduce the level of impact from underwater sounds caused by the planned activities on marine mammals present in the Offshore Development Area.

Acoustic Thresholds Used to Evaluate Potential Effects on Marine Mammals

To assess potential auditory injury or PTS, NMFS has provided technical guidance that establishes dual criteria for five different marine mammal hearing groups, four of which are shown in Table 4.7-3. The criteria are based on measured or assumed values for the onset of TTS in marine mammals, which are also shown for impulsive sounds in Table 4.7-3. The two criteria are based on different acoustic metrics or ways of measuring sound, the SPL_{pk} and the cumulative sound exposure level (SEL_{cum}). The SPL_{pk} metric captures the potential for auditory injury caused by intense, instantaneous sounds while the SEL_{cum} metric captures the potential for injury caused by fatiguing of the auditory system from sounds received over time (in this case, a maximum 24-hr period). The PTS onset acoustic thresholds for marine mammals exposed to continuous sound sources (NMFS 2018) are shown in Table 4.7-4.

Many studies on marine mammal behavioral responses to sound exposure have been conducted over the past 20 years; however, there is still no consensus in the scientific community regarding the appropriate metric to assess behavioral reactions. NMFS currently uses behavioral response thresholds of 160 dB re 1 Pa for impulsive sounds and 120 dB re 1 μPa for continuous sounds for all marine mammal species (NMFS 2018), based on observations of mysticetes (Malme et al. 1983, 1984; Richardson et al. 1986, 1990).

The marine mammal hearing groups are based on the frequencies of sound and the sensitivities of the species to the frequencies in that group. The frequency-dependent hearing sensitivities of each group are characterized by frequency weighting functions that are applied to the sounds being modeled and effectively filter out sound energy at frequencies of less importance to the species in each group. Frequency weighting is applied when calculating distances to the SEL_{cum} thresholds and some behavioral thresholds, while SPL_{pk} is not frequency weighted, which is also referred to as unweighted or flat-weighted (see Table 4.7-3).

Table 4.7-3 Marine Mammal Functional Hearing Groups and PTS and TTS Thresholds for Impulsive Sounds as Defined by NMFS

Marine Mammal Hearing Group	Generalized Hearing Range	PTS onset (Level A) Thresholds (Impulsive Sounds)	TTS onset Thresholds (Impulsive Sounds)	Behavioral Harassment Threshold (Impulsive Sounds)
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{pk,flat}$: 213 dB $L_{E,LF,24h}$: 168 dB	$L_{p,flat}$: 160 dB
Mid-frequency cetaceans (MF)	150 Hz to 160 kHz	$L_{pk,flat}$: 230 dB $L_{E,LF,24h}$: 185 dB	$L_{pk,flat}$: 224 dB $L_{E,LF,24h}$: 170 dB	$L_{p,flat}$: 160 dB
High-frequency cetaceans (HF)	275 Hz to 160 kHz	$L_{pk,flat}$: 202 dB $L_{E,LF,24h}$: 155 dB	$L_{pk,flat}$: 196 dB $L_{E,LF,24h}$: 140 dB	$L_{p,flat}$: 160 dB
Phocid pinnipeds (underwater) (PW)	50 Hz to 86 kHz	$L_{pk,flat}$: 218 dB $L_{E,LF,24h}$: 185 dB	$L_{pk,flat}$: 212 dB $L_{E,LF,24h}$: 170 dB	$L_{p,flat}$: 160 dB

Notes:
1. $L_{pk,flat}$ = unweighted/flat-weighted peak sound pressure (dB re 1 μPa).
2. $L_{E,LF,24h}$ = Cumulative sound exposure level (dB re 1 $\mu Pa^2 \cdot s$) over a 24-hour period.
3. $L_{p,flat}$ = Unweighted/flat-weighted root mean square sound pressure (dB re 1 μPa).

Table 4.7-4 Summary of PTS Onset Acoustic Thresholds for Marine Mammals Exposed to Continuous Sound Sources (NMFS 2018)

Marine Mammal Hearing Group	Generalized Hearing Range	Frequency-weighted $L_{E,24h}$ (dB re μPa^2 s)
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	199
Mid-frequency cetaceans (MF)	150 Hz to 160 kHz	198
High-frequency cetaceans (HF)	275 Hz to 160 kHz	173
Phocid pinnipeds (underwater) (PW)	50 Hz to 86 kHz	201

Scientific recommendations for revisions to these classifications were recently published by Southall et al. (2019). This publication proposes a new nomenclature and classification for the marine mammal hearing groups, but the proposed thresholds and weighting functions do not differ from those in NMFS (2018a). The hearing groups and nomenclature proposed by Southall et al. (2019) have not yet been incorporated into the NMFS guidelines.

The received level at which marine mammals may behaviorally respond to anthropogenic sounds varies by numerous factors including the frequency content, predictability, and duty cycle of the sound as well as the experience, demography, and behavioral state of the animal (Richardson et al. 1995; Southall et al. 2007; Ellison et al. 2012). Despite this variability, there is a practical need for a reasonable and specific threshold. NMFS currently defines the threshold for behavioral harassment, Level B take, as 160 dB re 1 µPa SPL_{rms} (unless otherwise noted, all dB values hereafter are referenced to 1 µPa) for impulsive or intermittent sounds, such as those produced by impact pile driving and some HRG survey equipment. For non-impulsive sounds, such as vibratory pile driving and drilling, NMFS defines the threshold for behavioral harassment at 120 dB SPL_{rms} (see Table 4.7-4).

Foundation Installation

Foundation installation is expected to require impact pile driving and may also require the use of a vibratory hammer and/or drilling. A vibratory hammer could be used to install the foundation through surficial sediments in a controlled fashion to avoid the potential for a "pile run," where the pile could drop quickly through looser surficial sediments and destabilize the installation vessel, risking the integrity of the vessel and safety of the crew. During vibratory pile driving, longitudinal vibration motion at the hammer's operational frequency and corresponding amplitude causes the soil to liquify, allowing the pile to penetrate into the seabed. Drilling could also be required if pile driving encounters refusal (e.g., due to a large boulder or bedrock). If drilling is required, a rotary drilling unit would likely be installed on top of the monopile or pin pile to remove obstructing material from the pile's interior.

Based on the results of the Vineyard Northeast acoustic modeling report (see Appendix II-E), behavioral disturbance associated with foundation installations is expected to be the most likely and common impact on marine mammals. Studies assessing the behavioral disturbance of harbor porpoise and harbor and gray seals showed some avoidance during periods of construction activity, followed by continued use of the area after construction activities were completed (Tougaard et al. 2009a, 2009b; Bailey et al. 2010; Edrén et al. 2010; Brandt et al. 2011; Dähne et al. 2013; Thompson et al. 2013; Russell et al. 2016; Dähne et al. 2017). Sound produced by pile driving noise produces low-frequency sound (generally >1 Khz), which falls on the lower end of mid-frequency cetaceans hearing range (Brandt et al. 2016; NOAA NMFS 2016). Therefore, short term avoidance in areas where sounds are above disturbance thresholds are expected to have little overall impact on these species. Odontocete and pinniped reactions to strong impulsive sounds are variable and, at least for delphinids and some porpoises, seem to be confined to a smaller radius than has been observed for some mysticetes. Bottlenose dolphins have been observed to detect pile driving noise up to 40–50 km (25–31 mi) away; however, change in behavior cannot be definitively attributed to pile driving sound (David 2006; Bailey et al. 2010). A study of tagged harbor seals during construction of an offshore wind farm in the United Kingdom (UK) showed a reduced seal abundance up to 25 km (15 mi) away from active pile driving (Russell et al. 2016). However, displacement was limited to piling activity, and seals returned to non-piling distribution within two hours of cessation of pile driving (Russel et al. 2016). Any displacement would likely only last for the duration that the sound source is active in that location, with animals resuming regular behavior once the sounds stop. If a marine mammal reacts to an underwater sound by slightly changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population (New et al. 2013).

Baleen whales generally tend to avoid strong impulsive sounds, but avoidance radii vary greatly, and available data are primarily from the use of seismic airgun arrays (Richardson et al. 1995; Gordon et al. 2003). Whales are often reported to show no overt reactions to impulsive sounds from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. Some cetaceans are known to increase the source levels of their calls, shift their peak frequencies, or otherwise modify their vocal behavior (increase or decrease call rates) in response to pulsed sounds from airguns (Clark and Gagnon 2006; Castellote et al. 2012; Blackwell et al. 2013; Blackwell et al. 2015). When observing migrating bowhead, humpback, and gray whales, the changes in behavior appeared to be of little or no biological consequence to the animals. Whales simply avoided the sound source by displacing their migration route to varying degrees still within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995; Dunlop et al. 2017). There has been increased concern regarding NARW displacement from foraging areas or migratory pathways due to noise (BOEM 2022). In feeding areas, displacement could lead to reduced foraging time, which may further result in a reduced body condition and health (Kraus et al. 2019). Additionally, displacement of NARW from foraging areas or migratory pathways may lead to overlap with vessel traffic and fishing activities, exposing them to increased risk of vessel strikes or entanglement (BOEM 2022). Overall, the effects of impact pile driving sounds on baleen whales are expected to be limited to short term avoidance of areas with the highest elevated sound levels.

Marine mammals may also be affected by impact pile driving through the masking of natural sounds. Masking is the obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Introduced underwater sound will, through masking, reduce the effective listening area and/or communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Erbe et al. 2016; Tennessen and Parks 2016; Guan and Miner 2020). If little or no overlap occurs between the introduced sound and the frequencies used by the species, listening and communication are not expected to be disrupted. Similarly, if the introduced sound is present only infrequently, very little to no masking would occur. In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in determining the extent of the masking (Madsen et al. 2002; Branstetter et al. 2013a, 2013b, 2016; Erbe et al. 2016; Sills et al. 2017). Baleen whales (low-frequency cetaceans) are most vulnerable to masking by low-frequency noise, such as noise produced by vessel traffic

(Richardson et al. 1995; Redfern et al. 2017). Humpback and NARW mother-calf pairs communicate quietly, likely as an anti-predator strategy, resulting in an increased vulnerability to masking (Kraus et al. 2019). Odontocetes are also vulnerable to masking; Bottlenose dolphin communication has been masked during pile driving activity up to 40 km from the source (Brandt et al. 2011). Harbor porpoise vocalizations were reduced up to 17.8 km (11 mi) from the pile driving source (Brandt et al. 2011).

TTS or PTS is possible when marine mammals are exposed to very intense sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds (Southall et al. 2007; Finneran 2015). There are empirical data on the sound exposures that elicit onset of TTS in captive bottlenose dolphins, belugas, porpoise, and three species of pinnipeds (Finneran 2015). Most of these data concern non-impulsive sound, but there are some limited published data concerning TTS onset upon exposure to pile driving sounds (Kastelein et al. 2015; Kastelein et al. 2016). There have not been any field studies that have examined TTS or PTS in free-ranging marine mammals exposed to anthropogenic sounds. However, some studies have shown that bottlenose dolphins can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (Nachtigall and Supin 2014; Nachtigall and Supin 2015; Nachtigall et al. 2016; Nachtigall et al. 2018; Finneran 2020; Kastelein et al. 2020). Such responses, as well as likely avoidance reactions of some marine mammals and the planned monitoring and mitigation measures will further reduce the already low probability of exposure of marine mammals to sounds strong enough to induce TTS or PTS.

To evaluate the potential risks to marine mammals from foundation installation noise, the Proponent conducted an underwater acoustic and animal exposure modeling analysis (see Appendix II-E). For WTG and electrical service platform (ESP)/booster foundation installations, sound exposure modeling was conducted to account for the movement and behavior of marine mammals and their exposure to the underwater sound fields produced during impact and vibratory pile driving. Sound exposure modeling involves the use of a three-dimensional computer simulation in which simulated animals (animats) move through the modeled marine environment over time as defined by the known or assumed movement patterns for each species. These movement patterns were derived from visual observation, animal borne tag, or other similar studies. The sound field produced by the activity, in this case impact and vibratory pile driving, is then added to the modeling environment at the location and for the duration of time anticipated for one or more pile installations. At each time step in the simulation, each animat records the received sound levels at its location resulting in a sound exposure history for each animat. These exposure histories are then analyzed to determine whether and how many animats were exposed above threshold levels. Finally, the density of animats used in the modeling environment, which is usually much higher than the actual density of marine mammals in the activity area so that the results are more statistically robust, is compared to the actual density of marine mammals anticipated to be in the activity area. The results are then used to scale the animat exposure estimates to the actual density estimates. A more detailed description of this method is available in Appendix II-E, including results for some species if avoidance of anthropogenic sounds (aversion) is included in the exposure modeling.

The sound fields used in the exposure modeling described above were generated through acoustic modeling of impact pile driving for monopiles and jacket foundation pin piles. Piles deform when driven with impact hammers, creating a bulge that travels down the pile and radiates sound into the surrounding air, water, and seabed. This sound may be received as a direct transmission from the sound source to biological receivers (e.g., marine mammals) through the water or as the result of reflected paths from the surface or re-radiated into the water from the seabed. Sound transmission depends on many environmental parameters, such as the sound speeds in water and substrates, sound production parameters of the pile and how it is driven, including the pile material, size (length, diameter, and thickness), and the make and energy of the hammer.

Noise abatement systems (NAS), also known as noise attenuation systems, are often used to decrease the sound levels in the water near a source by inserting a local impedance change that acts as a barrier to sound transmission. Attenuation by impedance change can be achieved through a variety of technologies, such as bubble curtains, evacuated sleeve systems (e.g., IHC-Noise Mitigation System [NMS]), encapsulated bubble systems (e.g., HydroSound Dampers [HSD]), or Helmholtz resonators (AdBm NMS). The effectiveness of each system is frequency dependent and may be influenced by local environmental conditions, such as current and depth. For example, the size of the bubbles determines the effective frequency band of an air bubble curtain, with larger bubbles needed for lower frequencies. The Proponent will use a NAS for all piling events to reduce sound levels by a target of approximately 10 dB during pile driving. The type and number of NAS to be used during construction have not yet been determined but preference will be given to systems effective at attenuating low frequency sounds. For example, the HSD shows the highest potential for noise reduction at lower frequencies (<200 Hz) and is often seen paired with a double big bubble curtain for monopiles with large diameters (Bellmann et al. 2020). Acoustic modeling has been completed for 10 dB, 12, dB, and 15 dB (see Appendix II-E).

The ranges to threshold levels resulting from the acoustic modeling are reported using two different terminologies to reflect the underlying assumptions of the modeling. The term "acoustic range" is used to refer to acoustic modeling results that are based only on sound propagation modeling and not animal movement modeling. Acoustic ranges assume receivers of the sound energy (marine mammals) are stationary throughout the duration of the exposure. These are most applicable to thresholds where any single instantaneous exposure above the threshold is considered to cause a take, such as the Level A SPL_{pk} thresholds and the Level B SPL_{rms} threshold. For SEL_{cum} based thresholds, acoustic ranges represent the maximum distance at which a receiver would be exposed above the threshold level if it remained present during the entire sound producing event or 24 hours, whichever is less. Since receivers are likely to move in and out of the threshold distance over the course of an exposure, these distances are more difficult to interpret. To address this, results from animal movement modeling are used to estimate an "exposure range." This involves analyzing the movements and resulting accumulated sound energy during the exposure modeling and identifying the ranges within which most animals (95%) were exposed above the threshold level if they occurred within that range at any point in time. Therefore, the exposure ranges provide a more realistic assessment of the distances within which animals would need to occur in order to accumulate enough sound energy to cross the applicable SEL_{cum} threshold.

Additional information on modelled acoustic ranges, exposure ranges, and exposure estimates can be found in Appendix II-E. With the implementation of the monitoring and mitigation measures described below, the potential for auditory injury will be negligible and instances of behavioral disturbance will be reduced.

HRG Surveys

HRG surveys may be conducted to support pre-construction site clearance activities as well as post-construction facilities surveys. HRG survey equipment has the potential to be audible to marine mammals (MacGillivray et al. 2014) including those with operating frequencies below 180 kHz. HRG survey sources with operating frequencies >180 kHz are outside the hearing range of marine mammals and will not result in exceedance of received sound levels above exposure criteria as defined by (NMFS 2018b). Most types of HRG survey equipment produce impulsive sounds that could have similar effects on marine mammals as described previously for impact pile driving; however, the sounds produced by HRG survey equipment are typically at higher frequencies, lower source levels, and have a much higher repetition rate than impact pile driving. This means that any effects on the hearing ability of marine mammals (TTS or PTS) are unlikely. Since some of the HRG survey equipment proposed for use during the HRG surveys produce sounds with frequency ranges overlapping that of marine mammal hearing and vocalizations, they could result in behavioral disturbance and/or masking (Richardson et al. 1995; Nowacek et al. 2007; Southall et al. 2007). However, the impulsive nature of these sounds, limited duration of the survey activities, and short distances over which they would be audible suggest that any masking experience by marine mammals would be highly localized and short term.

Vessel Noise

Offshore construction may occur over a period of several years, during which a number of different vessels will be utilized for transportation and installation activities within the Offshore Development Area. Vessel use will also occur during O&M and vessel activity is further described in Section 5.6. Vineyard Northeast vessels will follow the measures outlined below under the vessel strike avoidance subheading to reduce the possible risk of injury on marine mammals. Vessel activities also introduce sound into the water that may impact marine mammals.

Sounds produced by large vessels generally dominate underwater ambient noise at frequencies from 20–300 Hz (Richardson et al. 1995). However, some sound energy is also produced at higher frequencies (Hermannsen et al. 2014); low levels of high-frequency sound from vessels have been shown to elicit responses in harbor porpoise (Dyndo et al. 2015). Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Richardson et al. 1995; Clark et al. 2009; Jensen et al. 2009; Gervaise et al. 2012; Hatch et al. 2012; Rice et al. 2014; Dunlop et al. 2015; Erbe et al. 2016; Jones et al. 2017; Putland et al. 2017; Cholewiak et al. 2018).

Baleen whales are thought to be more sensitive to sound at these low frequencies than are toothed whales (e.g., MacGillivray et al. 2014), possibly causing localized avoidance of the Offshore Development Area during times with increased vessel traffic. Reactions of gray and humpback whales to vessels have been studied, and there is limited information available about the reactions of right whales and rorquals (fin, blue, and minke whales). Reactions of humpback whales to boats are variable, ranging from approach to avoidance (Payne 1978; Salden 1993). Baker et al. (1982, 1983) and Baker and Herman (1989) found humpbacks often move away when vessels are within several kilometers. Humpbacks seem less likely to react overtly when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984, 1986). Fin whale sightings in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana et al. 2015). Minke whales and gray seals have shown slight displacement in response to construction-related vessel traffic (Anderwald et al. 2013).

Routine vessel activities such as transits between ports and the Lease Area or OECCs are not expected to impact marine mammals, especially given the relatively high amount of vessel traffic already present in the region. As part of various construction related activities, including foundation installation, dynamic positioning (DP) thrusters may be utilized to hold vessels in position or move slowly. Sound produced through use of DP thrusters is similar to that produced by transiting vessels and DP thrusters are typically operated either in a similarly predictable manner or used for short durations around stationary activities. Sound produced by DP thrusters would be preceded by, and associated with, sound from ongoing vessel noise and would be similar in nature; thus, any marine mammals in the vicinity of the activity would be aware of the vessel's presence, further reducing the potential for startle or flight responses on the part of marine mammals. Monitoring of past projects that entailed use of DP thrusters has shown a lack of observed marine mammal responses as a result of exposure to sound from DP thrusters (NMFS 2018b). Therefore, vessel sounds within the Offshore Development Area would not be at levels expected to cause anything more than possible localized and temporary behavioral changes in marine mammals and would not be expected to result in significant negative effects on individuals or at the population level.

Wind Turbine Generators (WTGs)

Operating WTGs produce low levels of sound with source levels up to 151 dB SPL_{rms} in the 60 to 300 Hz frequency range (Dow Piniak et al 2012). The sound generated by WTGs is produced within the nacelle, the enclosed housing that stores the turbine generating parts, which is then transmitted through the foundation and radiated into the water. Measurements at the Block Island Wind Farm found that sound would likely decline to ambient levels at a distance of 1 km (0.5 NM) from the WTGs and an average sound level was recorded to be between 112–120 dB when wind speed was 2–12 m/s (6.5–39.4 feet per second) (HDR 2019). These measurements and the available literature indicate that noise generated during the operational phase of wind farms is minor and does not cause injury or lead to permanent avoidance (Wahlberg and Westerberg 2005; Bergström et al. 2013). The WTGs used by Vineyard Northeast WTGs may be larger in size than those studied at the Block Island Wind Farm; however, larger turbines are expected to produce similar sound. As the size of turbines increases so does the mechanical forces working on gears and bearings. However, an increased turbine size means an increase in distance from the noise source in the nacelle to the water (Tougaard et al. 2020).

Offshore Cable Installation and Cable Operation

During offshore cable installation, mechanical or water jetting equipment may be used to install the cable, but it is expected to produce intermittent sound at relatively low levels. Cable installation may involve vessels that use DP thrusters. As discussed above in the section on vessel noise, the impacts of noise exposure associated with the use of DP thrusters is expected to be low because noise from those vessels is likely to be similar to or less than the background vessel traffic noise in the area.

If high-voltage alternating current (HVAC) offshore cables are installed, they are expected to generate non-impulsive, low-frequency tonal vibration sound in the water. High voltage direct current (HVDC) cables do not produce a similar tonal sound because the current is not alternating. The sound pressure levels expected to be produced during HVAC cable operations are likely undetectable within the ambient soundscape of the Offshore Development Area (Meibner et al. 2006).

Aircraft

Aircraft may be used for a variety of activities during construction, O&M, and decommissioning. In addition to vessels, helicopters may be used for crew transfer and visual inspections of the offshore facilities. Fixed-wing aircraft or drones (autonomous underwater/surface vessels or aerial drones) may be used to support environmental monitoring and mitigation. Helicopters produce sound that could be audible to marine mammals. Sounds generated by aircraft, both fixed wing and helicopters, are produced within the air, but can transmit through the water surface and propagated underwater. In general, underwater sound levels produced by fixed wing aircraft and helicopters are typically low-frequency (16-500 Hz) and range between 84-159 dB re 1 μPa (Richardson et al. 1995; Patenaude et al. 2002; Erbe et al. 2018). Most sound energy from aircraft reflects off the air-water interface; only sound radiated downward within a 26-degree cone penetrates below the surface water (Urick 1972). Aircraft noise is typically in the low- to mid-frequency ranges used by marine mammals and therefore has the potential to cause temporary change in behavior and localized displacement of marine mammals to the extent it transmits from air through the water surface (Richardson et al. 1985a; Richardson and Würsig 1997; Nowacek et al. 2007).

Consistent with how sound from aircraft may enter the water, marine mammals tend to react to aircraft noise more often when the aircraft is lower in altitude, closer in lateral distance, and flying over shallow water (Richardson et al. 1985b; Patenaude et al. 2002). Temporary reactions by marine mammals include short surfacing, hasty dives, aversion from the aircraft or dispersal from the incoming aircraft (Bel'kovich 1960; Kleĭnenberg et al. 1964; Richardson et al. 1985a, 1985b; Luksenburg and Parsons 2009). The response of cetaceans to aircraft noise largely depends on the species as well as the animal's behavioral state at the time of exposure (e.g., migrating, resting, foraging, socializing) (Würsig et al. 1998). A study conducted in the Beaufort Sea in northern Alaska observed a general lack of reaction in bowhead and beluga whales to passing helicopters (Patenaude et al. 2002). Patenaude et al. (2002) reported behavioral response by only 17% of the observed bowhead whales to passing helicopters at altitudes below 150 m (492 ft) and within a lateral distance of 250 m (820 ft). Similarly, most observed beluga whales did not show any visible reaction to helicopters passing when flight altitudes were over 150 m (492 ft) (Patenaude et al. 2002). Although the sound emitted by aircraft has the potential to result in temporary behavioral responses in marine mammals, aircraft used within the Offshore Development Area would only occur at low altitudes over water during takeoff and landing at an offshore location where one or more vessels are located. Due to the intermittent nature and the small area potentially ensonified by this sound source, the potential for disturbance of marine mammals is expected to be negligible. Thus, the use of helicopters to conduct crew transfers or inspections is likely to provide an overall benefit to marine mammals in the form of reduced vessel activity and associated ship strike risk.

Potential Detonation of Unexploded Ordnances (UXO) and/or Discarded Military Munitions (DMM)

As described in Section 3.10.2 of COP Volume I, if potential UXO and/or DMM are discovered in the Lease Area or OECCs, the Proponent will prioritize avoidance of UXO/DMM wherever possible by micro-siting structures and cables around the object. Where avoidance is not possible (e.g., due to layout restrictions, presence of archaeological resources, etc.), UXO/DMM will be relocated or otherwise disposed of (e.g., via deflagration [burning without detonating], detonation, or dismantling the UXO/DMM to extract explosive components). The exact number and type of UXO/DMM that may be present, and which subset of those UXO/DMM cannot be avoided by micro-siting, are unknown at this time (further evaluation is ongoing). For the purposes of impact analyses, the Proponent conservatively assumes that up to two UXO in the Lease Area, four UXO in the Massachusetts OECC, and four UXO in the Connecticut OECC may need to be detonated in place (each detonation would occur on different days).

Underwater detonations create broadband impulsive sounds with high peak pressures and rapid rise times (Richardson et al. 1995). UXO/DMMs with more net explosive weight will produce higher peak pressures. For example, UXO/DMMs with 2.3 kg (5 pounds [lb]) may produce peak pressures of ~255 dB at 10 m (33 ft), while UXO/DMMs of 454 kg (1,000 lb) may produce peak pressures of over 270 dB at 10 m (33 ft). At close ranges, these sounds have the potential to cause non-auditory injury to marine mammals and at longer ranges, auditory injury and behavioral disturbance are possible. The unique nature of sounds and pressure into the water column from underwater detonations, including the high peak pressure levels and the fact that they are typically just a single impulsive event, means threshold criteria for UXO/DMM detonations are different than for other anthropogenic sounds. Significant masking effects would be unlikely during UXO/DMMs explosions given the intermittent nature of these sounds and short signal duration (Madsen et al. 2006).

Most UXO assessment work in the US has been performed by or for the US Navy, who have worked closely with NMFS to choose and define appropriate criteria for effects based on the best available science. Effects thresholds were based on three key sound pressure metrics as indicators of injury and behavioral disturbance: unweighted peak compressional pressure level (L_{pk}), frequency-weighted sound exposure level (SEL or $L_{E,W}$), and acoustic impulse (J_p). The onset of PTS (auditory injury) and TTS (behavioral disturbance) were assessed using a dual criteria of L_{pk} and frequency-weighted SEL $L_{E,w}$. All SEL modeling assumed a single detonation per day as the assessment criteria. For non-auditory injury and mortality, ranges to injury thresholds were calculated using metrics (L_{pk} and J_p) representing onset of injury to animal's lungs and gastrointestinal tracts from compression-related injury of tissues near enclosed air volumes or gas bubbles (blast shock pulse).

Underwater acoustic modeling of detonations of UXO/DMM occurring within the Offshore Development Area was conducted. Technical details of the modeling methods, assumptions, and results can be found in Appendix II-E.

Avoidance, Minimization, and Mitigation Measures for Noise

Seasonal Restrictions

The Proponent does not intend to conduct pile driving between January 1 and April 30 when higher numbers of NARW are expected to be present in the Offshore Development Area. This will reduce the potential impacts to NARW and other species with similar seasonal presence in the region. To concentrate impact pile driving during the remainder of the year, the Proponent may start (or continue) pile driving at night and/or in poor visibility conditions. To support activities in these conditions, additional monitoring and mitigation measures will also be proposed.

Noise Abatement System (NAS)

Pile driving NAS are effective in reducing sound propagated into the surrounding marine environment. Several recent studies summarizing the effectiveness of NAS have shown that broadband sound levels are likely to be reduced by anywhere from seven to 17 dB, depending on the environment, pile size, and the size, configuration and number of systems used (Buehler et al. 2015; Bellmann et al. 2020). Recent *in situ* measurements during installation of large monopiles (~8 m) for WTGs in comparable water depths and conditions indicate that attenuation levels of 10 dB are readily achieved for a single bubble curtain (Bellmann 2019; Bellmann et al. 2020). Large bubble curtains tend to perform better and more reliably, particularly when deployed with two rings (Koschinski and Ludemann 2013; Bellmann 2014; Nehls et al. 2016; Bellmann et al. 2020). A California Department of Transportation study tested several small, single, bubble curtain systems and found that the best NAS resulted in 10–15 dB of attenuation (Buehler et al. 2015). Buehler et al. (2015) concluded that attenuation greater than 10 dB could not be reliably predicted from small, single bubble curtains because sound transmitted through the seabed and re-radiated into the water column is the dominant sound in the water for bubble curtains deployed immediately around the pile. Combinations of systems (e.g., double big bubble curtain, hydrosound damper plus single big bubble curtain) could potentially achieve much higher attenuation. The Proponent will use a NAS to reduce sound levels by a target of approximately 10 dB during pile driving. The type and number of NAS to be used during construction have not yet been determined, but preference will be given to systems effective at attenuating low frequency sounds. For example, the HSD shows the highest potential for noise reduction at lower frequencies (<200 Hz) and is often seen paired with a double big bubble curtain for monopiles with larger diameters (Bellmann et al. 2020).

Sound Field Verification (SFV)

To assess the efficacy of mitigation measures like NAS and to determine the distance of pre-defined acoustic thresholds, the Proponent proposes to conduct sound field verification (SFV) when construction commences. SFV involves the measurement of underwater sounds produced by pile driving at various distances from the piles. The specific SFV framework will be further developed as the permitting of Vineyard Northeast progresses, but it is expected that sound measurements will be taken for a minimum of one of each of the pile types for comparison with modeling results.

Protected Species Observers (PSOs) and Trained Observers

The Proponent will contract qualified, trained PSOs to conduct marine mammal monitoring during all pile driving and HRG survey activities throughout the construction, O&M, and decommissioning phases. All PSOs will have met BOEM and NMFS training and/or experience requirements as stipulated in the Vineyard Northeast BOEM lease. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the installation vessels, support vessels, and pile driving activity; and documenting exposure to sound levels that may result in impacts to marine mammals. PSOs will not have any further responsibilities while on duty.

Other personnel working offshore will receive environmental training, which will stress individual responsibility for marine mammal awareness and reporting as well as marine debris awareness.

Visual Monitoring

PSOs will conduct observation from the best available safe vantage point on the construction or nearby support vessel to ensure visibility of the pre-start clearance zones (as defined below). The observers will scan systematically with the unaided eye, standard handheld (7x) and/or high magnification (25x) binoculars to search continuously for marine mammals during all observation periods. When a marine mammal is observed, PSOs will record all relevant information, regardless of the distance from the construction activity. As described further below, when a marine mammal is seen within or about to enter the pre-start clearance and/or shutdown zone applicable to that species, the pile installation crew will be notified immediately so that the appropriate mitigation measures can be implemented. Additionally, a PAM system is expected to be utilized to supplement visual monitoring during pre-start clearance and pile driving periods to allow initiation of pile driving when visual PSOs are unable to observe the entire pre-start clearance zone due to poor visibility. The specifics of the PAM system will be determined in consultation with BOEM and NMFS.

Should nighttime pile driving occur, a PAM system as well as PSOs using night vision devices (NVD) and infrared (IR) thermal imaging cameras would be used to monitor the pre-start clearance and/or shutdown zones and implement any necessary mitigation measures.

Pre-start Clearance and Shutdown Zones

Pre-start clearance and shutdown zones will be established to minimize and avoid potential impacts of underwater sound on marine mammals during pile driving, certain HRG survey activities for sources operating below specified frequencies (i.e., based on species' hearing ranges), and UXO/DMM detonation (if required). Pre-start clearance zones are typically zones in which marine mammal observations are conducted for a specified period prior to the commencement of pile driving activity. The duration and distance of the pre-start clearance zone will vary by marine mammal hearing group. If a marine mammal is observed either visually or acoustically within or about to enter the applicable species-specific pre-start clearance zone prior to initiation of pile driving, pile driving will be delayed or will not begin, and the observed animal will be allowed to leave the pre-start clearance zone on their own volition.

A shutdown zone is an area surrounding pile driving activities that may be defined relative to Level A Harassment Zones (as defined in NMFS 2018) or based on other criteria as appropriate. The size of Level A Harassment zones is based on environmental conditions and marine mammal hearing groups (see Table 4.7-3), and biologically appropriate and practicable zones vary by individual species. If a marine mammal is detected within or about to enter the applicable shutdown zone for that species, PSOs will request a shutdown of pile driving. The shutdown would stop pile driving if the lead installation engineer determines that doing so would not jeopardize the installation outcome, human safety, or vessel safety. If shutdown is determined to not be technically feasible due to human safety concerns or to maintain installation feasibility, a reduction in hammer energy of the greatest extent possible will be assessed and implemented. Pile driving will only be reinitiated after a shutdown once the pre-start clearance zones are confirmed to be clear of marine mammals for the defined minimum species-specific periods.

Ramp-up and Soft-start Procedures

A soft-start method will be followed at the beginning of pile driving events while ramp-up measures will be followed at the initiation of HRG survey operations. Soft-start measures are intended to allow for a gradual increase in sound levels before the full pile driving hammer energy is reached. This provides a "warning" to marine mammals in the area and allows time for them to move away, avoiding any potential injury or impairment of their hearing abilities. Soft-start measures will be used at the beginning of each pile driving event or any time pile driving has stopped for longer than 30 minutes. If a marine mammal is detected within or about to enter the shutdown zone (either visually or acoustically) during the soft-start procedure, pile driving will be delayed unless it is determined by the lead installation engineer that doing so would jeopardize the installation outcome or risk human or vessel safety. The duration of a delay in the soft-start procedure would be determined using the same procedure described above for detections within the shutdown zone during the pre-start clearance period.

Equipment and Technology

The Proponent will consider the best currently available technology to mitigate the potential impacts and result in the least practicable adverse impacts during construction, O&M, and decommissioning. This includes a variety of marine mammal detection and sound mitigation methodologies. Examples of potential technologies include PAM recorders, thermal cameras, and NAS. The Proponent will collaborate with BOEM and NMFS to integrate practicable technology choices in equipment, mitigation, and monitoring to meet the necessary standards for permitting and successful consultations.

4.7.2.2 Vessel Activity

Offshore construction, O&M, and decommissioning within the Offshore Development Area may occur over a period of several years. During this time, many different vessels will be utilized, as further described in Section 5.6. The potential for vessel strike is one of the primary threats to marine mammals from Vineyard Northeast (Redfern et al. 2013). Mitigation and monitoring measures, as described below, will be implemented during construction, O&M, and decommissioning to reduce the risk of vessel strike to the maximum extent possible.

The greatest potential for vessels to interact with marine mammals will be during transits to and from the Offshore Development Area. Expected use of vessels during construction and O&M is described in Section 5.6. During the busiest year of O&M, an average of approximately nine vessels are anticipated to operate in the Offshore Development Area at any given time, although additional vessels may be required during certain maintenance or repair activities. Based on the maximum design scenario, approximately 575 vessel round trips are estimated to take place annually during O&M. However, these estimates are highly dependent on the logistics approach used during O&M, the location of the O&M facilities, the timing and frequency of activities, and the final design of the offshore facilities.

Studies suggest that vessel collisions pose a greater threat to baleen whales than to other marine species due to their size, mobility, and surface behavior (Kraus et al. 2005; Parks et al. 2011; Davies and Brillant 2019). Vessel collision has been documented as the leading cause of mortality for NARW since the 1970s (Moore et al. 2006). Research indicates that most vessel collisions with whales resulting in serious injury or death occur when a ship is travelling at speeds over 7.2 m/s (14 knots) (Laist et al. 2001). Wiley et al. (2016) concluded that reducing ship speed is one of the most reliable ways to avoid ship strikes. Similarly, Currie et al. (2017) found a significant decrease in close encounters with humpback whales in the Hawaiian Islands, and therefore reduced likelihood of ship strike, when vessels speeds were below 6.4 m/s (12.5 knots).

Several studies have reported a shift in the distribution and behavior of marine mammals in high traffic areas (Erbe 2002; Jelinski et al. 2002; Nowacek et al. 2004). Therefore, increased vessel activity associated with construction could result in marine mammals avoiding the area, which would reduce the risk of collision with oncoming vessels, but the potential for vessel collision may increase if whales are displaced into higher shipping traffic areas (such as commercial shipping corridors) by sound from impact pile driving.

To minimize the potential for vessel interactions with marine mammals, trained visual observers aboard each vessel will maintain a vigilant watch for all marine mammals, and vessel operators will slow down or maneuver their vessel, as appropriate, to avoid striking protected species. Vessel operators and/or observers aboard each vessel will monitor NMFS NARW reporting systems at least once per day for the presence of NARW.

The Proponent will follow NMFS guidelines for vessel strike avoidance, including vessel speed restrictions and separation distances, that are applicable at the time of construction and operations.[58] Current NMFS guidelines for survey vessel separation distances are summarized below:

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58 Except where following these requirements would put the safety of the vessel or crew at risk.

- Vessels will maintain separation distances of >500 m (1,640 ft) from all ESA-listed whales (including NARW) or large unidentified whales.

- Vessels will maintain separation distances of >100 m (328 ft) from all other large whales (e.g., humpback whales).

- Vessels will maintain, to the greatest extent possible, separation distances of >50 m (164 ft) from all other marine mammals, with the exception of delphinids and pinnipeds that approach the vessel, in which case the vessel operator must avoid excessive speed or abrupt changes in direction.

Current NMFS guidelines for separation distances for all other vessel types are summarized below:

- Vessels will maintain separation distances of >500 m (1,640 ft) from NARW or large unidentified whales.

- Vessels will maintain separation distances of >100 m (328 ft) from all other (non-NARW) baleen whales and sperm whales.

- Vessels will maintain, to the greatest extent possible, separation distances of >50 m (164 ft) from all other marine mammals, with the exception of delphinids and pinnipeds that approach the vessel, in which case the vessel operator must avoid excessive speed or abrupt changes in direction.

With respect to vessel speed restrictions, all vessels will comply with the final amendments to the North Atlantic Right Whale Vessel Strike Reduction Rule at 50 CFR Part 226 (81 FR 4838 2016). All vessel speeds will be reduced to 18.4 km/hr or less (≤10 knots) when mother/calf pairs, pods, or large assemblages of marine mammals are observed.

Reporting of Dead or Injured Marine Mammals

Reporting of dead or injured marine mammals observed during construction and O&M activities, and the actions taken immediately after an observation, will vary depending on the likely cause of the incident. If a marine mammal is injured or killed as a result of Vineyard Northeast activities, that activity will be stopped immediately, as long as it can be accomplished safely. Once the activity(ies) are stopped, the incident will be reported as required by permits or guidance from relevant agencies.

4.7.2.3 Habitat Modification

Temporary to long-term seafloor disturbance may occur from the installation, maintenance, and decommissioning of foundations (for the WTG, ESP, and booster station), scour protection, export cables, inter-array and inter-link cables, and cable protection (if required). Long-term habitat modification may result from installation of foundations, scour protection, and cable protection (if required). Additional temporary habitat modification may result from installation, maintenance, and decommissioning of export, inter-array, and inter-link cables; pre-installation activities (such as sand bedform dredging, boulder clearance, and a pre-lay grapnel run); and usage of equipment that contacts the seafloor (such as jack-up vessels, vessel anchors or spud legs). Additional details are available in Section 3.11 of COP Volume I.

For Vineyard Northeast, WTGs and ESPs will be oriented in an east-west, north-south grid pattern with 1.85 km (1 NM) spacing between WTG/ESP positions. This layout orientation is consistent throughout the MA and RI/MA Wind Energy Areas. Such large distances between individual foundations will minimize the extent of marine mammals being prevented from use of natural habitat, including migration and feeding. All seafloor disturbance and associated suspended sediments is expected to be short-term and temporary with minimal effects on marine mammal habitat or prey items.

The presence of foundations (monopiles and piled jackets), scour protection, and cable protection will result in a conversion of the existing primarily sandy bottom habitat to a hard bottom habitat with areas of vertical structural relief (Wilhelmsson et al. 2006; Reubens et al. 2013; Bergström et al. 2014; Coates et al. 2014). Artificial structures can create increased habitat heterogeneity, which is important for species diversity and density (Langhamer 2012). The WTG and ESP foundations will extend through the water column, which may serve to increase settlement of meroplankton or planktonic larvae on the structures in both the pelagic and benthic zones (Boehlert and Gill 2010). Fish and invertebrate species are also likely to aggregate around the foundations and scour protection which could provide increased prey availability and structural habitat (Boehlert and Gill 2010; Bonar et al. 2015). Given the likely benefits to some marine mammal species from increased prey abundance and the uncertain, but likely minimal negative impacts on large whales from the presence of the widely spaced foundations, overall impacts to marine mammal habitat are anticipated to be negligible.

4.7.2.4 Marine Debris

In accordance with applicable federal, state, and local laws, comprehensive measures will be implemented prior to and during construction, O&M, and decommissioning activities to avoid, minimize, and mitigate impacts related to marine debris disposal. Any items that may become marine debris will be appropriately discarded onshore and disposed of or recycled at a licensed waste management and/or recycling facility. The law prohibits any solid waste disposal or marine debris at sea. The Proponent will require vessel operators, employees, and contractors who engage in offshore activities to participate in a marine trash and debris prevention training program.

4.7.2.5 Entanglement and Entrapment

Entanglement risk to marine mammals is not expected to occur as a result of Vineyard Northeast activities. The Proponent will use steel anchor cables on construction vessels, which will be taut during deployment, eliminating the potential for entanglement of marine mammals. Additionally, metocean buoys and anchor or tow lines used during cable installation will be kept taut at all times; therefore, if a marine mammal comes in contact with the line, entanglement risk will be eliminated. No underwater cables are expected to result in entanglement risk; these cables have large diameters and will be buried at a target depth of 1.5 to 2.5 m (5 to 8 ft) beneath the stable seafloor.[59] WTG and ESP structures themselves are not expected to pose entanglement risk to marine mammals due to the large, static nature of the structures (Inger et al. 2009). However, WTG and ESP structures may cause a secondary entanglement risk to marine mammals through ghost gear and/or marine debris caught on the structures themselves. The foundations have large diameters preventing much of the ghost gear and/or marine debris from being snagged on the structures. The Proponent will inspect the foundations and scour protection at regular intervals for the presence of marine debris (see Section 4.2.2 of COP Volume I) and will remove ghost gear and/or marine debris which may result in the entanglement of marine mammals.

4.7.2.6 Electromagnetic Fields

Electromagnetic fields (EMFs) are areas of electric and magnetic energy that occur naturally but may also be caused by anthropogenic sources. Certain marine mammals are capable of detecting naturally occurring EMFs (Kirschvink et al. 1986; Walker et al. 1992; Walker et al. 2003; Vanselow et al. 2009; Granger et al. 2020). EMFs consist of two components: electric fields and magnetic fields (MFs). Due to cable configuration and shielding, electric fields are not expected in the marine environment from Vineyard Northeast cables and the intensity of any generated MFs will be minimized through cable burial or the placement of cable protection.

Limited research has been conducted on the impacts of EMF on marine mammals. The studies which have been conducted demonstrate cetaceans are unlikely to be affected by subsea cable EMFs. Kirschvink et al. (1990) observed statistical increases in strandings near naturally occurring EMFs as well as behavioral disturbances such as altered migration routes and short-term changes in swim direction. Behavioral changes were not observed in harbor porpoises exposed to operating subsea cable EMFs (Walker 2001; Gill et al. 2005; Slater et al. 2010). Species that feed near the benthos have been observed to be at greater risk to behavioral disturbance due to EMF exposure than those that feed in the water column (Normandeau Associates et al. 2011). Species likely to occur within the Offshore Development Area are not benthic foragers. Nonetheless, as further described in Section 4.5.2.4, modeling of MFs from potential Vineyard Northeast cables was completed and the model results indicate that MFs are likely only able to be sensed, if at all, directly over the buried cable centerline. Because they breathe at the sea surface and have large migratory ranges, marine mammals would not be expected to spend significant amounts of time near the seafloor in the vicinity of specific submarine export cables. Accordingly, the area potentially affected by MFs created by

[59] Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

Vineyard Northeast's offshore cables is likely too small to result in behavioral and/or displacement of cetaceans within the Offshore Development Area (Normandeau Associates et al. 2011; Gill et al. 2014; Copping et al. 2016). Thus, EMFs associated with Vineyard Northeast's offshore cable system are not expected to impact marine mammals.

4.7.2.7 Reduction in Prey Availability

The marine mammal species found within the Offshore Development Area feed on various pelagic and benthic fish species, cephalopods, and crustaceans. Elevated noise levels, installation of structures that disturb the seafloor and other factors associated with Vineyard Northeast vessels and equipment may cause some prey species to leave the immediate area of operations, temporarily reducing the availability of prey within the area and thus potentially disrupting feeding and behavior. Displaced prey species are expected to return shortly after construction is completed. Although pathological or physiological effects are also possible (Hawkins and Popper 2017; Weilgart 2017), the number of prey items affected would be a very small percentage of the stocks available in the region.

The most common behavioral responses by fish to anthropogenic noise are avoidance, alteration of swimming speed and direction, and alteration of schooling behavior (Vabø et al. 2002; Handegard and Tjøstheim 2005; Sarà et al. 2007; Becker et al. 2013). Increased sound levels from the construction activities have the potential to temporarily affect local prey populations, which might indirectly affect marine mammals by altering prey abundance, behavior, and distribution (McCauley 2003; Popper and Hastings 2009; Slabbekoom et al. 2010; Danil and St. Leger 2011; von Benda-Beckmann et al. 2015). Marine fish are typically sensitive to noise in the 100 to 500 Hz range, which coincides with the primary frequency range of vessels and pile driving activities. Noise generated by impact pile driving, as well as other Offshore Development Area activities, has the potential to elicit behavioral responses in fish, and impact pile driving has the potential to cause injury or even mortality as a result of the high peak pressure levels near the source (Yelverton et al. 1975; Hastings and Popper 2005). Any effects from construction sounds are anticipated to be limited to the time during which the sounds are produced and relatively short distances from the sound source.

During the O&M phase, numerous studies have documented significantly higher fish concentrations including species like cod and pouting (*Trisopterus luscus*), flounder (*Platichthys flesus*), eelpout (*Zoarces viviparus*), and eel (*Anguila anguilla*) near the foundations than in surrounding soft bottom habitat (Langhamer and Wilhelmsson 2009; Bergström et al. 2013; Reubens et al. 2013). The presence of the foundations and resulting fish aggregations is expected to be a long-term habitat impact, but the increase in prey availability could potentially be beneficial for marine mammals. Pinnipeds and some odontocete species are likely to benefit the most from increases in the availability of prey species that are attracted to the physical structures. Numerous surveys at offshore wind farms, oil and gas platforms, and artificial reef sites have documented increased abundance of smaller odontocete, and pinniped species attracted to the increase in pelagic fish and benthic prey (Hammar et al. 2010; Lindeboom et al. 2011; Mikkelsen et al. 2013; Russell et al. 2014; Arnould et al. 2015). Currently there are no quantitative data on how large whale species (i.e., mysticetes) may be impacted by offshore wind farms (Kraus et al. 2019). Additionally, wakes in water currents created by the presence of the foundations are not expected to affect pelagic fish, plankton, or benthic species, so marine mammals foraging on these species are unlikely to be adversely affected. Given the likely benefits to some marine mammal species from increased prey abundance, overall impacts to marine mammal habitat are anticipated to be negligible.

Some scientists have recently raised concerns about the potential for the presence of offshore wind structures in this region to affect the availability of zooplankton prey to NARW. The concerns arise because in recent years NARW have appeared to increase their use of SNE waters in and around Nantucket Shoals (Roberts et al. 2016; Quintana-Rizzo et al. 2021; Roberts et al. 2022). Although right whales may be present in this area at any time of year (Davis et al. 2017b), their numbers have been observed to be much higher in winter and early spring (Roberts et al. 2016; Roberts et al. 2022). Analysis of photo-identification data from aerial surveys in 2017–2018 indicated that 15–20% of the NARW population may occur in SNE waters between December and May and that average individual residency time is 13 days (Quintana-Rizzo et al. 2021). Observations of NARW at that time of year have been described as consistent with foraging, but it is not known where in the water column or on what type of prey they may be foraging. It is further suggested that potential effects on oceanographic processes from the presence of offshore wind structures, both in the water and the air, could alter whatever food source may be present. Thus, in order for effects to occur, NARW present in this area would have to be foraging on prey that could be affected by changes to oceanographic processes and any changes to those processes would have to be large enough to alter the availability of NARW prey to a biological meaningful extent.

The presence of offshore wind structures is expected to alter atmospheric and oceanographic processes to a limited extent, as discussed in Section 3.2.2.4. The extraction of energy from the wind creates a downstream wake effect where wind speeds are reduced and there is less wind stress at the sea surface boundary. Similarly, the presence of structures in the water will create turbulence in the water column as currents move past the structures. Some studies of these effects at European wind farms suggest that the magnitude of effect is likely to be small relative to natural processes, while other studies have produced contradictory results showing greater or lesser impacts. One recent modeling study cited by those raising concerns suggests that large scale hydrodynamic effects from development of multiple wind farms could result in changes to ecosystem dynamics within the North Sea (Christiansen et al. 2022). However, the North Sea is a shallow-water environment with primarily wind-driven currents (Sündermann and Pohlmann 2011) where wake effects in the atmosphere are likely to have a greater impact. Thus, modeling results from that region should not be translated directly to the somewhat deeper and tidal current driven environment offshore SNE (see Section 3.2.1.3). Other differences include the spacing and size of turbines installed in the North Sea compared to those being considered off New England further exacerbate the comparison.

A hydrodynamic modeling study commissioned by BOEM (Johnson et al. 2021) that considered several different scales of offshore wind development in the MA and RI/MA WEAs predicted that the magnitude of effects to currents from full build-out would be limited to 1–10%; with some increased current speeds to the north and west of the MA and RI/MA WEAs and small reductions or no changes to current speeds within and in other directions around the MA and RI/MA WEAs. The changes to currents were the primary determinant of larval settlement modeling that generally predicted likely increases in larval settle (of the three species modeled) where current speeds were likely to decrease and no significant changes in the area of Nantucket Shoals (Johnson et al. 2021). Currents moving past offshore wind structures are generally predicted to increase mixing and primary production (Dorrell et al. 2022). Potential increased mixing in this area could augment the existing tidal mixing that occurs on and along the western edge of Nantucket Shoals (Potter and Lough 1987; Lough and Manning 2001; Ullman and Cornillon 2001; White and Veit 2020) where NARW have recently been observed. Depending on what the NARW prey actually are, rather than disrupting prey aggregations and distribution, development of offshore wind structure may actually enhance production and aggregation in this area.

4.7.2.8 Suspended Sediments and Deposition

Temporary increases in suspended sediments and subsequent sediment deposition may occur in the Lease Area and OECCs from the installation, maintenance, and decommissioning of export cables, inter-array cables, inter-link cables, foundations, and scour protection. The majority of these activities would occur during construction with potential for limited activities during O&M if cables require repair or maintenance; however, any maintenance impacts would be expected to be far less than those from construction activities. Impacts from suspended sediments and deposition would be temporary and confined to a small area close to the location of the installation or maintenance activity. Sediment plume modeling conducted for the Block Island Wind Farm resulted in a larger modeled plume than the actual sediment plume, without any evidence of the jet plow causing a sediment plume in the water column (Elliot et al. 2017). Further description of the potential for suspended sediments and deposition is provided in Section 3.2.

Areas affected by temporarily suspended sediments are likely to overlap with areas impacted by pile driving, dredging and offshore cable installation. Marine mammals are likely to avoid such areas as previously described and are likely to be absent in areas impacted by temporarily suspended sediments before sediments are settled at the bottom. Suspended sediment and deposition causing activities within the Offshore Development Area are not expected to pose a risk to marine mammals.

4.7.2.9 Artificial Light

Vessels transiting to or working within the Offshore Development Area during periods of darkness and fog will utilize artificial lighting as required by vessel regulations. Navigational lighting on structures placed in the Offshore Development Area will be close to sea level and some light could penetrate into the water. Artificial light that enters the water may result in attracting or deterring certain prey species of marine mammals (e.g., finfish and invertebrates). However, the amount of artificial lighting that penetrates the sea surface is expected to be minimal and localized from vessels and structures. Therefore, artificial light is unlikely to have a large enough effect to cause adverse impacts to marine mammals or their prey species.

During O&M, structures will be lit in compliance with Federal Aviation Administration (FAA), US Coast Guard (USCG), and BOEM guidelines for lighting and marking. The Proponent will work with the USCG, BOEM, and the Bureau of Safety and Environmental Enforcement (BSEE) to determine the appropriate marine lighting and marking scheme in terms of the number, location, and type of lighting for the proposed offshore facilities. Lighting at the top of WTG structures for aviation safety will likely be too high above sea level to penetrate the water surface, meaning it is unlikely to cause adverse impacts to marine mammals or their prey species.

4.7.2.10 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to marine mammals during Vineyard Northeast are summarized in Table 4.7-5.

Table 4.7-5 Summary of Monitoring and Mitigation Measures

Category	Description
Seasonal Pile Driving Restrictions	
Seasonal pile driving restrictions	• The Proponent does not intend to conduct pile driving between January 1 and April 30.
Noise Abatement System	
Noise abatement system	• The Proponent expects to implement a NAS to reduce sound levels by a target of approximately 10 dB during pile driving.
Protected Species Observers (PSOs) and Trained Observers	
Observer qualification and training	• The Proponent will contract qualified, trained PSOs to conduct marine mammal monitoring during pile driving, HRG surveys, and UXO/DMM (if necessary) mitigation activities. • Personnel working offshore will receive environmental training, stressing individual responsibility for marine mammal awareness and reporting as well as marine debris awareness.
Visual Monitoring	
Visual monitoring methods	• PSOs will conduct observations from the best available safe vantage point on the construction vessel or nearby support vessel to ensure visibility of the pre-start clearance zones. • When conducting observations during pile driving, PSOs will scan systematically with the unaided eye, using standard handheld (7x) and/or high magnification (25x) binoculars to search continuously for marine mammals during all observation periods. • When a marine mammal is observed, PSOs will record all relevant information, regardless of the distance from the construction activity.
Nighttime visual monitoring methods	• During nighttime operations, a PAM system as well as PSOs using night vision devices and infrared thermal imaging cameras would be used to monitor the pre-start clearance and/or shutdown zones and implement any necessary mitigation measures.

Table 4.7-5 Summary of Monitoring and Mitigation Measures (Continued)

Category	Description
Acoustic Monitoring	
Passive acoustic monitoring (PAM) methods	• The Proponent expects to use a PAM system to supplement visual monitoring during pre-start clearance and pile driving periods to allow initiation of pile driving when visual PSOs are unable to observe the entire pre-start clearance zone due to poor visibility.
Sound field verification	• A sound field verification plan will be developed in consultation with BOEM and NMFS. • Sound measurements will be taken for a minimum of one of each of the pile types for comparison with modeling results. • Measures may include measurement of one or more piles without the use of noise attenuation to quantify the effectiveness of the system.
Pre-Start Clearance and Shutdown Zones	
Pre-start clearance	• Prior to the beginning of each pile driving event, PSOs will monitor for marine mammals and will continue to monitor at all times during pile driving. • If a marine mammal is observed either visually or acoustically within or about to enter the applicable species-specific pre-start clearance zone prior to the initiation of pile driving, pile driving will be delayed or will not begin and the observed animal will be allowed to leave the pre-start clearance zone on their own volition.
Shutdowns	• If a marine mammal is detected within or about to enter the applicable shutdown zone for that species once activities have commenced, PSOs will request a shutdown of pile driving. • If shutdown is not technically feasible due to human safety concerns or to maintain installation stability, a reduction in hammer energy of the greatest extent possible will be assessed and implemented. • Pile driving will only be reinitiated after a shutdown once the shutdown zones are confirmed to be clear of marine mammals for the defined minimum species-specific periods. • Following shutdown, pile driving will restart using the same procedure described above during pre-start clearance.

Table 4.7-5 Summary of Monitoring and Mitigation Measures (Continued)

Category	Description
Ramp-up and Soft-start Procedures	
Ramp-up and soft-start	• Soft-start measures will be used at the beginning of each pile driving event or any time pile driving has stopped longer than 30 minutes. • Ramp-up measures will be followed at the beginning of HRG survey operations.
Ramp-up and soft-start	• If a marine mammal is detected within or about to enter the shutdown zone (either visually or acoustically) during the soft-start procedure, pile driving will be delayed unless it is determined by the lead engineer that doing so would jeopardize the installation outcome or risk human or vessel safety.
Equipment Technology	
Equipment	• The Proponent will consider the best currently available technology to mitigate the potential impacts and result in the least practicable adverse impacts to marine mammals during construction, O&M, and decommissioning.
Vessel Strike Avoidance	
General measures	• Vessel operators and/or observers aboard each vessel will monitor NMFS NARW reporting systems at least once per day for the presence of NARW.
Survey vessel separation distances	• Vessels will maintain separation distances of >500 m (1,640 ft) from all ESA-listed whales (including NARW) or large unidentified whales. • Vessels will maintain separation distances of >100 m (328 ft) from all other large whales (e.g., humpback whales). • Vessels will maintain, to the greatest extent possible, separation distances of >50 m (164 ft) from all other marine mammals, with the exception of delphinids and pinnipeds that approach the vessel, in which case the vessel operator must avoid excessive speed or abrupt changes in direction.

Table 4.7-5 Summary of Monitoring and Mitigation Measures (Continued)

Category	Description
Vessel Strike Avoidance (Continued)	
All other vessel separation distances	• Vessels will maintain separation distances of >500 m (1,640 ft) from NARW or large unidentified whales. • Vessels will maintain separation distances of >100 m (328 ft) from all other (non-NARW) baleen whales and sperm whales. • Vessels will maintain, to the greatest extent possible, separation distances of >50 m (164 ft) from all other marine mammals, with the exception of delphinids and pinnipeds that approach the vessel, in which case the vessel operator must avoid excessive speed or abrupt changes in direction.
Speed reduction	• With respect to vessel speed restrictions, all vessels will comply with the final amendments to the North Atlantic Right Whale Vessel Strike Reduction Rule at 50 CFR Part 224. • All vessel speeds will be reduced to 18.4 km/hr or less (≤10 knots) when mother/calf pairs, pods, or large assemblages of marine mammals are observed.
Reporting of Dead or Injured Marine Mammals	
Reporting	• Reporting of dead or injured marine mammals observed during construction and O&M activities, and the actions taken immediately after an observation, will vary depending on the likely cause of the incident. • If a marine mammal is injured or killed as a result of Vineyard Northeast activities, that activity will be stopped immediately, so as long as this can be accomplished safely. Once the activity(ies) are stopped, the incident will be reported as required by permits or guidance from relevant agencies.
Siting	
Siting	• Foundations will be oriented in an east-west, north-south grid pattern with 1.85 km (1 NM) spacing between WTG/ESP positions.

Table 4.7-5 Summary of Monitoring and Mitigation Measures (Continued)

Category	Description
Marine Debris	
Marine debris	• In accordance with applicable federal, state, and local laws, comprehensive measures will be implemented prior to and during construction, O&M, and decommissioning activities to avoid, minimize, and mitigate impacts related to marine debris disposal. • The Proponent will require vessel operators, employees, and contractors who engage in offshore activities to participate in a marine trash and debris prevention training program.
Reduced Entanglement Risk	
Reduced entanglement risk	• The Proponent will use steel anchor cables on construction vessels. • Lines will remain taut.

4.8 Sea Turtles

This section addresses the potential impacts of Vineyard Northeast on sea turtles in the Offshore Development Area. An overview of the affected environment sand sea turtle species is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to sea turtles during the construction, operation, and decommissioning of Vineyard Northeast.

4.8.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. Given the regional nature of sea turtle distribution, species that are present within the Massachusetts Wind Energy Area (MA WEA) and the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) are also considered likely to be present within the Offshore Development Area including the entirety of Lease Area OCS-0522 as well as the two OECCs.

As listed in Table 4.8-1, there are four species of sea turtles that routinely occur in the Western North Atlantic Outer Continental Shelf (OCS) region: loggerhead sea turtles (*Caretta caretta*), green sea turtles (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), and leatherback sea turtles (*Dermochelys coriacea*). The populations of loggerhead and green turtles that occur in the Offshore Development Area are listed as threatened under the Endangered Species Act (ESA) and Kemp's ridley and leatherback turtles are listed as endangered. None of these species are year-round residents of the northern Mid-Atlantic Bight (MAB), but they seasonally forage and migrate through these waters during the summer and autumn months. Owing to this potential overlap, activities associated with offshore wind energy construction, operations and maintenance (O&M), and decommissioning have the potential to result in IPFs for sea turtles. IPFs are further discussed in Section 4.8.2 and may either directly influence sea turtles (such as through disrupting sensory perception, entanglement, or vessel strikes) or indirectly influence sea turtles (such as through changes in the distribution or abundance of prey or predators).

Table 4.8-1 Sea Turtles that Could be Present in the Offshore Development Area

Common Name (Species Name) and Stock	Stock/Distinct Population Segments[1]	Regulatory Status	Occurrence in the MA and RI/MA WEAs	Abundance
Green sea turtle (*Chelonia mydas*)	North Atlantic distinct population segments (DPS)	Threatened	Uncommon	167,424 mature females[1]

Table 4.8-1 Sea Turtles that Could be Present in the Offshore Development Area (Continued)

Common Name (Species Name) and Stock	Stock/Distinct Population Segments[1]	Regulatory Status	Occurrence in the MA and RI/MA WEAs	Abundance
Kemp's ridley sea turtle (*Lepidochelys kempii*)	N/A	Endangered	Regular (Summer and fall)	28,133 9+ year old females[2]
Leatherback sea turtle (*Dermochelys coriacea*)	Atlantic	Endangered	Common (Summer and fall)	20,659 nesting females[3]
Loggerhead sea turtle (*Caretta caretta*)	Northwest Atlantic DPS	Threatened	Common (Summer and fall)	40,000 – 60,000 individuals in the Northwest Atlantic[4]

Notes:

1. Seminoff et al. (2015); [2]Gallaway et al. (2016); [3]NMFS and USFWS (2020); [4]NEFSC and SEFSC (2011).

4.8.1.1 Loggerhead Sea Turtle (Caretta caretta)

The loggerhead sea turtle is widely distributed, occurring in tropical, subtropical, and temperate waters of the Atlantic, Pacific, and Indian oceans (Valverde and Holzwart 2017). Adults generally forage in coastal and shelf waters but can pass through oceanic waters during migrations. This species' distribution extends into more temperate waters than other sea turtles and is the most abundant sea turtle species found in the United States (US) Atlantic (TEWG 2009).

Loggerhead sea turtles are among the largest of the hard-shelled Cheloniidae sea turtles, with carapace lengths (CLs) reaching 120 centimeters (cm) (47 inches [in]) (TEWG 2009). They have a reddish-brown carapace, with a dull brown integument (outer protective layer) dorsally and a light-to-medium yellow integument ventrally (Conant et al. 2009). When in pelagic habitats, juvenile loggerheads feed on invertebrates associated with sargassum as well as salps and jellyfish (Bjorndal 1997). Once they reach a size of 40–60 cm (16–24 in) CL, they recruit to coastal inshore and waters of the continental shelf throughout the US Atlantic to feed on a wide range of animals at the seafloor and within the water column, including crabs, mollusks, jellyfish, and vegetation at or near the surface (Bjorndal 1997). Loggerhead sea turtles spend approximately 3.8% of the time (or 2.3 minutes per hour) at the surface and are otherwise submerged, foraging, or resting (Thompson 1988). Adults generally forage in coastal and shelf waters but can pass through oceanic waters during migrations.

Status

Loggerhead turtles are listed as threatened under the ESA and the Massachusetts Endangered Species Act (MA ESA). They are also considered species of greatest concern (SGCN) in the Rhode Island Wildlife Action Plan. Nine distinct population segments (DPS) comprise the loggerhead sea turtle species, as listed under the ESA. Five loggerhead DPS are listed as endangered (North Pacific, South Pacific, North Indian, and Northeast Atlantic) and four are listed as threatened (Northwest Atlantic, South Atlantic, Southeast Indo-Pacific, and Southwest Indian). These DPS are genetically distinct and, in some cases, DPS exhibit further genetic differentiation among nesting sites that warrant consideration as subregional management units. Based on genetic samples obtained from fisheries interactions, loggerheads that seasonally occur within the Offshore Development Area are likely all from the Northwest Atlantic DPS (Stewart et al. 2019). The Northwest Atlantic DPS is the world's largest DPS of loggerhead turtles, and only one other management region (Northwest Indian Ocean) has comparable nesting numbers (Wilson et al. 2020), and these two regions combined account for 90% of global loggerhead nesting (Witherington et al. 2009).

There are ten subregional management units within Northwest Atlantic DPS include nesting aggregations along (1) Virginia through northeastern Florida, (2) central eastern Florida, (3) southeastern Florida, (4) Dry Tortugas, Florida, (5) Cay Sal, Bahamas, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012). The greatest abundance of loggerhead nesting occurs at central eastern and southeastern Florida beaches (~75% of nesting for the entire DPS) (Stewart et al. 2019). Genetic analyses of 683 loggerhead turtles caught as bycatch north of Cape Hatteras indicated that smaller turtles (straight carapace lengths [SCL] < 63 cm) are primarily from Central East Florida (64%) with minor contributions from Southeast Florida, Northwest Florida, and Quintana Roo, Mexico. Larger turtles (SCL > 63 cm) within this region are primarily from Southeast Florida (44%), the northern US (33%), Central East Florida (12%), and Quintana Roo, Mexico (5%) (Stewart et al. 2019).

Like other sea turtle species along the US Atlantic Coast, loggerhead turtles are vulnerable to multiple anthropogenic impacts, including habitat loss, pollutant ingestion, climate change and bycatch.

Distribution

Loggerhead sea turtle distribution in the Northwest Atlantic is influenced by water temperature and water depth (Bureau of Ocean Energy Management [BOEM] 2012). Results from the Cetacean and Turtle Assessment Program (CeTAP) aerial surveys found that 84 percent of loggerhead sea turtle sightings occurred in waters less than 80 meters (m) (262.5 feet [ft]) suggesting that they prefer shallow waters (CeTAP 1982). Loggerheads tend to be absent during the winter months and are rare during the spring months, although sightings in spring were found within the Offshore Development Area (Kraus et al. 2016). The MAB of the Northwest Atlantic continental shelf region is a seasonal foraging area for loggerheads. Loggerhead thermal habitat and seasonal duration will likely increase in northern regions of the northwestern (NW) Atlantic shelf. This change in spatiotemporal range for sea turtles in a region of high anthropogenic use may prompt adjustments to the localized protected species conservation measures (Patel et al. 2021).

Neither the Offshore Development Area nor the surrounding waters of the Mid-Atlantic Bight are considered Critical Habitat for loggerhead sea turtles. Critical Habitat within coastal waters extends from western Mississippi through North Carolina and juvenile Critical Habitat associated with pelagic *Sargassum* algae extends from Texas to the oceanic waters (>200 m deep) offshore of Maryland. Nonetheless, loggerhead turtles were regularly observed in waters in the northern MAB by manned aerial surveys and the New York State Energy Research and Development Authority (NYSERDA) Digital Aerial Baseline Surveys, predominantly in the summer and fall (Kraus et al. 2016; Normandeau and APEM 2019). Surveys of the northern MAB found that loggerhead sea turtles occur throughout the region, with the most sightings occurring during the summer and fall months (over 92% of sightings occurred in August and September). One loggerhead sea turtle in Lease Area OCS-A 0501 was also identified during high resolution geophysical surveys (Vineyard Wind 2016); four unidentified species were sighted in 2017.

<u>Abundance</u>

The complex nature of sea turtle dive-surfacing behavior can lead to results from abundance surveys that are site-specific, ambiguous, and highly variable. Previous aerial surveys have estimated that between approximately 40,000 and 60,000 loggerheads seasonally inhabit the northwest Atlantic, particularly the Mid-Atlantic Bight. For context, between approximately 500,000 and 1,000,000 inhabit the South Atlantic Bight (NEFSC and SEFSC 2011). Owing to the limited time loggerheads spend at the surface and given that turtles < ~40 cm SCL are typically unobservable, these may be underestimates (Hatch et al. 2022). Stable isotope analysis and satellite telemetry distribution data indicate that 30–50% of loggerheads that nest and reside along the US eastern seaboard seasonally forage within the Mid-Atlantic Bight (Ceriani et al. 2017). For instance, ~84% of the turtles that nest in the northern US management unit likely forage in the Mid-Atlantic Bight (Pfaller et al. 2020). For a major nesting beach in central east Florida, ~25% of nesting turtles forage in the Mid-Atlantic Bight regions (Ceriani et al. 2017). Given data that suggest Florida hosts a nesting population of ~51,319 turtles (Ceriani et al. 2019), such percentages imply the Mid-Atlantic Bight is an important foraging ground for adult, female loggerheads and that loggerhead sea turtles should be expected to occur in the vicinity of the Offshore Development Area in summer and fall.

4.8.1.2 Green Sea Turtle (Chelonia mydas)

Green turtles are globally distributed, occurring primarily in tropical and subtropical waters, though occasionally extending into more temperate regions (Valverde and Holzwart 2017). Adults and larger juveniles typically forage in coastal waters. The green sea turtle is the largest of the hard-shelled turtles but has a comparatively small head and exceeded in size only by the leatherback (Valverde and Holzwart 2017). A typical adult is 90 to 120 cm SCL and weighs 130 to 160 kilograms (kg). They have dark brown-, grey-, or olive-colored shells and a much lighter, yellow-to-white underside. Green turtles have a serrated beak on the lower jaws which they use to forage on seagrasses and macroalgae. The life history of green turtles involves a series of stages of development from hatchling to adult. After emerging from the nest, hatchlings swim to offshore areas, where they live for several years in pelagic habitat. Juveniles leave the open ocean habitat after three to five years and travel to nearshore foraging grounds in shallow coastal habitats, where they mature by 20 to 35 years old and may live for at least 70 years. Every two to five years they undertake reproductive migrations and return to nest on a beach in the general area where they hatched decades earlier.

Status

Green turtles were listed under the ESA in 1978 and subsequently separated into two ESA-listing designations: endangered for breeding DPSs in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range (81 Fed. Reg. 20058 2016). On April 6, 2016, National Marine Fisheries Service (NMFS) listed 11 DPSs of green sea turtle. Three DPS are endangered (Central South Pacific, Central West Pacific, and Mediterranean) and eight are threatened (Central North Pacific, East Pacific, North Atlantic Pacific, South Atlantic Pacific, East Indian-West Pacific, North Indian, Southwest Indian, Southwest Pacific). The primary DPS known to occur in the Offshore Development Area, the North Atlantic DPS, is listed as threatened. This DPS is estimated to have 167,424 mature females at 73 nesting sites. Nesting occurs across the southeastern US, Mexico, and the wider Caribbean with the center of abundance, more than 100,000 mature females, nesting at Tortuguero, Costa Rica (Seminoff et al. 2015). The homing behavior of green turtles results in detectable genetic structure across regions within the DPS, however, genetics-based estimates of the contributions of individual nesting beaches to the waters in the Mid-Atlantic Bight do not appear to be available. For the waters around North Carolina, green turtles primarily originate from beaches in Mexico (30.6%), Florida (25.9%), and Costa Rica (25.9%), with smaller percentages (<5%) from other locations in the Caribbean, South America, and West Africa (Putman and Naro-Maciel 2013). Given the ocean circulation patterns and the locations of green turtle nesting sites relative to major current systems, similar relative contributions could be expected for the northern Mid-Atlantic Bight as well (Putman and Naro-Maciel 2013).

Distribution

Green turtles are generally considered a species that occurs in the tropics and subtropics; the only Critical Habitat for green turtles of the North Atlantic DPS is around Culebra Island, east of Puerto Rico. Even so, green turtles regularly occur within the Mid-Atlantic Bight, as indicated from stranding records and satellite telemetry data. Green turtles that were rehabilitated after becoming cold-stunned in the northern Mid-Atlantic Bight and subsequently released from Long Island, New York with satellite transmitters showed use of the waters of Long Island Sound through months of July through October (Robinson et al. 2020). These turtles transitioned to southern or offshore waters during the months of January through June. Compared to similarly tracked loggerhead and Kemp's ridley turtles, green turtles occupied warmer waters (Robinson et al. 2020). Green turtles routinely cold stun north of the Offshore Development Area (e.g., in Cape Cod) and would thus at least intermittently migrate through this area.

Abundance

Throughout the North Atlantic, green turtle abundance appears to be increasing, including the recruitment of juvenile green turtles to the eastern US coast (Putman et al. 2020a). In the MA WEA and RI/MA WEA, no green turtles were observed during the Northeast Large Pelagic Survey Collaborative (NLPSC) conducted from 2011-2015 (Kraus et al. 2016). There were also no recorded observations of green turtles in northeastern US waters during Atlantic Marine Assessment Program for Protected Species (AMAPPS) I surveys or AMAPPS II surveys conducted from 2010-2016 and 2017-2018, respectively (Palka 2017; NEFSC and SEFSC 2018). This lack of sightings, however, should be interpreted cautiously given the sizes of green turtles that are found stranded in this region. Of the cold stunned green turtles that were rehabilitated and subsequently tracked by Robinson et al. (2020), only two of the 12 were a size that might be detectable from aerial surveys (42.0 and 58.9 cm SCL). Four green sea turtle observations were recorded in Sea Turtle Stranding and Salvage Network (STSSN) reports of Massachusetts waters from 2015-2019, though these reports are not always updated regularly (SEFSC 2020). Observations included three stranding events in August and October of 2016 and one stranding event in October 2018. In 2021, at least eight green sea turtles had been reported stranded in November.[60] As the DPS continues to increase (owing to protections and demographic momentum) and waters in the Mid-Atlantic Bight continue to warm (owing to climate change) more green turtles in this region may be expected.

4.8.1.3 Kemp's Ridley Sea Turtle (Lepidochelys kempii)

Kemp's ridley sea turtles are the smallest of the Chelonidae species, with CLs reaching 70 to 75 cm (Avens et al. 2017; Shaver et al. 2016) It has a triangular-shaped head and a nearly circular-shaped carapace that is almost as wide as it is long. The carapace is grayish-green in color, integument coloration is olive-gray dorsally and light yellow ventrally. The plastron (bottom shell) is a pale cream-white (76 FR 58781). Kemp's ridley are notable among sea turtles for their restricted in-water and nesting distributions. They show similar habitat transitions between life history stages, which hatchlings located primarily offshore and adults spending their time in nearshore habitats (76 FR 58781; USFWS and NMFS 2015). When in pelagic habitats, juvenile Kemp's ridleys feed on small invertebrates associated with pelagic *Sargassum* such as mollusks and crabs (Bjorndal 1997). Once they recruit to nearshore habitats, their diet often includes crabs, though they are opportunistic and will eat other benthic invertebrates and fish (especially discards from shrimp trawl bycatch). Kemp's ridleys spend approximately 11% of their time at the surface and are otherwise submerged, foraging, or resting (Renaud 1995). Kemp's ridley sea turtles typically forage and migrate close to the coastline and in shallow water depths of <50m (Shaver et al. 2016).

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60 See:https://www.neaq.org/about-us/news-media/press-kit/press-releases/annual-sea-turtle-stranding-season-seeing-growing-numbers/

Status

The Kemp's ridley sea turtle was listed as endangered in 1970 (35 Fed. Reg. 18319 1970). There is only one population of Kemp's ridley sea turtles, and nearly all nesting occurs in the western Gulf of Mexico, with upwards of 90% along the coast of Tamaulipas near Rancho Nuevo. Two other nesting areas exist in Veracruz, Mexico and Texas, US; scattered nests are documented in Campeche, Mexico, and Alabama, Florida, Georgia, South Carolina, and North Carolina (Valdivia et al. 2019). Kemp's ridley sea turtles and the closely related Olive ridley sea turtles (*Lepidochelys olivacea*) and are the only turtle species that exhibit a synchronized mass nesting behavior where large numbers of females gather offshore and then come to shore as a group to nest in an arribada. While hybrids among turtle species can be common, there are no instances of detected hybridization between the two ridley species (Plotkin 2007).

Kemp's ridley sea turtles have the smallest population size, most restricted nesting habitat, and are considered the most endangered sea turtle in the world (Bevan et al. 2016; NMFS et al. 2011). The entire Kemp's ridley sea turtle population is listed as endangered under the ESA and MA ESA (NMFS 2020d). They are also considered SGCN in the Rhode Island Wildlife Action Plan. The number of nests increased exponentially through the 1990s as a result of beach protections and the development of Turtle Excluder Devices (TEDs) for shrimp trawls (Caillouet et al. 2018). However, in 2010, the number of nests decreased dramatically and have since shown wide annual variation, but with no clear trend through time (Caillouet et al. 2018). According to the International Union for Conservation of Nature (IUCN), there are estimated to be 22,341 mature female Kemp's ridley sea turtles globally (Wibbels and Bevan 2019). Historically, the primary threat to Kemp's ridleys was the harvest of both eggs and turtles. Small levels of harvesting continue to occur on some nesting beaches in Mexico, but extensive protections have dramatically decreased this from historical levels (NMFS, USFWS, and SEMARNAT 2011). Current threats include vehicles on beaches and coastal development in terrestrial habitats, oils spills, and bycatch in fisheries (NMFS, USFWS, and SEMARNAT 2011).

Distribution

Kemp's ridley sea turtles are distributed throughout the Gulf of Mexico and along the US Atlantic seaboard as far north as Nova Scotia; their range encompasses the Offshore Development Area. Whereas the Mid-Atlantic Bight is habitat for adult loggerhead and leatherback sea turtles, Kemp's ridley that occur in this area are predominantly younger juveniles (< 40 cm SCL). As with other sea turtle species, the distribution of Kemp's ridley is influenced by water temperature and water depth. Kemp's ridley sea turtles that occur in southern New England (SNE) can be seen in Long Island Sound, along the Rhode Island coastline, and in Cape Cod Bay, Massachusetts (CeTAP 1982; Waring et al. 2012). They are more common in the New York Bight region and along the Long Island coastline. Tracks of Kemp's ridley sea turtles that were rehabilitated after becoming cold-stunned in the region and subsequently released with satellite transmitters from Long Island migrated northwards into Massachusetts waters (two out of 12), before migrating southwards by November. Kenney and Vigness-Raposa (2010) reported 14 observations of Kemp's ridley sea turtles offshore Rhode

Island around Block Island in the summer and fall (but none during the winter or spring). Kemp's ridley sea turtles are considered regular summer visitors in the nearshore waters of Rhode Island, and some have been observed in Narraganset Bay (Schwartz 2021). It has recently been suggested that ocean temperature changes and rates of cold-stunning may be related, especially to the north in Cape Cod (Griffin et al. 2019; Liu et al. 2019). As waters in this region become warmer, turtles may remain longer; however, because temperatures will eventually (and at times rapidly) become inhospitable to turtles this climatic pattern may act as an "ecological trap," whereby large numbers of turtle cold-stun because they do not leave the region at seasonally appropriate times. Juvenile Kemp's ridley sea turtles are susceptible to cold-stunning (especially in years when the seasonal temperature drop occurs earlier in the fall) as they are migrating south to overwinter along the Florida coast (Liu et al. 2019).

Abundance

In the Kraus et al. (2016) surveys of the MA WEA and RI/MA WEA, during the three sampling years, the only confirmed sightings of Kemp's ridley sea turtles occurred within a four-week span in 2012 (one on August 23, four on September 12, and one on September 17, 2012). Opportunistic sampling from fishing and whale watching vessels indicate the presence of Kemp's ridley sea turtles in the Mid-Atlantic Bight, including around Rhode Island and Southern Massachusetts; 85% of the 14 records reported by Kenney and Vigness-Raposa (2010) were during the summer months (Kenney and Vigness-Raposa 2010). The AMAPPS surveys did not detect Kemp's ridley sea turtles near the Offshore Development Area (NEFSC and SEFSC 2011a, 2011b, 2012, 2014a, 2014b, 2015, 2016, 2018, 2019). However, the STSSN records indicate that Kemp's ridleys are the most common species to be found stranded within or near the Offshore Development Area. Assessing their abundance in this region with available data is challenging due to several factors. First, most of the individuals that occur along the eastern US coast are juveniles that have recently recruited from oceanic to more coastal habitats. These individuals tend to be too small to be detected in aerial surveys, as they are < 40 cm (16 in) SCL. Second, the shallow bays and estuaries that are often preferred habitats of Kemp's ridleys in the region have historically been excluded from survey designs, including Kraus et al. (2016). These two factors result in underestimates of Kemp's ridley abundance from aerial surveys and may also explain their relatively high numbers in stranding records. A third confounding issue is that the number of juvenile turtles entering the Atlantic Ocean from the Gulf of Mexico likely differs among years due to variation in hatchling production and ocean circulation dynamics and sporadic pulses of large numbers of smaller Kemp's ridley are possible (Putman et al. 2020a, 2020b).

4.8.1.4 Leatherback Sea Turtle (Dermochelys coriacea)

Leatherback sea turtles are the only remaining species of the family Dermochelyidae and are characterized by an extreme reduction of the bones of the carapace and plastron and a lack of scutes (i.e., bony plates) (Pritchard 1997). They are the largest of the sea turtles, reaching over 180 cm (71 in) CL. They are black in coloration on their dorsal surfaces with varying patterns of white spotting; ventrally they are mottled pinkish-white and black (NMFS and USFWS 1992).

The carapace has seven longitudinal ridges that taper to a blunt point. Their diet primarily consists of jellyfish and salps. They have also been known to feed on sea urchins, squid, crustaceans, tunicates, fish, blue green algae and floating seaweed (USFWS and NMFS 2015). Juveniles are oceanic and likely spend their early years in tropical waters until they reach a length of ~100 cm (39 in), when they can be found in more temperate waters (Eckert et al. 2012). The leatherback sea turtle is a highly migratory pelagic species that can be found in boreal and tropical waters throughout the world's oceans (Dodge et al. 2014; Plotkin 2002). Mean dive duration for leatherback sea turtles is approximately 10 minutes with mean surface interval time of five minutes, suggesting they spend about one third of their time at the surface (Eckert et al. 1989).

Status

The leatherback sea turtle was listed as endangered in 1970 (35 Fed. Reg. 8,491 [1970]). There are seven leatherback DPS, which include the Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian, Northeast Indian, West Pacific, and East Pacific. Many of these DPS (e.g., Eastern pacific) are in extreme risk of extinction. The Northwest Atlantic DPS seasonally occur within the Mid-Atlantic Bight within the Offshore Development Area. Leatherback nesting had been increasing for this DPS (Mazaris et al. 2017), however, there have been significant decreases in recent years at numerous locations. The Northwest Atlantic DPS consists of 55 nesting aggregations that extend from the French Guiana and Suriname in the south, throughout the Caribbean Sea, and northward along the east coast of Florida and minimal nesting in South Carolina and North Carolina. The total index of nesting female abundance is 20,659. Presently Trinidad hosts the largest rookery with ~29% of nesting females (NMFS and USFWS 2020). Nesting at relatively high abundance beaches (Trinidad, French Guiana, Suriname, and Costa Rica) appear to be in a downward trend.

Distribution

Leatherback sea turtles have thermoregulatory adaptations, including counter-current heat exchange systems, a high oil content, and large body size that allow them to have the widest geographical distribution of all sea turtles (Spotila et al. 2017). They occur as far north as British Columbia, Newfoundland, and the British Isles in the Northern Hemisphere. During the non-breeding season, the leatherback turtle undertakes long-distance migrations between its tropical and subtropical nesting grounds and high latitude foraging grounds in continental shelf and pelagic waters (Eckert et al. 2012). Leatherbacks are expected to occur seasonally in the Offshore Development Area. Leatherback sea turtles were the most frequently sighted turtle species in the MA WEA and RI/MA WEA and were predominantly observed from summer through fall (Kraus et al. 2016). The greatest number of leatherback sea turtle detections in the MA WEA and RI/MA WEA occurred in August, and in the fall, there was a high concentration of sightings south of Nantucket (Kraus et al. 2016). The greatest anticipated potential for interactions with leatherback sea turtles can therefore be expected in the Offshore Development Area during the summer and fall (Kraus et al. 2016).

Abundance

Modeled seasonal abundance patterns of leatherback sea turtles based on surveys conducted between October 2011 and June 2015 suggest that they are primarily present in the Offshore Development Area during summer and fall (Kraus et al. 2016). Estimated abundances in the survey area by Kraus et al. (2016) indicate that several hundred leatherbacks could occur in summer and autumn. A lack of winter and spring survey sightings are consistent with previous studies that suggest leatherback sea turtles are not expected to be present during these seasons (Kenney and Vigness-Raposa 2010). Data from recent leatherback sea turtle survey efforts corroborates historical data analyzed by Kenney and Vingess-Raposa (2010). Leatherback sea turtles were also the primary sea turtle species identified during follow-up surveys conducted in 2018-2019, with sightings mainly occurring south of Nantucket Island (O'Brien et al. 2021). The majority of observations occurred in the summer and fall, followed by two sightings in spring and none in the winter; 71 observations were recorded in August alone. Observations suggest a particularly heavy leatherback sea turtle presence just south of Nantucket and in the Muskeget Channel in the summer. Leatherback sea turtles are considered regular summer visitors in the nearshore waters of Rhode Island; though they rarely come further inshore than the mouth of the Narraganset Bay (Schwartz 2021). In the fall months, the majority of recorded observations occurred immediately south of Nantucket; there were no observations recorded in the Lease Area in the fall. In the spring, one observation occurred in waters between Nantucket and the Offshore Development Area and a second occurred just south of the Offshore Development Area. No leatherback sea turtles were observed in the MA WEA and RI/MA WEA during the AMAPPS surveys between 2009-2015 (Palka et al. 2017). Leatherback sea turtle data collected as part of the 2017-2018 AMAPPS II aerial surveys recorded one leatherback turtle observation outside of the MA WEA and RI/MA WEA, just north of Georges Bank (NEFSC and SEFSC 2018). One hundred-ninety leatherback sea turtle observations were recorded in STSSN reports of Massachusetts waters from 2015-2019 (SEFSC 2020). Observations included 121 stranding observations in the summer and 69 incidental captures in the summer and fall of 2015-2019. Based on the information above, it is expected for leatherback sea turtles to be common in the Lease Area and may co-occur with activities in the Offshore Development Area, particularly during the summer and fall and in the offshore export cable corridors due to its preference for foraging in shallow, coastal waters.

4.8.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect sea turtles during the construction, operations, O&M, and/or decommissioning of Vineyard Northeast are presented in Table 4.8-2.

Table 4.8-2 Impact Producing Factors for Sea Turtles

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Noise	•	•	•
Vessel Activity	•	•	•
Habitat Modification	•	•	•
Marine Debris	•	•	•
Entanglement and Entrapment	•	•	•
Electromagnetic Fields		•	
Reduction in Prey Availability			
Suspended Sediments and Deposition			
Artificial Light	•	•	•

Potential effects to sea turtles were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

4.8.2.1 Noise

In general, there is much less information available on sea turtle hearing and response to sounds compared to marine mammals. Several recent papers discuss the morphology of the turtle ear (e.g., Christensen-Dalsgaard et al. 2012; Willis et al. 2013) and the hearing ability of sea turtles (e.g., Martin et al. 2012; Dow Piniak et al. 2012a, 2012b; Lavender et al. 2014). Both Dow Piniak et al. (2016) and Ridgway et al. (1969) found that green sea turtles are most sensitive to underwater sounds between 50 and 1,600 hertz (Hz), with maximum sensitivity between 200 and 400 Hz. In loggerhead sea turtles, Bartol et al. (1999) found the range of effective hearing was between 250 and 750 Hz, while Martin et al. (2012) identified the greatest sensitivity in an adult to occur between 100 and 400 Hz. In post-hatchling and juvenile loggerheads, Lavender et al. (2014) estimated the range to be 50 to 1,100 Hz, with the greatest sensitivity between 100 and 400 Hz. Taken together, these studies indicate the upper limit of sea turtle hearing is approximately 1–1.5 kilohertz (kHz), with the greatest sensitivity from 100–400 Hz.

Acoustic Thresholds Used to Evaluate Potential Impacts to Sea Turtles

Injury, impairment, and behavioral thresholds for sea turtles were developed for use by the US Navy (Finneran et al. 2017) based on exposure studies (e.g., McCauley et al. 2000). Dual criteria (peak [PK] and sound exposure level [SEL]) have been suggested for permanent threshold shift (PTS) and temporary threshold shift (TTS), along with auditory weighting functions published by Finneran et al. (2017) used in conjunction with SEL thresholds for PTS and TTS. The behavioral threshold recommended in the National Marine Fisheries Service Greater Atlantic Regional Fisheries Office (NMFS GARFO) acoustic tool (NMFS GARFO 2020) is an sound pressure level (SPL) of 175 decibels (dB) relative to one microPascal (re 1 μPa) (McCauley et al. 2000; Finneran et al. 2017).

Table 4.8-3 summarizes the acoustic thresholds that are used to evaluate potential impacts to sea turtles from impact pile driving activities. For further discussion of acoustic thresholds for sea turtles, see Appendix II-E.

Table 4.8-3 Acoustic Metrics and Thresholds Used to Evaluate Potential Injury, TTS, and Behavioral Response for Sea Turtles

Faunal Group	Impulsive Signals				Behavior
	Injury (PTS)		Impairment (TTS)		
	L_{pk}	L_E	L_{pk}	L_E	L_p
Sea Turtle	232	204	226	189	175

Notes:
1. L_{pk} = peak sound pressure (dB re 1 μPa).
2. L_E = sound exposure level (dB re 1 $\mu Pa^2 \cdot s$).
3. L_p = root mean square sound pressure (dB re 1 μPa).

Foundation Installation

Foundation installation is expected to require impact pile driving and may also require the use of a vibratory hammer and/or drilling. A vibratory hammer could be used to install the foundation through surficial sediments in a controlled fashion to avoid the potential for a "pile run," where the pile could drop quickly through looser surficial sediments and destabilize the installation vessel. During vibratory pile driving, longitudinal vibration motion at the hammer's operational frequency and corresponding amplitude causes the soil to liquify, allowing the pile to penetrate into the seabed. Drilling could also be required if pile driving encounters refusal (e.g., due to a large boulder or bedrock). If drilling is required, a rotary drilling unit would likely be installed on top of the monopile or pin pile to remove obstructing material from the pile's interior.

There is substantial overlap in the frequencies that sea turtles can detect and the sounds produced by impact pile driving (see Appendix II-E). However, in the absence of absolute hearing threshold data, it is not possible to estimate how far away the sounds might be audible to sea turtles. Moein et al. (1994) and Lenhardt (2002) reported TTS for loggerhead turtles exposed to repeated low-frequency impulsive sounds. This suggests that sounds from impact pile driving might cause temporary hearing impairment in sea turtles if they do not avoid areas where such levels occur. However, it is unknown if lost or damaged sensory cells in the sea turtles' auditory system can regrow after a loss, as occurs in fish (Warchol 2011). Because of their rigid external anatomy, it is possible that sea turtles are protected from the impulsive sounds produced by pile driving (Popper et al. 2014).

Additionally, several monitoring studies indicate that some sea turtles do show localized movement away from low-frequency impulsive sounds. For example, McCauley et al. (2000b) and Moein et al. (1995) reported that sea turtles displayed avoidance reactions to low-frequency, impulsive seismic signals at levels between 166–179 dB. Sea turtles were also observed adjusting their behavior in response to seismic survey sounds by DeRuiter and

Doukara (2012). However, due to the nature of the studies, the extent of avoidance could not be determined. An avoidance response could help reduce the potential for auditory impacts since, when close to the sound source, received sound levels diminish rapidly with increasing distance from the source. Thus, even a small-scale avoidance response could result in a significant reduction in sound exposure. Pile driving activities are short-term, and the results of one investigation have suggested that, while sea turtles may avoid an area of active pile driving, they will return to the area upon completion (USCG 2006).

Acoustic masking is one of the main effects that anthropogenic sounds may have on marine animals (Peng et al. 2015; Vasconcelos et al. 2007). Masking can interfere with communication between individuals, localization of prey, avoidance of predators, and, in the case of sea turtles, identification of an appropriate nesting site (Nunny et al. 2008). While there is some evidence that sea turtles use sound to communicate, the few vocalizations described are restricted to the grunts of nesting females and the chirps, grunts, and complex hybrid tones of eggs and hatchlings (Cook and Forrest 2005; Ferrara et al. 2014; Mrosovsky 1972). Thus, potential masking is unlikely to interrupt communication among sea turtles. Similarly, sounds from impact pile driving will be produced far from potential nesting locations, so they will not disrupt the identification of suitable nesting sites. Nonetheless, the overlap of frequencies produced during impact pile driving and sea turtle hearing range means that some degree of masking is likely. The impact of masking on sea turtles is currently unknown (Dow Piniak et al. 2012a; Lucke et al. 2014) but given the apparent limited use of sound by sea turtles, especially in locations where they will be produced by Vineyard Northeast, any potential impacts are likely to be very limited.

The Proponent plans to select a noise abatement system (NAS) to reduce sound levels by a target of approximately 10 dB. Additional information on modelled acoustic ranges, exposure ranges, and exposure estimates can be found in Appendix II-E.

Vessel Noise

As described in Section 4.7.2.2, vessel use will occur during both the construction and O&M periods within the Offshore Development Area. The expected noise associated with vessel use within the Offshore Development Area is further described in Section 4.7.2.2. Sea turtles are regularly exposed to commercial shipping traffic as well as other vessel noise; therefore, sea turtle may habituate to vessel noise as a result of the regular exposure (BOEM 2014). Sounds associated with vessel transit and operation are expected to be lower than those associated with pile driving noise. Therefore, it is expected that the risk associated with sea turtle exposure to vessel noise is low given the low model predicted estimates of exposure to pile driving sound.

Potential Detonation of Unexploded Ordnances (UXO) and/or Discarded Military Munitions (DMM)

As described in Section 3.10.2 of COP Volume I, if potential UXO and/or DMM are discovered in the Lease Area or OECCs, the Proponent will prioritize avoidance of UXO/DMM wherever possible by micro-siting structures and cables around the object. Where avoidance is not possible (e.g., due to layout restrictions, presence of archaeological resources, etc.), UXO/DMM will be relocated or otherwise disposed of (e.g., via deflagration [burning without detonating], detonation, or dismantling the UXO/DMM to extract explosive components). The exact number and type of UXO/DMM that may be present, and which subset of those UXO/DMM cannot be avoided by micro-siting, are unknown at this time (further evaluation is ongoing). For the purposes of impact analyses, the Proponent conservatively assumes that up to two UXO in the Lease Area, four UXO in the Massachusetts OECC, and four UXO in the Connecticut OECC may need to be detonated in place (each detonation would occur on different days).

Underwater detonations create broadband impulsive sounds with high peak pressures and rapid rise times (Richardson et al. 1995). UXO/DMMs with more net explosive weight will produce higher peak pressures. For example, UXO/DMMs with 2.3 kg (5 pounds [lb]) may produce peak pressures of ~255 dB at 10 m (33 ft), while UXO/DMMs of 454 kg (1,000 lb) may produce peak pressures of over 270 dB at 10 m (33 ft). At close ranges, these sounds have the potential to cause non-auditory injury to sea turtles and at longer ranges, auditory injury and behavioral disturbance are possible. The unique nature of sounds and pressure into the water column from underwater detonations, including the high peak pressure levels and the fact that they are typically just a single impulsive event, means threshold criteria for UXO/DMMs detonations are different than for other anthropogenic sounds. Significant masking effects would be unlikely during UXO/DMM explosions given the intermittent nature of these sounds and short signal duration (Madsen et al. 2006).

Underwater acoustic modeling of detonations of UXO/DMM occurring within the Offshore Development Area was conducted. Technical details of the modeling methods, assumptions, and results can be found in Appendix II-E.

Wind Turbine Generators (WTGs)

As stated in Section 4.7.2.1, operating WTGs produce low levels of sound with source levels up to 151 dB root-mean-square sound pressure level SPL_{rms} in the 60 to 300 Hz frequency range (Dow Piniak et al 2012b). This overlaps the most sensitive hearing range of sea turtles (Bartol et al. 1999; Ridgway et al. 1969), but the low source levels mean it may only be detectable by sea turtles at short ranges. At longer distances from WTGs, it is unlikely for sea turtles to detect sound generated by WTGs when in the presence of ambient noise in the Offshore Development Area. With the larger turbines used by Vineyard Northeast, an increased distance from the noise source in the nacelle to the water is expected (Tougaard et al. 2020). Additionally, sea turtles may habituate to the low WTG noise level produced in the

Offshore Development Area (Moein et al. 1995). Due to the increased distance between the nacelle and the water and possible habituation, impacts to sea turtles from exposure to noise from WTGs is unlikely.

4.8.2.2 Vessel Activity

Vessel activity is a concern for sea turtles because they are susceptible to injury or death if struck by a boat and the issue is increasing as a management concern (Ataman et al. 2021; Fuentes et al. 2021). However, quantifying the magnitude of this risk is challenging, in part because sea turtles spend a majority of their time below the water surface where they will not be struck by a passing vessel. Nonetheless, a particularly thorough study across the coast of Florida found that the proportion of stranded turtles with vessel strike injuries increased from 1986 through 2014, coincident with the increasing number of registered vessels across the state (Foley et al. 2019). While these vessels are largely associated with recreational boating activities, it nonetheless suggests that increasing vessel traffic is likely to have a negative impact on sea turtles. Estimated sea turtle mortalities from vessel strikes in Florida alone (Foley et al. 2019) exceed mortality estimates for some major industrial fisheries operating across the entire southeast such as shrimp trawlers (Babcock et al. 2018). The ability of turtles to evade oncoming vessels decreases with vessel speed and boats traveling at speeds > 4 kilometers per hour (km/h) (~ 2.16 knots) are unlikely to be avoided by most turtles (Hazel et al. 2007). Avoidance by turtles is likely to be increased when auditory and visual information from vessels is available to turtles; thus, risks may be increased in noisy or lower visibility environments. Hazel et al. (2007) speculate that visual detection of oncoming boats best explains the avoidance behaviors of turtles observed in the wild. Reductions in vessel speed and watchful crew will help reduce the risks associated with potential vessel strikes. Proposed mitigation and monitoring measures to reduce vessel strike risk to marine mammals will provide protection to sea turtles as well. However, sea turtles are at low risk for vessel strike because they spend the majority of their time below the water surface. Further detailed vessel strike avoidance measures are described in Section 4.7.2.2.

4.8.2.3 Habitat Modification

The infrastructure associated with marine energy structures typically functions as reef-like habitat that is colonized by a variety of encrusting and sessile organisms along with fish and other species that use such habitats for shelter, foraging, and spawning. Sea turtles have been shown to shelter and forage at artificial reefs and there may be positive impacts to species, such as loggerhead sea turtles, if prey items are concentrated or enhanced by the addition of these structures as they are likely to be (Perry and Heyman 2020). However, there could be some indirect negative impacts from fishing activities that are likely to increase with the development of reef habitat and associated fish communities. Incidental capture by recreational or commercial fishers could occur and entanglement/drowning is a risk for turtles as lost fishing gear (e.g., snagged rope, nets, or monofilament line) may accumulate around these structures through time (Barnette 2017). The Proponent will inspect the foundations and scour protection at regular intervals for the presence of marine debris (see Section 4.2.2 of

COP Volume I) and will remove ghost gear and/or marine debris which may result in the entanglement of sea turtles. Assuming fisheries precautions are taken against bycatch and regular cleaning of the structures occurs, it is likely that any modification to habitat would be a net positive for sea turtles.

4.8.2.4 Marine Debris

Throughout the life of Vineyard Northeast, vessels and equipment operating in the Offshore Development Area will generate sanitary and other waste fluids, trash, and miscellaneous debris. Accidental discharges, releases, and disposal can pose a risk to sea turtles, as turtles are known to ingest debris in oceanic and nearshore habitats. The Mid-Atlantic Bight is currently considered a lower risk area for marine debris ingestion by sea turtles (Schuyler et al. 2016). Entanglement in marine debris lost overboard from vessels or from the structures during operation is also a concern. However, much of this problem appears to be related to lost fishing gear (e.g., monofilament lines and nets) (Carr et al. 1987; Laist 1997), and the scale of this issue is not likely to be a concern. The Proponent will require vessel operators, employees, and contractors who engage in offshore activities to participate in a marine trash and debris prevention training program. All waste streams will be properly managed in accordance with federal and state laws and best management practices will be implemented to avoid accidental release of debris to the marine environment and therefore not create an additional risk to sea turtles.

4.8.2.5 Entanglement and Entrapment

The direct risk of entanglement from construction and operation of the infrastructure associated with wind turbines is extremely low for turtles. The large monopile foundations are not shaped in a way that pose a risk to turtles, and the potential to "snag" rope or fishing gear (owing to lack of protrusions) is likely lower than other artificial reef designs (Barnette 2017). As stated in section 4.8.2.3, the Proponent will inspect the foundations and scour protection at regular intervals for the presence of marine debris (see Section 4.2.2 of COP Volume I) and will remove ghost gear and/or marine debris which may result in the entanglement of sea turtles. Therefore, it is unlikely that secondary entanglement of sea turtles in such debris would occur.

4.8.2.6 Electromagnetic Fields (EMF)

When electricity runs through a wire it produces an electric field and a magnetic field (MF) that radiates outward. The configuration and sheathing of the inter-array, inter-link and export cables that transmit electricity from wind WTGs and ESPs will block electric fields; however, MFs readily pass through sheathing into the environment. Although the intensity of any generated MFs will be minimized through cable burial or the placement of cable protection, this is a potential concern because many and diverse species rely on Earth's MF to guide their movements over a wide range of spatial scales (Putman 2022). Within the marine environment in particular, the ontogenetic shifts in habitat and seasonal migrations that characterize the life cycles of many animals are hypothesized to have evolved owing to the species' abilities to extract map-like and compass-like information from Earth's MF (Putman 2018). Given that Earth's MF is relatively weak, this implies an exquisite sensitivity of the receptor systems of these animals – even though the receptor mechanism for how animals detect MFs remains uncertain (Putman 2022).

Sea turtles have been at the forefront of research into how animals use Earth's MF for navigation. Use of the MF as a compass (i.e., maintaining a heading) has been demonstrated in loggerhead and leatherback turtles (Lohmann 1991; Lohmann and Lohmann 1993) and use of the MF as a map (i.e., to assess position) has been demonstrated in loggerhead and green turtles (Lohmann et al. 2001; Lohmann et al. 2004). The magnetic compass of loggerheads functions independently of light; distinguishes poleward and equatorward (rather than north and south) by comparing the direction of MF lines to the gravity vector (Light et al. 1993); can be entrained to visual cues (light) and vestibular cues (the orbital movement of waves) (Goff et al. 1998); and is disrupted by a strong (~1000x earth strength) but brief (4 millisecond) magnetic pulse (Irwin and Lohmann 2005). The magnetic map of loggerheads is based on their ability to independently detect both the inclination angle (the angular difference between the magnetic vector and gravity vector) and the total field intensity (MF strength) and relate these values to geographic regions (Lohmann and Lohmann 1994; Lohmann and Lohmann 1996). In laboratory studies, MFs differing by 1% of inclination angle (i.e., 0.7°) and 1% of total field intensity (i.e., 0.5 microtesla [µT]) elicited significantly different orientation behavior in hatchling loggerheads (Fuxjager et al. 2011). While no formal experiments have been conducted to determine the threshold of magnetic sensitivity in sea turtles, it is known that the sensitivity to magnetic cues allows turtles to assess both latitudinal and longitudinal information (Putman et al. 2011); to orient along their oceanic migratory route (Lohmann et al. 2012); and to maintain relatively fine-scaled population structure for females homing to their nesting beaches (Brothers and Lohmann 2018).

EMF modeling conducted for Vineyard Northeast (see Appendix II-O[61]) examined how MF deviations from the Earth's geomagnetic field would be altered under a range of different scenarios (e.g., whether the transmission lines were high-voltage alternating current [HVAC] carrying 1700 amps, high voltage direct current [HVDC] carrying 2,300 amps, buried at 1.5 m [5 ft], or placed directly on the seabed and covered with cable protection). While there are slight differences among these arrangements, the orders of magnitude of potential impact are similar. In all scenarios, the amount that Earth's total field intensity is predicted to deviate decreases rapidly with distance from the cable. Overall, the analysis shows >95 to >99% reductions in MF levels at lateral distances of ±7.6 m (±25 ft) from the centerlines of HVAC cables or HVDC cable bundles. The 60-Hz HVAC offshore export cables under consideration are considerably above the frequency range of Earth's steady (i.e., direct current [DC]) geomagnetic field to which magnetosensitive marine species such as sea turtles are specifically

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[61] Modeling was focused on export cables because inter-array cables are expected to have lower currents and MFs. Inter-link cables are expected to have similar or lower MFs.

tuned for navigation/migration purposes, and thus may not be detected by sea turtles. Nonetheless, frequencies of 0.1 to 85 megahertz (MHz), with magnetic magnitudes as low as 1 nanotesla (nT) (0.01 milligauss [mG]), have been reported to disrupt magnetic orientation in other animals—potentially by interacting with chemical reactions that allow detection of the MF (Granger et al. 2022; Leberecht et al. 2022). The "broadband electromagnetic noise" potentially produced by these cables has not been investigated, nor have the effects of electromagnetic noise on turtles.

In contrast to the uncertainty surrounding the HVAC cables, DC cable bundles will contribute to highly localized DC MF deviations from the Earth's geomagnetic field in the immediate vicinity of the cable bundles that would be detectable to sea turtles. This includes MF deviations at 3 m (10 ft) from the centerline of a cable bundle that range between -81.0 mG and +81.2 mG (-15.9% and +16.0% of the Earth's geomagnetic field) across the buried cable and surface-laid cable modeling scenarios. At the slightly greater distance of 7.6 m (25 ft) from the centerline of a cable bundle, MF deviations decreased to a range of -12.9 mG to +12.9 mG (-2.5% to +2.5% of the Earth's geomagnetic field). The percent change in MF deviations from the Earth's geomagnetic field is sufficiently strong out to at least 7.6 m (25 ft) from the center of a cable whereby changes in turtle orientation could occur. The field change out to 22.9 m (75 ft) of the cable center is 1.2 mG (0.23% of the Earth's MF) and may also be detectable to turtles. Previous experiments with sea turtles demonstrate brief (3-8 minute) exposures to a change in the MF of only 5 mG (0.5 μT) can result in significant differences in orientation (Fuxjager et al. 2011). Thus, it seems plausible that a change of 1.2 mG could also be detectable to turtles (especially given that the sensitivity shown in other species is potentially an order of magnitude lower than this value [Kirschvink and Gould 1981; Walker and Bitterman 1989; Dennis et al. 2007; Deigo-Rasilla and Phillips 2021]).

How the offshore cables influence the inclination angle or the local direction of magnetic north was not modeled, but alterations to those aspects of the MF could also influence turtle behavior (Klimley et al. 2021). Presumably, whatever impacts there are to turtles would be greater in shallower depths along the OECCs because a larger percentage of the water column would be exposed to detectable magnetic distortions. Sea turtle behaviors in these areas include both foraging and migration, and magnetic cues are especially important to sea turtles during migration (Avens and Lohmann 2003; Avens and Lohmann 2004; Putman 2018). Nonetheless, given that the scale of movement for turtles in this setting is quite large as they migrate towards broad, seasonal foraging grounds, the navigational task associated with migration may require less precise use of magnetic cues compared to female turtles attempting to relocate a specific nesting site. If this is the case, the effects of any one export cable would likely be negligible and the Vineyard Northeast cables are unlikely to result in significant impacts on sea turtle migration.

4.8.2.7 Reduction in Prey Availability

During the construction phase, disturbances to the seafloor may reduce benthic invertebrates that serve as prey to loggerhead sea turtles in the immediate area, but no long-term reduction in prey populations is expected. Moreover, the reef-like habitat created by these structures may be expected to increase prey abundances in this region over the lifetime of the WTG and ESP structures (Perry and Heyman 2020).

4.8.2.8 Suspended Sediments and Deposition

The impact of suspended sediments is unlikely to be a high risk for sea turtles. Any increase in suspended sediments is likely to be primarily during construction activities and impacts would be temporary and confined to a small area close to the location of the installation activity. Even so, green, loggerhead, and Kemp's ridley forage across a wide range of habitats, including in turbid waters of estuaries and bays (Witzell and Schimid 2004; Thomson et al. 2013) and any potential impacts are likely to be negligible. Further description of the potential for suspended sediments and deposition is provided in Section 3.2.

4.8.2.9 Artificial Light

During certain life-stages and under certain circumstances, sea turtles are highly attracted to artificial light. Immediately upon hatching, young turtles will orient towards bright lights when crawling on land but typically not after entering the sea (Salmon and Wyneken 1990; Lorne and Salmon 2007). Older turtles are attracted to "lightsticks" affixed to longline fishing gear underwater, resulting in bycatch (Wang et al. 2007). Interestingly, these same lightsticks reduce sea turtle entanglement in gillnets, presumably by allowing sea turtles to see and avoid the nets (Wang et al. 2010). Regardless, risk of impacts to turtles from artificial lights on vessels or structures above the surface of the water in offshore areas are likely to be low as there is no evidence of turtles, aside from hatchlings, being attracted to or avoiding lights in such contexts. Given the lack of sea turtle nesting beaches in this region, hatchling turtles are not expected to be present.

4.8.2.10 Summary of Avoidance, Minimization, and Mitigation Measures

Mitigation and monitoring measures will be implemented to reduce potential impacts on threatened and endangered sea turtle species during Vineyard Northeast activities. Avoidance, minimization, and mitigation measures for sea turtles will follow the same measures proposed for marine mammals (see Table 4.7-5). Measures proposed to reduce potential impacts on marine mammals are stricter than those required for sea turtles. Therefore, the measures are considered conservative and more protective when applied to sea turtle species. For example, implementing the use of a NAS for the protection of sea turtles minimizes the potential for both injurious and behavioral sound interaction. Further detail on specific mitigation and monitoring measures during construction activities can be found in Section 4.7.2.10 (see Table 4.7-5).

5 Socioeconomic Resources

5.1 Demographics, Employment, and Economics

This section addresses the potential impacts and benefits of Vineyard Northeast on demographics, employment, and economic baseline characteristics of the jurisdictions affected by Vineyard Northeast. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to demographics, employment, and economics during the construction, operation, and decommissioning of Vineyard Northeast.

5.1.1 Description of Affected Environment

The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts, and New London County, Connecticut. With respect to demographics, employment, and economics, the Onshore Development Area includes the counties in which Vineyard Northeast's onshore facilities, operations and maintenance (O&M) facilities, onshore construction staging areas, and/or port facilities may be located. For the purposes of this section, potential ports evaluated are located in Essex County, Massachusetts as well as Providence County and Washington County, Rhode Island. These port facilities are representative of facilities that may be utilized. See Table 3.10-1 of Construction and Operations Plan (COP) Volume I for a full list of ports that may be used during construction and Table 4.4-1 for ports that may be used during O&M.

Table 5.1-1 lists the communities included in the Onshore Development Area.

Table 5.1-1 Vineyard Northeast Affected Environment for Demographics, Employment, and Economics

County	Vineyard Northeast Components		Port Usage	
	Component	Municipality	Port Name	Municipality
Massachusetts				
Bristol County	Landfall site	Westport	New Bedford Marine Commerce Terminal and other areas in New Bedford	New Bedford
	Onshore cable route	Westport; Fall River; Somerset		
	Onshore substation site	Westport; Fall River; Somerset	Brayton Point Commerce Center	Somerset
Essex County	N/A	N/A	Salem Harbor	Salem

Table 5.1-1 Vineyard Northeast Affected Environment for Demographics, Employment, and Economics (Continued)

County	Vineyard Northeast Components		Port Usage	
	Component	Municipality	Port Name	Municipality
Connecticut				
New London County	Landfall site	New London; Groton; East Lyme	New London State Pier	New London
	Onshore cable route	Groton; Ledyard; Montville; Waterford; East Lyme		
	Onshore substation site	Montville		
Rhode Island				
Providence County	N/A	N/A	Port of Providence (ProvPort) and South Quay Terminal	Providence
Washington County	N/A	N/A	Port of Davisville (Quonset)	North Kingstown

Note:

1. Table 5.1-1 reflects representative ports. A full list of ports that may be used during Vineyard Northeast are provided in Table 3.10-1 and 4.4-1 of Volume I.

Demographic, employment, and economic baselines, including existing socioeconomic activities and resources in the onshore and coastal environment that may be affected by Vineyard Northeast are described in the sections that follow. Many of the coastal and ocean amenities that attract visitors to these regions are free for public access, thereby generating limited direct employment, wages, or gross domestic product (GDP). Nonetheless, these nonmarket features function as key attributes of the Onshore Development Area's coastal economy.

5.1.1.1 Demographics

Demographic characteristics of each state and county of the Onshore Development Area are summarized in Table 5.1-2. These data are compiled from United States (US) Census Bureau statistics and describe general population attributes of the Onshore Development Area (US Census Bureau 2021).

Table 5.1-2 Population and Income

Jurisdiction	Land Area (mi^2)	Population (2010)	Population (2020)	Percentage Change of Population (base year and recent year)	Population Density	Median Age
Massachusetts	7,800	6,547,629	7,029,917	7.4%	901.3	39.6
Bristol County	553	548,285	579,200	5.6%	1,086.7	41.0
Essex County	493	743,159	809,829	9.0%	1,642.7	40.9
Connecticut	4,842	3,574,097	3,605,994	0.9%	744.7	41.1
New London County	665	274,055	268,555	-2.0%	403.8	41.4
Rhode Island	1,034	1,052,567	1,097,379	4.3%	1,061.3	40.0
Providence County	410	626,667	660,741	5.4%	1,611.6	37.4
Washington County	329	126,979	129,839	2.3%	394.6	45.0

Massachusetts

Bristol County, located in the southeast coastal region of Massachusetts (see Figure 5.1-1), consists of 20 municipalities and it is the sixth most populous county of the state's 14 counties. Based on the US Census Bureau's 2020 Census, the population of Bristol County's largest cities, New Bedford and Fall River, is 101,044 and 94,000 residents, respectively. Bristol County is more densely populated than the statewide average, and its population increased by 5.6% from 2010 to 2020 (US Census Bureau 2022a).

Essex County, located in the northeast coastal region of Massachusetts (see Figure 5.1-2), consists of 34 municipalities and it is the third most populous county of the state's 14 counties. Based on the US Census Bureau's 2020 Census, the population of Essex County's largest cities, Lynn and Lawrence is 100,843 and 88,508 residents, respectively. Essex County is more densely populated than the statewide average, and its population increased by 9.0% from 2010 to 2020 (US Census Bureau 2022a).

Connecticut

New London County, located in the southeastern coastal region of Connecticut (see Figure 5.1-3), consists of 23 municipalities and it is the sixth most populous county of the state's eight counties. Based on the US Census Bureau's 2020 Census, the population of New London County's largest cities, Norwich and Groton, is 40,125 and 38,411 residents, respectively. New London County is less densely populated than the statewide average, and its population decreased by 2.0% from 2010 to 2020 (US Census Bureau 2022a).

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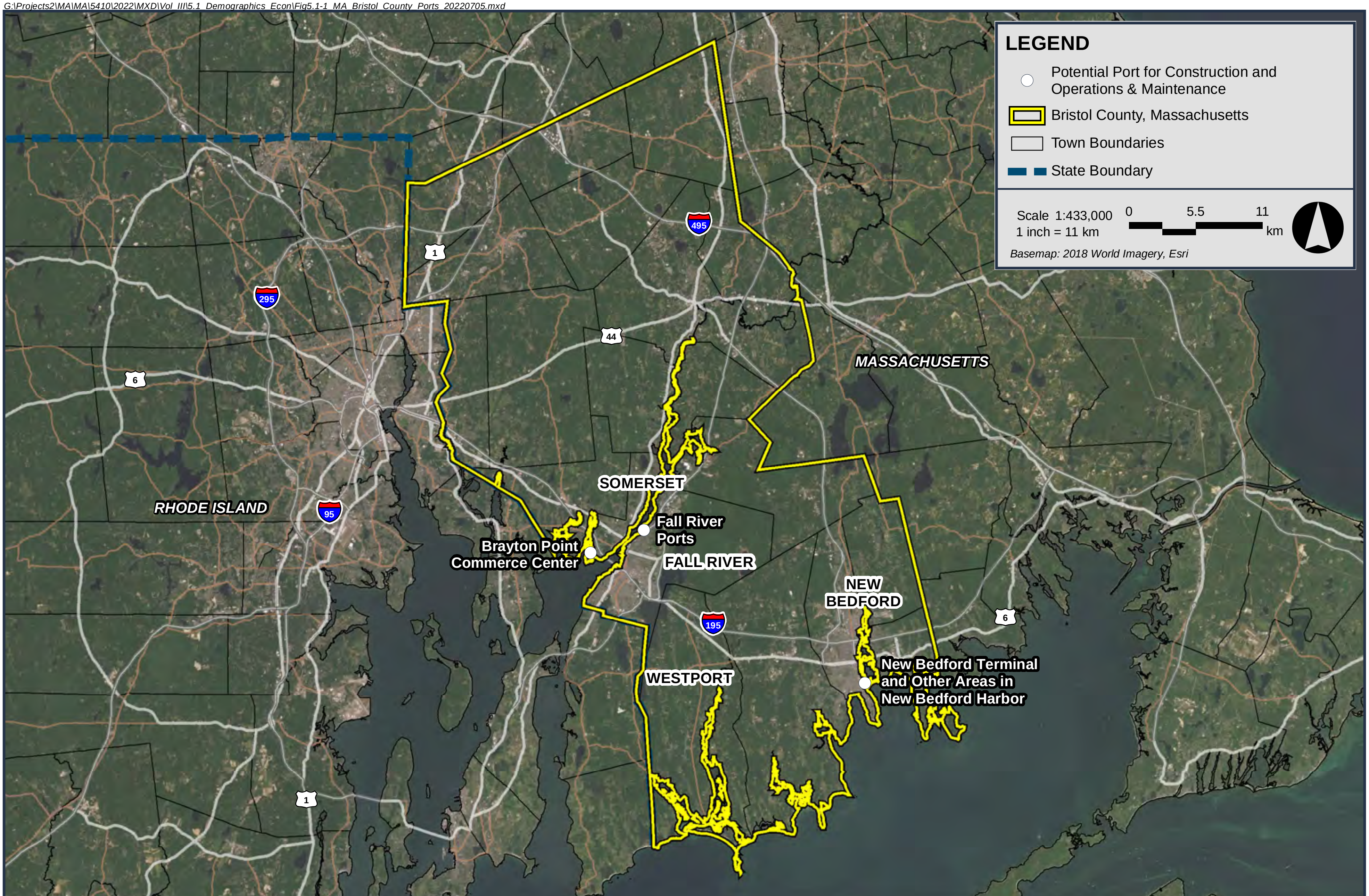

Figure 5.1-1
Bristol County, Massachusetts

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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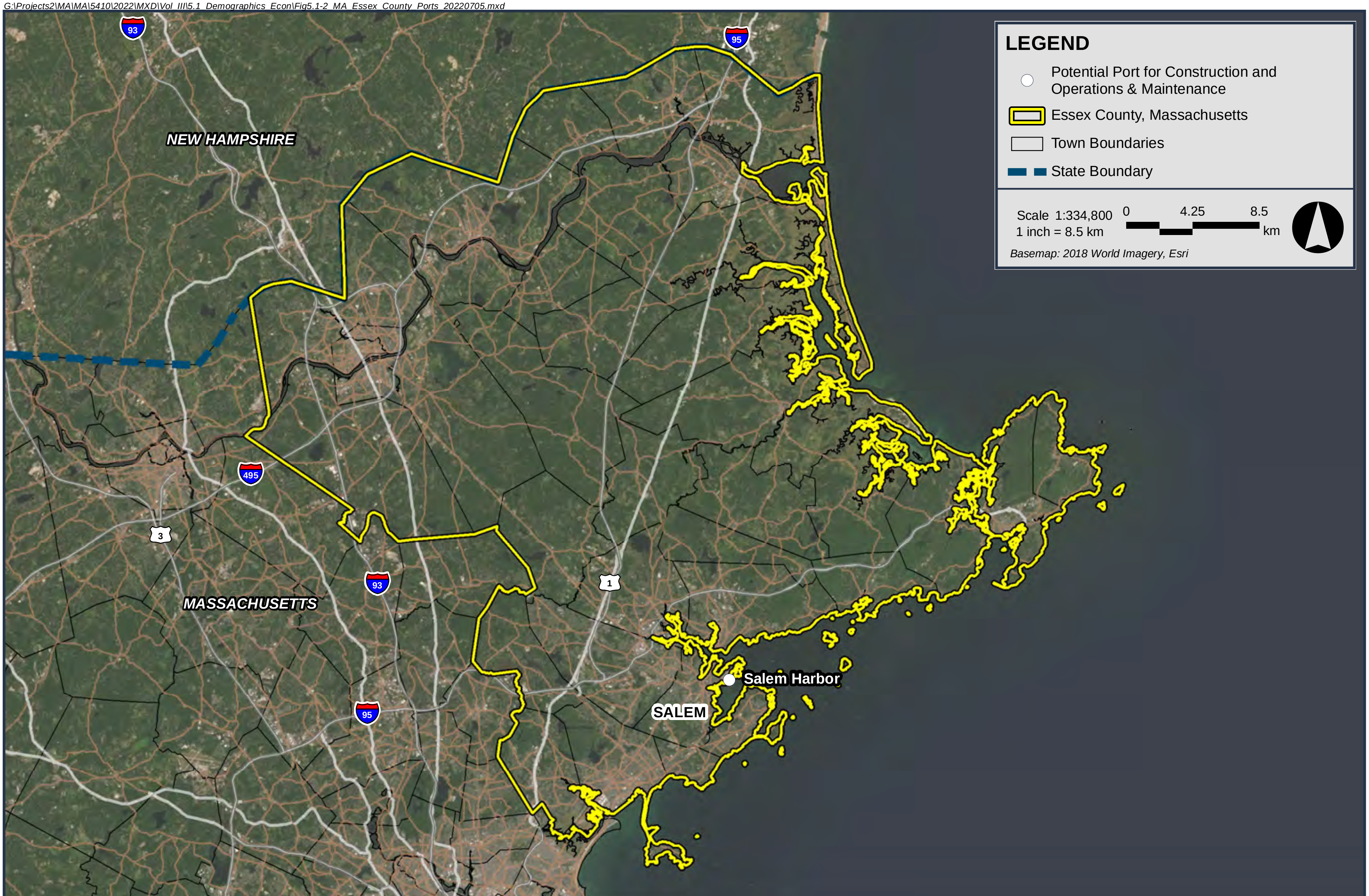

Figure 5.1-2
Essex County, Massachusetts

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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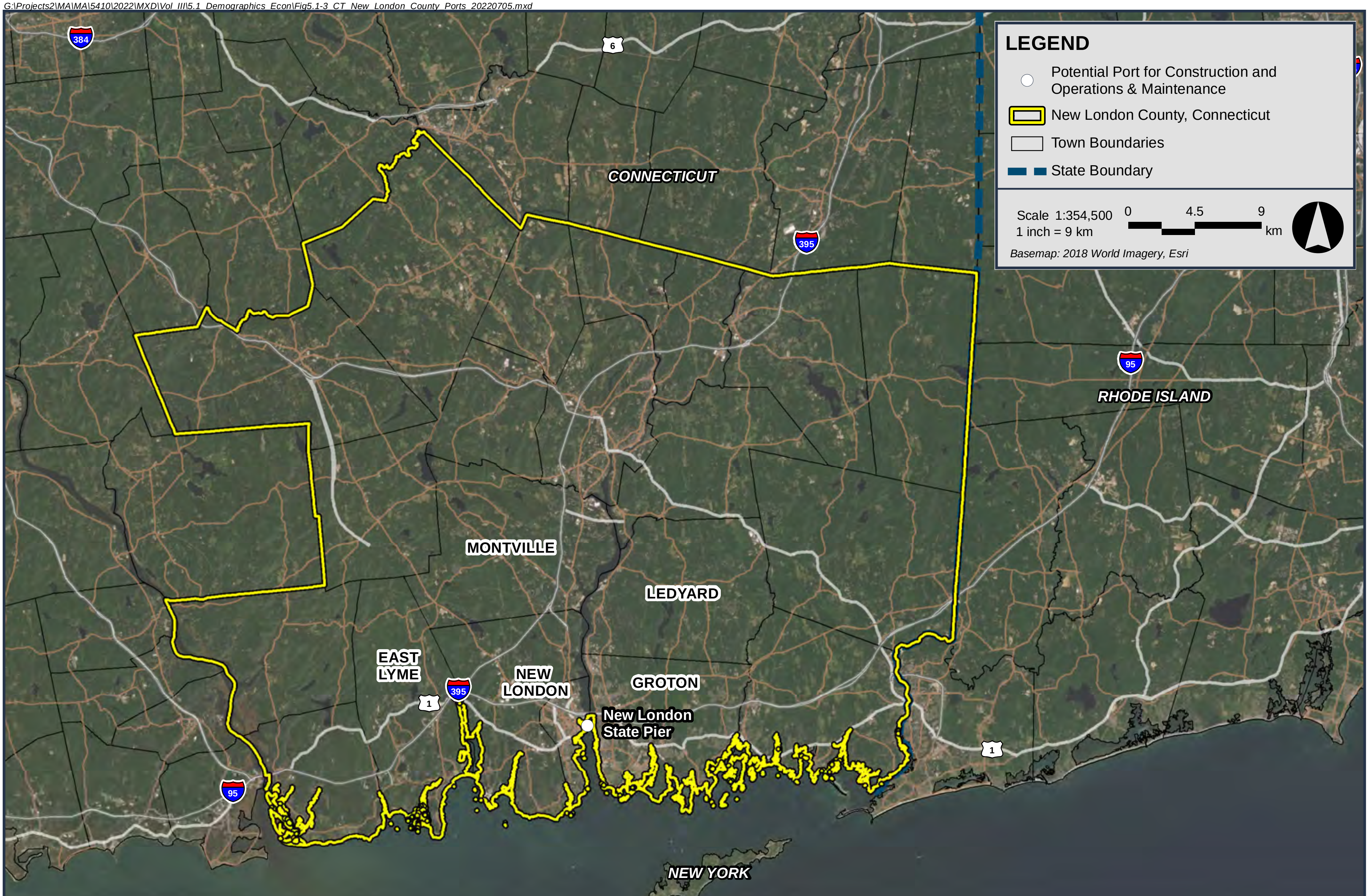

Figure 5.1-3
New London County, Connecticut

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Rhode Island

Providence County, located in the northernmost region of Rhode Island (see Figure 5.1-4), consists of 16 municipalities and it is the most populous county of the state's five counties. Based on the US Census Bureau's 2020 Census, the population of Providence County's largest cities, Providence and Cranston, is 190,284 and 82,566 residents, respectively. Providence County is more densely populated than the statewide average, and its population increased by 5.4% from 2010 to 2020 (US Census Bureau 2022a).

Washington County, located in the southwest of Rhode Island (see Figure 5.1-5), consists of nine municipalities and it is the third most populous county of the state's five counties. Based on the US Census Bureau's 2020 Census, the population of Washington County's largest towns, North Kingstown and South Kingstown is 31,623 and 27,825 residents, respectively. Washington County is less densely populated than the statewide average, and its population increased by 2.3% from 2010 to 2020 (US Census Bureau 2022a).

5.1.1.2 Housing

The following section describes general housing characteristics of each state and county within the Onshore Development Area. Data from the US Census Bureau (2021), summarized in Table 5.1-3, identify the total number of housing units, vacant housing units including those units intended for seasonal, recreational, or occasional use, and the number of housing units available for rental. These data are useful for understanding the availability and cost of housing within the Onshore Development Area.

Table 5.1-3 Housing Information of the Onshore Development Area

Jurisdiction	Housing Units	Vacant Housing Units	Housing Units for Rent	Housing Units for Seasonal, Recreational, or Occasional Use	Home-owner Vacancy Rate	Rental Vacancy Rate	Median Value	Median Gross Rent
Massachusetts	2,913,009	266,029	34,129	123,556	0.9%	3.3%	$398,800	$1,336
Bristol County	236,043	15,678	3,259	2,802	0.8%	3.8%	$317,800	$934
Essex County	313,956	16,702	2,829	5,236	0.8%	2.6%	$436,600	$1,298
Connecticut	1,521,199	135,762	27,938	29,669	1.5%	5.6%	$279,700	$1,201
New London County	123,849	14,233	1,467	4,981	1.9%	3.8%	$246,800	$1,144
Rhode Island	469,289	54,559	8,747	17,599	1.4%	5.1%	$276,600	$1,031
Providence County	266,624	25,738	5,954	1,183	1.5%	5.1%	$248,500	$989
Washington County	64,361	14,141	687	10,720	1.3%	5.1%	$359,300	$1,115

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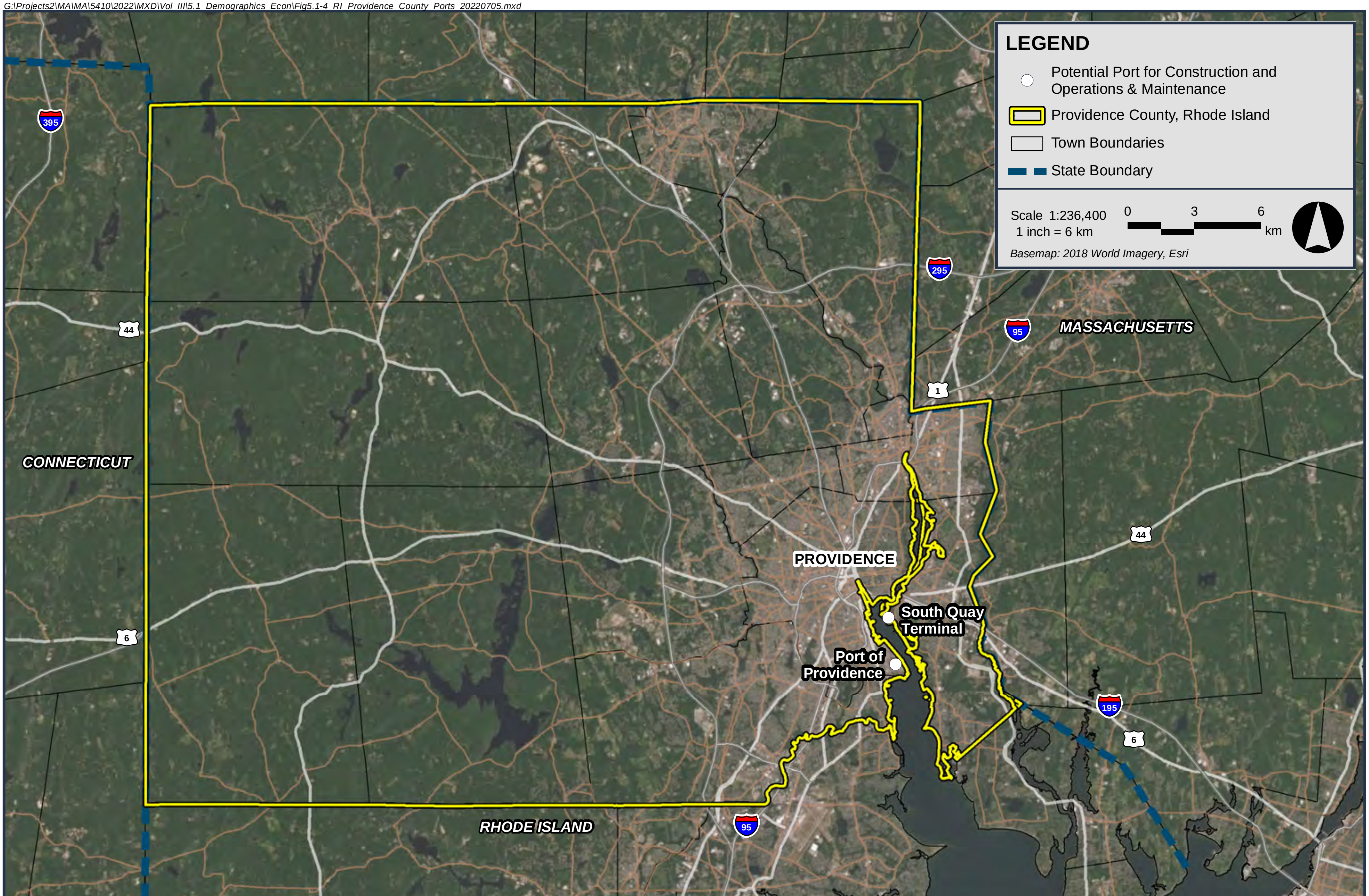

Figure 5.1-4
Providence County, Rhode Island

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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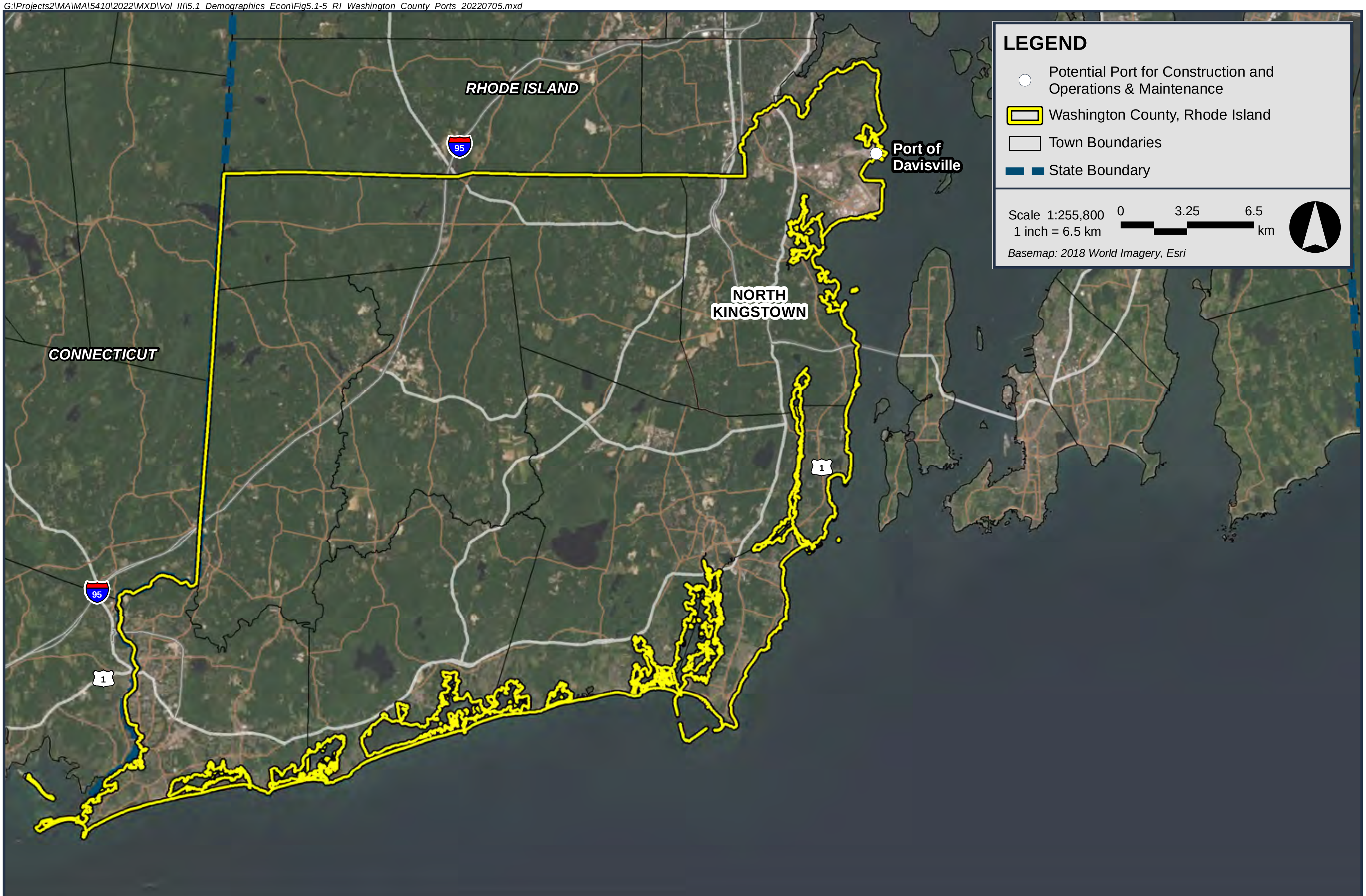

Figure 5.1-5
Washington County, Rhode Island

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Massachusetts

Bristol and Essex Counties contain approximately 18.9% of all housing units in Massachusetts. Homeowner vacancy rates in Bristol and Essex County are the same, and lower than the state average. The rental vacancy rate in Bristol County is greater than that of Essex County and the state average. When compared to vacant housing units, the proportion of housing units designated for seasonal, recreational, or occasional use in both counties is lower than that of the state; however, Essex County has a significantly higher proportion of units designated for seasonal, occupational, or occasional use than Bristol County.

Connecticut

New London County contains approximately 8.1% of all housing units in Connecticut. The homeowner vacancy rate in New London County is greater than the state average, while the rental vacancy rate is less than the state average. When compared to vacant housing units, the proportion of housing units designated for seasonal, recreational, or occasional use in New London County is greater than that of the state, suggesting New London County has a significant seasonal population.

Rhode Island

Providence and Washington Counties contain approximately 70.5% of all housing units in Rhode Island, most of which are located in Providence County which, alone, accounts for approximately 56.8% of all Rhode Island housing units. The homeowner vacancy rate in Providence County is similar to (and slightly greater than) the state average, and the Washington County homeowner vacancy rate is similar to (and slightly less than) the state average. When compared to vacant housing units, the proportion of housing units designated for seasonal, recreational, or occasional use in Providence County is significantly lower than that of the state. Washington County has a substantially higher proportion of units designated for seasonal, occupational, or occasional use than the state average, suggesting Washington County has a significant seasonal population.

5.1.1.3 Employment

The following section provides general labor force, income, and employment rates of each state and county within the Onshore Development Area. Data from the US Census Bureau (2021) are summarized in Table 5.1-4. Additional information about employment in specific industry sectors is provided in Section 5.1.1.4.

Table 5.1-4 Employment Information of the Onshore Development Area

Jurisdiction	Civilian Labor Force	Per Capita Income	Median Household Income	Unemployment Rate	Labor Force Participation Rate
Massachusetts	3,709,494	$45,555	$84,385	5.1%	67.2%
Bristol County	300,051	$36,900	$71,450	5.4%	65.1%
Essex County	432,253	$43,948	$82,225	5.2%	63.7%
Connecticut	1,923759	$45,668	$79,855	6.0%	66.0%
New London County	139,446	$40,995	$75,831	5.3%	66.4%
Rhode Island	566,403	$37,504	$70,305	5.5%	65.0%
Providence County	336,648	$32,739	$62,323	5.9%	64.6%
Washington County	68,921	$44,325	$86,970	5.9%	64.1%

Massachusetts

Essex and Bristol Counties have unemployment rates approximately equal to or greater than the state average, while labor force participation rates in each county are lower than the state average. Per capita and median household income in each county are less than the state average. According to data from the US Census Bureau (2022b), 52.2% of Essex County residents and 54.3% of Bristol County residents work outside of their respective counties.

Connecticut

The unemployment rate for New London County is less than the state average, while the labor force participation rate is slightly greater than the state average. Per capita and median household income of New London County is less than the state average. According to data from the US Census Bureau (2022b), 37.7% of New London County residents work outside of the county.

Rhode Island

Providence and Washington Counties have unemployment rates that are slightly greater than the state average, while labor force participation rates in each county are lower than the state average. Per capita and median household income in Providence County are less than the state average, whereas per capita and median household income in Washington County are greater than the state average. According to data from the US Census Bureau (2022b), 38.0% of Providence County residents and 58.4% of Washington County residents work outside of their respective counties.

5.1.1.4 Economy

The following section describes general economic characteristics and trends of each state and county within the Onshore Development Area by providing the GDP from the Bureau of Economic Analysis (2022) in Table 5.1-5 and the distribution of the civilian workforce by major industry sector using North American Industry Classification System (NAICS) codes based on US Census Bureau data (2021) in Table 5.1-6. The National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management data on "Ocean Economy" activities are also provided in Table 5.1-7. The categories for these activities are based on NAICS codes that depend on the ocean for inputs and include: Living Resources (such as commercial fishing, aquaculture, and seafood processing, and markets), Marine Construction, Marine Transportation, Offshore Mineral Resources, Ship and Boat Building, and Tourism and Recreation (NOAA 2022).

Table 5.1-5 GDP of the Onshore Development Area

Jurisdiction	Real GDP[1]		Percentage Change of GDP (2009-2019)	Percentage of US GDP	
	2009	2019		2009	2019
Massachusetts	$407,219.6	$517,727.1	27.1%	2.67%	2.72%
Bristol County	$20,760.5	$24,369.7	17.4%	0.14%	0.13%
Essex County	$35,557.7	$42,568.8	19.7%	0.23%	0.22%
Connecticut	244,894.7	251,495.1	2.7%	1.61%	1.32%
New London County	16,681.5	17,508.8	5.0%	0.11%	0.09%
Rhode Island	50,004.3	53,225.0	6.4%	0.33%	0.28%
Providence County	29,258.1	31,288.2	6.9%	0.19%	0.16%
Washington County	5,652.2	6,079.2	7.6%	0.04%	0.03%

Note:
1. Millions of chained 2012 dollars

Table 5.1-6 Percentage of Workforce Employment by Industry in the Onshore Development Area

Economic Sector	Massachusetts	Bristol County	Essex County	Connecticut	New London County	Rhode Island	Providence County	Washington County
Educational Services, and Health Care and Social Assistance	28.2%	26.7%	25.3%	26.5%	24.9%	27.4%	27.3%	28.0%
Professional, Scientific, and Management, and Administrative and Waste Management Services	14.4%	9.4%	14.0%	11.7%	9.0%	10.6%	10.3%	10.5%
Retail Trade	10.1%	12.6%	11.0%	10.5%	10.5%	11.6%	12.2%	10.8%
Manufacturing	8.8%	10.8%	10.6%	10.5%	13.9%	10.6%	11.2%	10.4%
Arts, Entertainment, and Recreation, and accommodation and Food Services	8.2%	8.3%	8.7%	8.3%	14.3%	10.0%	9.7%	11.7%
Finance and Insurance, and Real Estate and Rental and Leasing	7.3%	5.9%	6.9%	9.1%	4.5%	6.7%	6.3%	6.3%
Construction	5.8%	7.9%	5.7%	6.1%	5.9%	6.1%	5.9%	6.5%
Other Services, Except Public Administration	4.5%	4.4%	4.7%	4.6%	4.3%	4.6%	4.9%	4.1%
Transportation and Warehousing, and Utilities	4.0%	4.7%	4.3%	4.3%	4.0%	4.2%	4.5%	3.2%
Public Administration	3.8%	3.9%	4.0%	3.7%	5.2%	4.0%	3.7%	3.9%
Wholesale Trade	2.2%	3.2%	2.1%	2.4%	1.7%	2.2%	2.3%	2.0%
Information	2.2%	1.5%	2.1%	2.0%	1.3%	1.5%	1.5%	1.2%
Agriculture, Forestry, Fishing and Hunting, and Mining	0.4%	0.7%	0.4%	0.4%	0.6%	0.5%	0.3%	1.5%

Table 5.1-7 presents the ocean economy statistics for the Onshore Development Area.

Table 5.1-7 Ocean Economy in the Onshore Development Area

Jurisdiction	Ocean Economy GDP (2009]), Millions United States Dollar (USD)	Ocean Economy GDP (2019), Millions USD	Percentage Change of Ocean Economy GDP (2009-2019)	Ocean Economy as Percent of Total GDP (2019)	Individuals Employed in Ocean Economy (2019)	Number of Ocean Economy Establishments	Largest Ocean Economy Sector by Percentage of GDP
Massachusetts	$5,200.0	$8,200.0	57.7%	1.4%	100,067	5,983	Tourism & Recreation
Bristol County	$638.9	$780.3	22.1%	2.9%	6,565	486	Living Resources
Essex County	$495.3	$1,100.0	122.1%	2.4%	18,741	1,264	Tourism & Recreation
Connecticut	$3,800.0	$4,900.0	28.9%	1.7%	60,167	3,182	Tourism & Recreation
New London County	$1,800.0	$2,500.0	38.9%	13.7%	20,729	547	Suppressed
Rhode Island	$1,900.0	$3,300.0	73.7%	5.3%	45,897	2,452	Tourism & Recreation
Providence County	$538.8	$824.2	53.0%	2.1%	16,407	935	Tourism & Recreation
Washington County	$470.5	$1,200.0	155.0%	18.4%	11,079	516	Suppressed

Massachusetts

In 2019, the GDP of Bristol and Essex Counties were the sixth and fourth largest, respectively, of all 14 Massachusetts counties. Growth of Bristol County's GDP was less than the state average from 2009 to 2019 (see Table 5.1-5). The distribution of each county's workforce by industry sector, as shown in Table 5.1-6, is generally consistent with the state-wide distribution. Both counties have slightly smaller percentages of workforce in education services, health care, and social assistance compared to all of Massachusetts. The percentage of Bristol County's workforce in professional, scientific, management, administrative and waste management services is also notably less than the state percentage, while the construction and retail trade sectors are greater than the state percentage (US Census 2021). Based on NOAA (2022) data, the ocean economies of Bristol and Essex County accounted for 9.5% and 13.4%, respectively, of the Massachusetts ocean economy.

Connecticut

In 2019, the GDP of New London County was the fourth largest of all eight Connecticut counties. Growth of New London County's GDP was greater than the state average from 2009 to 2019. When compared to the distribution of the Connecticut workforce by industry sector, as shown in Table 5.1-6, the New London County workforce is more concentrated in the manufacturing and arts, entertainment, recreation, and accommodation and food services sectors (US Census 2021). Based on NOAA (2022) data, the ocean economy of New London County accounted for 51.0% of the Connecticut ocean economy.

Rhode Island

In 2019, the GDP of Providence and Washington Counties were the largest and third largest, respectively, of all five Rhode Island counties. Growth of Providence County's and Washington County's GDP was greater than the state average from 2009 to 2019. The distribution of each county's workforce by industry sector, as shown in Table 5.1-6, is generally consistent with the state-wide distribution. Washington County has modestly smaller percentages of workforce in the retail trade and transportation, warehousing, and utilities sectors compared to all of Rhode Island. The percentage of Washington County's workforce in the arts, entertainment, recreation, accommodation and food services sectors is notably greater than the state percentage (US Census 2021). Based on NOAA (2022) data, the ocean economies of Providence and Washington Counties accounted for 28.4% and 24.8%, respectively, of the Rhode Island ocean economy.

5.1.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect demographics, employment, and economics during the construction, O&M, and/or decommissioning of Vineyard Northeast are presented in Table 5.1-8.

Table 5.1-8 Impact Producing Factors for Demographics, Employment, and Economics

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Workforce Initiatives and Economic Activity	•	•	•
Housing	•		•
Procurement of Materials and Services	•	•	•
Port Utilization	•	•	•

Potential effects to demographics, employment, and economics were assessed using the maximum design scenario for Vineyard Northeast as described in Section 1.5.

5.1.2.1 *Workforce Initiatives and Economic Activity*

Vineyard Northeast is expected to result in significant long-term economic benefits, including considerable new employment opportunities. Vineyard Northeast will include a diverse workforce across a range of professions, engaging labor for fabrication, component assembly, other construction tasks, and maintenance of the offshore facilities. Construction and O&M activities are also anticipated to diversify and generate jobs and revenues in the "ocean economy" sectors, particularly for vessel owners and operators, dockage, fueling, inspection/repairs, provisioning, and crew work within the communities near any of the ports identified in Tables 3.10-1 and 4.4-1 of COP Volume I. Job opportunities will be created that increase employment stability, particularly within those sectors heavily influenced by seasonal hiring.

The Proponent commissioned Daymark Energy Advisors (Daymark) to develop an economic impact analysis report based on internal direct expenditure and job creation estimates to approximate the associated indirect and induced economic impacts that would materialize across the New England and Mid-Atlantic regions during the development, construction, and operation of Vineyard Northeast assuming a minimum capacity of approximately 2,600 megawatts (MW) (see Appendix II-S). These impact results include total estimated jobs, associated labor income, and economic output.[62] (Note the analysis specifically reviewed potential economic impacts to Massachusetts, New York, and New Jersey; potential impacts to these states are considered representative of potential impacts to the broader New England and Mid-Atlantic regions where the majority of economic impacts are expected to occur.) The outputs of this report serve as a conservative approximation of the expected minimum economic impacts[63] associated with the buildout of Vineyard Northeast.

The indirect and induced expenditure and job creation estimates included in the Vineyard Northeast economic impact analysis report were generated utilizing the IMPLAN model, for which the Proponent provided Daymark internal estimates of direct expenditure and direct full-time equivalent (FTE) job-years. As defined in Appendix II-S, direct benefits are realized directly from expenditures associated with the development, construction, and operation of Vineyard Northeast, including through the purchase of goods and services from Northeast-based businesses, direct employment in Vineyard Northeast, investment in supply chain and infrastructure development and workforce training, and other expenditures. Indirect benefits arise from the business-to-business transactions that are inherent within an industry's supply chain (for example, should a developer hire a contractor, and the contractor in turn leases a crane, that lease would be considered an indirect benefit). Lastly, induced economic benefits

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62 Output is the estimated value of all goods and services sold (i.e., expenditures other than payroll).

63 While Vineyard Northeast may deliver over 3 gigawatts (GW) of power, the minimum nameplate capacity required to remain technically and economically practicable or feasible is 2,600 MW; 2,600 MW is used in the economic impact analysis.

are also reported, which reflect household spending resulting from the direct investment. While induced benefits are included in Appendix II-S and summarized below, they are harder to track, measure, and verify, and they should therefore be viewed as less precise estimates than direct or indirect benefits.

When fully developed, constructed, and operational (assuming a 30-year operations period), Vineyard Northeast is expected to generate substantial economic benefits (see Appendix II-S). Table 5.1-9 presents the projected jobs and expenditures during pre-construction, construction, and operations and maintenance.

Table 5.1-9 Projected Jobs and Economic Impact During Pre-Construction, Construction, and Operations and Maintenance

Category		Total	Pre-Construction and Construction	Operations and Maintenance
Jobs (FTE Job-Years)[1]	Direct	9,396	4,656	4,740
	Indirect	9,716	4,712	5,005
	Induced	13,827	6,526	7,301
	Total	**32,939**	**15,894**	**17,046**
Direct Labor Income (millions in 2023$ present value)	Direct	$1,409	$850	$559
	Indirect	$727	$387	$340
	Induced	$684	$397	$288
	Total	**$2,820**	**$1,634**	**$1,187**
Output[2] (millions in 2023$ present value)	Direct	$5,079	$2,562	$2,516
	Indirect	$2,309	$999	$1,310
	Induced	$1,878	$1,088	$790
	Total	**$9,265**	**$4,650**	**$4,616**

Notes:

1. A FTE job year represents the FTE jobs multiplied by the number of employment years. One FTE job-year is the equivalent of one person working full time for 1 year (2,080 hours). Thus, two half-time employees would equal one FTE.
2. Output is the estimated value of all goods and services sold (i.e., expenditures other than payroll).
3. Values may not sum perfectly due to rounding.

Most of the direct pre-construction and construction jobs, and the direct O&M jobs, are anticipated to be located within the New England and Mid-Atlantic regions. A small number of personnel may temporarily relocate to the Onshore Development Area, including those with specialized technical skills or project-specific management experience. Additional workforce may be required for planned periodic maintenance of the onshore facilities, including the onshore export and grid interconnection cables, and periodic maintenance and repairs to the offshore facilities.

Economic activity associated with Vineyard Northeast is expected to result in a substantial positive impact on state and local tax receipts. Anticipated positive impacts include increased personal income tax, payroll tax, sales tax, property tax, corporate tax and other fee and tax revenues paid by the Proponent, its employees, and contractors (direct impacts) and taxes generated through the economic activities created in other areas of the economy through indirect and induced impacts. Additional information on potential tax benefits is found in Appendix II-S.

Vineyard Northeast is expected to provide steady, well-paying jobs that will have direct positive and stabilizing impacts on the workforce within the Onshore Development Area and will result in significant growth in sectors servicing the offshore wind industry. The Proponent is committed to working cooperatively with educational institutions and others to further develop training and educational opportunities for students and residents of the Onshore Development Area. As the development progresses, additional commitments are expected, and this section will be updated as needed.

5.1.2.2 Housing

The anticipated increase in employment opportunities during construction may result in an increased demand for temporary housing for workers and their families. As a result, the demand for temporary housing units may increase, potentially resulting in a decrease in vacancy rates and an increase in housing costs within the Onshore Development Area. Based on housing data presented in Section 5.1.1.2, the anticipated increase of workers relocating into the area is unlikely to be greater than the available number of housing units.

5.1.2.3 Procurement of Materials and Services

Construction and O&M activities are expected to result in the increased purchasing of construction and other materials, goods, and services in the Onshore Development Area, including the purchasing of domestic goods and services by the Vineyard Northeast workforce. Where feasible, construction and other materials, including vessel provisioning and servicing, will be sourced from within the Onshore Development Area. Impacts associated with the sourcing of materials and services are anticipated to have a stimulating effect on the Onshore Development Area's economy. The procurement of materials and services are anticipated to have location-specific effects, largely dependent on the magnitude of changes relative to existing local conditions.

5.1.2.4 Port Utilization

As described further in Section 3.10 and 4.4 of COP Volume I, Vineyard Northeast has identified several existing and planned ports to be utilized for construction and O&M. Each port under consideration for Vineyard Northeast is either located in an industrial waterfront area with sufficient existing infrastructure or where another entity may develop such infrastructure by the time construction proceeds. The Proponent has identified a wide range of potential staging ports due to the uncertainty in Vineyard Northeast's construction schedule(s) and to minimize any potential conflicts due to the expected demand for ports by other offshore wind developers in the coming years. The O&M facilities, which could be located at or near any of the ports identified in Table 4.4-1 of COP Volume I, are expected to support service operation vessels (SOVs), service accommodation and transfer vessels (SATVs), crew transfer vessels (CTVs), and/or other support vessels (see Section 4.4 of COP Volume I). The O&M facility would likely be used for dispatching technicians and crew exchange, bunkering, and loading supplies and spare parts onto vessels.

5.1.2.5 Summary of Avoidance, Minimization, and Mitigation Measures

Vineyard Northeast will result in significant long-term economic benefits and high-quality jobs. Accordingly, impacts associated with Vineyard Northeast will largely be beneficial to the Onshore Development Area. The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to demographics, employment, and economics during Vineyard Northeast are summarized below:

- Vineyard Northeast is expected to support a minimum of 15,894 direct, indirect, and induced full-time equivalent (FTE) job-years during pre-construction and construction. Construction of Vineyard Northeast is also estimated to generate at least ~$1.63 billion in total labor income and ~$4.65 billion in output.[64] The operation of Vineyard Northeast is projected to generate approximately 17,046 FTE job-years assuming a 30-year operational life (equivalent to 568 direct, indirect, and induced FTEs annually), as well as at least ~$1.19 billion in total labor income and ~$4.62 billion in total output.

- The Proponent is committed to working cooperatively with educational institutions and others to further develop training and educational opportunities for students and residents of the Onshore Development Area.

- The Proponent anticipates sourcing many goods and services throughout the multi-decade O&M period from local and regional providers.

- The Proponent recognizes the importance of early engagement with local municipalities and leaders to gain their input with respect to local workforce development and other opportunities. Meetings held between the Proponent and local agencies and elected officials are detailed in Appendix I-G. The Proponent will continue to coordinate closely with federal, state, local authorities, and other stakeholders in advance of construction to ensure that that the benefits of Vineyard Northeast are maximized within the Onshore Development Area.

- Monitoring, outreach, and communication plans for Vineyard Northeast are expected to be implemented, as necessary.

[64] Output is the estimated value of all goods and services sold (i.e., expenditures other than payroll).

5.2 Environmental Justice

This section addresses the potential impacts and benefits of Vineyard Northeast on Environmental Justice (EJ) communities surrounding the Offshore Development Area and Onshore Development Area. An overview of the affected environment and the characteristics of EJ communities is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to EJ communities during the construction, operation, and decommissioning of Vineyard Northeast. This section also evaluates whether EJ communities will bear any disproportionately high or adverse impacts as well as whether EJ communities will receive disproportionately low benefits from Vineyard Northeast.

Executive Order (EO) No. 12898,[65] *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, issued in 1994, requires federal agencies to identify and address any potential disproportionately high and adverse health or environmental effects of federal actions (such as projects requiring federal permits) on population groups of potential concern, including minority populations, low-income populations, and Native American tribes. EO No. 12898 has come to be known as Environmental Justice. EJ is defined by the Environmental Protection Agency (EPA) as:

> *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 that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or policies.*

EO No. 14096, *Revitalizing Our Nation's Commitment to Environmental Justice for All,* which was signed in April 2023, supplements EO No. 12898. The EO affirms the need for all federal agencies to better protect EJ communities and strengthen engagement with these communities. This includes promoting the latest science and research, expanding interagency coordination, and creating a new Office of Environmental Justice within the White House Council on Environmental Quality (CEQ).

In February 2022, the Bureau of Ocean Energy Management (BOEM) issued interim guidelines for identifying and characterizing EJ communities for offshore wind projects in the Atlantic (BOEM 2022). The EJ assessment presented below follows these guidelines, including how the geographical analysis area is defined and how the EJ communities are identified. Based on

[65] 59 FR 7629; February 16, 1994

BOEM's guidelines, this EJ assessment considers the following EJ populations: low-income populations, minority populations, and Native American tribes. These terms are defined further in Sections 5.2.1.1 and 5.2.1.2.

5.2.1 Description of Affected Environment

As specified in BOEM's EJ guidelines, the affected environment includes EJ communities surrounding the Offshore Development Area and Onshore Development Area. This includes EJ communities that may be affected by views of Vineyard Northeast's offshore facilities and onshore facilities.

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut, as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities. With respect to EJ, the Onshore Development Area includes the communities surrounding Vineyard Northeast's onshore facilities, operations and maintenance (O&M) facilities, onshore construction staging areas, and/or potential port facilities.

EJ communities within the Preliminary Area of Potential Effects (PAPE) for direct visual effects are also considered in this assessment. The PAPE for direct visual effects includes areas from which Vineyard Northeast would, with some certainty, be visible and recognizable under a reasonable range of meteorological conditions. For Vineyard Northeast's offshore facilities, the PAPE for direct visual effects includes onshore areas on Martha's Vineyard and Nantucket (and its adjacent outlying islands). For Vineyard Northeast's onshore facilities, the PAPE for direct visual effects is related to the onshore substations and a potential segment of overhead transmission lines across the Taunton River [redacted] (the remainder of the onshore cables will be underground).[66] The delineation of the PAPE for direct visual effects is further described in Section 6.2.3 and Appendix II-K.

Table 5.2-1 lists all counties with EJ communities that may be affected by Vineyard Northeast (see Figure 5.2-1 for the overall geographic analysis area).

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66 As shown in Table 5.2-1 and in Figures 5.2-2 and 5.2-7, the PAPE for direct visual effects from the onshore facilities includes areas within Bristol County, Massachusetts and New London County, Connecticut. [redacted]

Table 5.2-1 Vineyard Northeast Affected Environment for Environmental Justice

County	Presence of Onshore and/or Offshore Facilities[1]	Port Usage and O&M Facilities	Visibility of the Onshore and/or Offshore Facilities
Massachusetts			
Bristol	Landfall site, onshore cable route, onshore substation site, POI, and offshore export cables	Port of New Bedford, Fall River Ports, and Brayton Point Commerce Center	Yes (onshore facilities)
Essex	N/A	Salem Harbor	No
Dukes	N/A	Vineyard Haven Harbor	Yes (offshore facilities)
Nantucket	N/A	N/A	Yes (offshore facilities)
Connecticut			
New London	Landfall site, onshore cable route, onshore substation site, POI, and offshore export cables	New London State Pier	Yes (onshore facilities)
Fairfield	N/A	Port of Bridgeport	No
New Haven	N/A	Port of New Haven	No
New York			
Albany	N/A	Port of Albany-Rensselaer and Port of Coeymans	No
Rensselaer	N/A	Port of Albany-Rensselaer and New York State (NYS) Offshore Wind Port	No
Kings	N/A	South Brooklyn Marine Terminal, GMD Shipyard, and Red Hook Container Terminal	No
Richmond	N/A	Homeport Pier and Arthur Kill Terminal	No
Suffolk	Offshore export cables	Greenport Harbor, Shoreham, and Port Jefferson Harbor	No
Rhode Island			
Providence County	N/A	Port of Providence (ProvPort) and South Quay Terminal	No
Washington County	N/A	Port of Davisville (Quonset)	No
New Jersey			
Gloucester	N/A	Paulsboro Marine Terminal	No
Salem	N/A	New Jersey Wind Port	No

Note:

1. Onshore construction staging areas (i.e., equipment laydown and storage areas) would be proximate to the onshore cable routes. Communities that may be affected by the onshore cable routes may also be affected by onshore construction staging areas.

[redacted]

Since EO 12898 was issued, a number of state and federal guidance documents have been published to identify EJ populations and address EJ concerns. The EJ assessment presented herein was conducted in accordance with the following:

- BOEM's interim EJ guidance, *Environmental Justice Section of the Annotated EIS Outline Interim Process for Community Identification for Offshore Wind in the Atlantic* (BOEM 2022)
- EPA's EJScreen: Environmental Justice Screening and Mapping Tool (EPA 2023a, 2023b)
- EPA's *Technical Guidance for Assessing Environmental Justice in Regulatory Analysis* (EPA 2016)
- CEQ's (1997) *Environmental Justice: Guidance Under the National Environmental Policy Act*
- National Environmental Policy Act (NEPA) Committee and the Federal EJ Interagency Working Group's (EJ IWG) *Promising Practices for EJ Methodologies in NEPA Reviews* (NEPA Committee and EJ IWG 2016)
- The Commonwealth of Massachusetts' Environmental Justice Policy (EJ Policy) (Executive Office of Energy and Environmental Affairs [EEA] 2021)
- The Connecticut Public Act 20-6 *An Act Concerning Enhancements to the State's Environmental Justice Law* (Section 22a-20a of the Connecticut General Statutes [CGS])
- The Connecticut Department of Energy and Environmental Protection (CT DEEP) Environmental Equity Policy (CT DEEP 1993)
- The New York State Department of Environmental Conservation (NYSDEC) Commissioner Policy CP-29: *Environmental Justice and Permitting* (NYSDEC 2003)
- New York State Climate Justice Working Group (NYSCJWG) Draft Disadvantaged Communities Criteria and List Technical Documentation (NYSCJWG 2022)
- The Rhode Island Department of Environmental Management's (RIDEM's) Draft Environmental Justice Policy (RIDEM 2022)
- New Jersey Environmental Justice Law, N.J.S.A. 13:1D-157 (NJDEP 2020)
- New Jersey Department of Environmental Protection's *Environmental Justice: Mapping, Assessment, and Protection (EJMAP): Technical Guidance* (NJDEP 2022)

The federal and state criteria for identifying EJ communities included in these guidance documents are summarized in Table 5.2-2 and described in detail in Sections 5.2.1.1 and 5.2.1.2. This EJ assessment considers all populations identified as EJ communities based on both the federal and state criteria. Other communities that may not be fully captured by the federal and state EJ criteria, such as Native American tribes and low-income and minority workers who rely on commercial and recreational fishing, are discussed in Section 5.2.1.3. Section 5.2.1.4 summarizes all EJ communities that may be affected by Vineyard Northeast.

Table 5.2-2 Environmental Justice Community Identification Standards

Geography/Indicator	Indicator Definition	Threshold for EJ Community
Federal		
Low-income population	A household whose annual income is less than twice the federal poverty level, as set by the United States (US) Census Bureau.[1]	If the low-income population exceeds 50% of the total population or is meaningfully greater[2] than the general population.[3]
Minority population	American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; Hispanic.	If the minority population exceeds 50% of the total population or is meaningfully greater[2] than the general population.
Massachusetts		
Low-income population	Based on annual median household income in the state.	The annual median household income is not more than 65% of the statewide annual median household income.
Minority population	Latino/Hispanic, Black/African American, Asian, Indigenous people, and people who otherwise identify as non-white.	Minorities comprise 40% or more of the population.
English isolation	English proficiency in no one over 14 years old in the household.	25% or more of households lack English proficiency.
Combined (low-income and minority)	Same as above.	Minorities comprise 25% or more of the population and the annual median household income of the municipality does not exceed 150% of the statewide annual median household income.
Connecticut		
Low-income population	Census block where the population is living below 200% of the federal poverty level.	30% or more of the population consists of low-income persons.
Minority population	Not considered in EJ definition.	
Distressed Municipality	Score based on fiscal and economic indicators such as the tax base, resident's income, and the resident's need for public services.	Towns are ranked based on several criteria (e.g., per capita income, percent of poverty, unemployment). The top 25 towns with highest total scores are designated as Distressed Municipalities.

Table 5.2-2 Environmental Justice Community Identification Standards (Continued)

Geography/Indicator	Indicator Definition	Threshold for EJ Community
New York[4]		
Low-income population	A population having an annual income that is less than the federal poverty level.	A low-income population equal to or greater than 22.82% of the total population.[5]
Minority population	Hispanic; African American or Black; Asian and Pacific Islander; or American Indian.	Having a minority population equal to or greater than 52.42% of the total population in an urban area and 26.28% of the total population in a rural area.[5]
Disadvantaged Communities (DACs)	Identified based on 45 indicators related to environmental burden, climate change risk, population characteristics, and health vulnerabilities. DACs include census tracts where individual members are considered by the US Census Bureau to be part of an American Indian and Alaska Native population or where at least 5% of the land is federally designated reservation territory or State-recognized Nation-owned Land.	Census tracts are ranked in terms of both "Environmental and Climate Change Burdens and Risks" and "Population Characteristics and Health Vulnerabilities." DACs have either: (a) high-to-moderate scores on both components, or (b) a high score on one component, and moderate score on the other component.
Rhode Island		
Low-income population	Based on annual median household income in the state.	Annual median household income is not more than 65% of the statewide annual median household income.
Minority population	Hispanic; African American or Black; Asian and Pacific Islander; or American Indian.	Minority population is equal to or greater than 40% of the population.
English proficiency	English proficiency.	25% or more of the households lack English language proficiency.
Combined (low-income and minority)	Same as above.	Minorities comprise 25% or more of the population and the annual median household income of the municipality does not exceed 150% of the statewide annual median household income.
New Jersey[6]		
Low-income household	A household that is at or below twice the poverty threshold as determined by the US Census Bureau.	At least 35% of the households are low-income.
Minority population	A population who does not identify as a single race white and non-Hispanic. Minority populations include: Black, Hispanic, Asian-American, American Indian or Alaskan Native.	At least 40% of the residents identify as minority or a member of a state-recognized tribal community.

Table 5.2-2 Environmental Justice Community Identification Standards (Continued)

Geography/Indicator	Indicator Definition	Threshold for EJ Community
New Jersey[6] (Continued)		
Limited English proficiency	A household without an adult that speaks English "very well" as determined by the US Census Bureau.	At least 40% of the households have limited English proficiency.

Notes:
1. Definition from EJScreen technical documentation (EPA 2023b).
2. The 80th percentile is used as the threshold for "meaningfully greater." That is, a community is identified as minority or low-income if it is in the 80th or higher percentile for minority or low-income status as compared to the state population.
3. Threshold as defined by BOEM's interim EJ guidance (BOEM 2022).
4. New York City has slightly different criteria than New York State; the State criteria are listed and used in the EJ analysis.
5. These criteria define the Potential EJ Areas (see NYSDEC 2020).
6. EJ communities in New Jersey are termed "Overburdened Communities" and are identified using the criteria outlined in the table for low-income household, minority population, and limited English proficiency.

EJ assessments are based on statistics primarily obtained from United States (US) Census Bureau datasets. These datasets include the last full-count census (currently dated 2020), which is re-done every decade, the rolling five-year American Community Survey (ACS) estimates from smaller annual survey samplings (utilized by EPA in EJScreen), or one-year smaller survey estimates.

5.2.1.1 Federal EJ Criteria

The federal EJ criteria for a minority population group are defined by CEQ's (1997) *Environmental Justice Guidance Under the National Environmental Policy Act*. CEQ defines a minority as "individual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic." CEQ identifies a minority EJ population (or community) as one where either: (1) the minority population of the affected area exceeds 50%, or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. CEQ defines low-income populations based on the annual statistical poverty thresholds from the US Census Bureau's Current Population Reports Series P-60 on Income and Poverty, but does not provide a threshold level for identifying a low-income population or community.

Therefore, for the purposes of this EJ assessment, criteria from BOEM's interim EJ guidance (BOEM 2022) and data from EJScreen were used to identify an EJ community at the federal level. EJScreen data is from ACS version (v) 2022, which includes ACS five-year summary data from 2016–2020 based upon 2020 census block group boundaries. Communities were identified as EJ communities if the minority or low-income population in the block group is greater than 50% or if the block group is in the 80th percentile or greater compared to all other block groups in the state for minority or low-income status. The 80th percentile criteria are used as a proxy for the term "meaningfully greater." The federal EJ community criteria used in this analysis are summarized in Table 5.2-2 above.

5.2.1.2 State-Specific EJ Policies

The EJ community criteria specific to the states that may be affected by Vineyard Northeast activities are summarized above in Table 5.2-2 and described in the following sections.

Massachusetts

EJ populations are the focus of the state's EJ Policy, which establishes EJ as a key consideration in all EEA programs when applicable and allowable by law (EEA 2021). Specifically, as stated in the state's EJ Policy (EEA 2021):

> *It is the policy of the Executive Office of Energy and Environmental Affairs that environmental justice principles shall be an integral consideration, to the extent applicable and allowable by law, in making any policy, making any determination or other action related to a project review, in undertaking any project…. including but not limited to, the grant of financial resources or technical assistance, the promulgation, implementation and enforcement of laws, regulations, and policies, the provision of access to both active and passive open space, and the diversification of energy sources, including energy efficiency and renewable energy generation.*

In Massachusetts, an EJ population is defined as a neighborhood (census block group) that meets one or more of the following criteria:

- The annual median household income is not more than 65% of the statewide annual median household income;
- Minorities comprise 40% or more of the population;
- 25% or more of households lack English language proficiency; or
- Minorities comprise 25% or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150% of the statewide annual median household income.

The Massachusetts Environmental Justice Maps were last updated in 2022; this update included EJ communities based on 2020 census block groups and data from 2016–2020 ACS five-year estimates.

Connecticut

It is the policy of CT DEEP that, "no segment of the population should, because of its racial or economic makeup, bear a disproportionate share of the risks and consequences of environmental pollution or be denied equal access to environmental benefits. The Department is committed to incorporating environmental equity into its program development and implementation, its policy making and its regulatory activities" (CT DEEP 2024).

Connecticut's state-level criteria for an "Environmental Justice Community" uses the following definitions contained in Connecticut's Public Act 20-6, *An Act Concerning Enhancements to the State's Environmental Justice Law*:

- A census block group, as determined in accordance with the most recent US census, for which 30% or more of the population consists of low-income persons who are not institutionalized and have an income below 200% of the federal poverty level; or
- A Distressed Municipality, as discussed below.

The 2022 EJ census block groups were determined using data from the 2016–2020 ACS five-year estimates. Distressed Municipalities are scored based on fiscal and economic indicators including the tax base, personal income of residents, and the residents' need for public services; the top 25 towns with the highest total scores are designated as Distressed Municipalities. The Department of Economic and Community Development (DECD) maintains a list of Distressed Municipalities, which are used by state agencies to target funding for housing, insurance, open space, brownfield remediation, and economic development programs.

New York

NYSDEC's policy related to EJ, Commissioner Policy CP-29: *Environmental Justice and Permitting,* "provides guidance for incorporating environmental justice concerns into the NYSDEC environmental permit review process and the NYSDEC application of the State Environmental Quality Review Act. The policy also incorporates environmental justice concerns into some aspects of the NYSDEC's enforcement program, grants program and public participation provisions" (NYSDEC 2003).

NYSDEC (2020) identifies "Potential EJ Areas" as census block groups that meet or exceed at least one of the following statistical thresholds:

1. At least 52.42% of the population in an urban area reported themselves to be members of minority groups;
2. At least 26.28% of the population in a rural area reported themselves to be members of minority groups; or

3. At least 22.82% of the population in an urban or rural area had household incomes below the federal poverty level.

The federal poverty level and urban/rural designations for census block groups are established by the US Census Bureau. The thresholds are based on statistical analysis of the 2014–2018 ACS data, which was the most recent data available at the time of the analysis in 2020.

New York City has slightly different thresholds for EJ populations than New York State. For low-income communities, New York City defines EJ populations as those where 23.59% or more of the total population is below the federal poverty level. New York City defines minority communities as those where the minority population is greater than or equal to 51.1% of the total population. For the purposes of this EJ assessment, New York State thresholds were used.

In addition to defining Potential EJ Areas, the New York State Climate Justice Working Group finalized criteria for defining "Disadvantaged Communities" (DACs). The Working Group's goal is to advance the implementation of the Climate Leadership and Community Protection Act ("Climate Act"). Under the Climate Act, DACs are defined as "communities that bear burdens of negative public health effects, environmental pollution, impacts of climate change, and possess certain socioeconomic criteria, or comprise high-concentrations of low- and moderate- income households." DACs are identified based on a set of 45 indicators that include environmental burden, climate change risk, population characteristics, and health vulnerabilities (NYSCJWG 2022). Census tracts must rank relatively high in terms of both "Environmental and Climate Change Burdens and Risks" and "Population Characteristics and Health Vulnerabilities" (or very high in one of these categories) to be identified as a DAC. DACs also include census tracts where individual members are considered by the US Census Bureau to be part of an American Indian and Alaska Native population or where at least 5% of the land is federally designated reservation territory or State-recognized Nation-owned Land, regardless of indicator scores. The DAC criteria will be used to prioritize these communities with regard to reducing air pollution and greenhouse gas emissions, as well as in regulatory impact statements and in the allocation of investments in clean energy and energy efficiency.

Rhode Island

RIDEM has published a Draft *Environmental Justice Policy*, which "represents DEM's ongoing commitment and dedication to the State of Rhode Island and the people who live within its communities who are often disproportionately impacted by environmental issues and lack of access to natural resource opportunities" (RIDEM 2022).

As specified in the draft EJ Policy, Rhode Island has identified "Environmental Justice Focus Areas," which are the same as EJ communities, as a census tract that meets one or more of the following criteria:

- Annual median household income is not more than 65% of the statewide annual median household income;

- Minority population is equal to or greater than 40% of the population;
- 25% or more of the households lack English language proficiency; or
- Minorities comprise 25% or more of the population and the annual median household income of the municipality does not exceed 150% of the statewide annual median household income.

There are some areas of Rhode Island that are not EJ communities but may be considered EJ communities using the above criteria because of the inclusion of prisons in the area or seasonal student populations that might be counted as non-white populations with low or no income. This is a limitation of how the US Census Bureau compiles demographic statistics at the census block level. For example, the Quonset Point and the Newport Naval Base areas of Narragansett are comprised of primarily seasonal homes that are used by University of Rhode Island students during the school year. This means that this assessment is likely overcounting the EJ communities in some areas of Rhode Island.

New Jersey

In 2020, New Jersey published its Environmental Justice Law requiring "the New Jersey Department of Environment Protection to evaluate the environmental and public health impacts of certain facilities on overburdened communities when reviewing certain permit applications" (NJDEP 2020).

The law defines an "Overburdened Community" (equivalent to an EJ community) as a census block group where:

- At least 35% of the households qualify as low-income households (at or below twice the federal poverty level);
- At least 40% of the residents identify as minority or members of a state-recognized tribal community; or
- At least 40% of the households have limited English proficiency (a household without an adult that speaks English "very well," as determined by the US Census Bureau).

In addition, New Jersey identifies "adjacent block groups" as a "block group identified by the US Census Bureau with a population of zero that are also immediately next to one or more statutorily defined overburdened communities" (NJDEP 2022).

The EJ map for New Jersey used in the analysis is based on data from the five-year ACS for 2016–2020.

5.2.1.3 Other Communities

This EJ assessment considers Native American tribes as well as low-income and minority workers who are employed in commercial fishing, for-hire recreational fishing, and supporting industries (e.g., seafood processing and distribution, vessel and port maintenance) or who rely on recreational fisheries as a food source and may be impacted by Vineyard Northeast-related activities.

EPA's EJ policies recognize the need to consider Native American tribes that may not be included in the definition of minority (EPA 2016). Communities with federally or state-recognized Native American tribes that may not fall under the federal or state definition of minority were identified using US Census Bureau Geographic Information System (GIS) data (US Census Bureau 2022).[67] The GIS data were obtained from the ACS and include "American Indian and Alaska Native legal and statistical areas," such as federally recognized American Indian reservations and off-reservation trust land areas, state-recognized American Indian reservations, tribal designated statistical areas, and state-designated tribal statistical areas (US Census Bureau 2022).

Along with identifying federal or state-recognized Native American tribes, there are some areas that are considered traditional cultural properties (TCPs), which may be impacted by Vineyard Northeast-related activities. These include the Chappaquiddick Island TCP (western portion of Martha's Vineyard), the Nantucket Sound TCP, and the Vineyard Sound and Moshup's Bridge TCP (encompasses the Elizabeth Islands, Vineyard Sound, and the western portion of Martha's Vineyard). TCPs are discussed in more detail in Appendix II-K.

As further described in Sections 5.3 and 5.4, Vineyard Northeast-related activities may impact commercial and recreational fisheries, which may, in turn, affect EJ communities who rely on these industries. National Oceanic and Atmospheric Administration (NOAA) Fisheries' Community Social Vulnerability Indicators were used to evaluate potential EJ populations in the geographic analysis area that also have a high level of "fishing engagement" or "fishing reliance" (NOAA 2019). Fishing engagement indicates that there is a relatively large amount of commercial or recreational fishing activity in the area (e.g., based on permits, fish dealers, etc.), whereas fishing reliance is a measure of the amount of commercial or recreational fishing in relation to the population size of a community. While subsistence fishing may be affected by Vineyard Northeast-related activities, there are a lack of subsistence fishing reliance indicators; therefore, recreational fishing reliance is used as a proxy for subsistence fishing reliance. The results of this evaluation are summarized for each state in Section 5.2.1.4.

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[67] The GIS datafile is named "TIGER/Line Shapefile, 2022, Nation, U.S., American Indian/Alaska Native/Native Hawaiian Areas (AIANNH)"and is available at https://www.census.gov/cgi-bin/geo/shapefiles/index.php

5.2.1.4 *Environmental Justice Populations*

Table 5.2-1 above lists all counties with EJ communities that may be affected by Vineyard Northeast-related activities. Table 5.2-3 shows the number of EJ communities in each of these counties, as defined by federal and state criteria, as well as the counties with any tribal areas or high fishing engagement (no EJ areas overlap with areas of high fishing reliance). These EJ communities are illustrated in Figures 5.2-2 through 5.2-16. A summary of the EJ communities in each state is provided below.

Table 5.2-3 Environmental Justice Communities Within the Study Area

Location (County)	Figure	Number of EJ Communities		Tribal Areas	High Fishing Engagement
		Federal	State[1]		
Massachusetts					
Bristol	5.2-2 and 5.2-6	130	183	1	Yes (commercial)
Essex	5.2-3 and 5.2-6	165	267	0	Yes (commercial and recreational)
Dukes	5.2-4	4	7	1	No
Nantucket	5.2-5	1	6	0	No
Connecticut					
New London	5.2-7 and 5.2-9	47	8 EJ Areas & 7 Distressed Municipalities	5	Yes (recreational)
Fairfield	5.2-8	228	93 EJ Areas & 1 Distressed Municipalities	1	No
New Haven	5.2-8	237	108 EJ Areas & 6 Distressed Municipalities)	0	No
New York					
Suffolk	5.2-10 and 5.2-13	198	217 EJ Areas & 25 DACs	2	Yes (commercial and recreational)
Kings	5.2-11 and 5.2-13	1,470	1,432 EJ Areas & 285 DACs	0	Yes (recreational)
Richmond	5.2-11 and 5.2-13	110	99 EJ Areas & 33 DACs	0	No
Rensselaer	5.2-12	27	31 EJ Areas & 9 DACs	0	No
Albany	5.2-12	62	56 EJ Areas & 21 DACs	0	No
Rhode Island					
Providence	5.2-14	207	87	0	No
Washington	5.2-14 and 5.2-15	7	0	1	Yes (commercial and recreational)

Table 5.2-3 Environmental Justice Communities Within the Study Area (Continued)

Location (County)	Figure	Number of EJ Areas		Tribal Areas	NOAA High Fishing Engagement[2]
		Federal	State[1]		
New Jersey					
Gloucester	5.2-16	31	53	0	No
Salem	5.2-16	13	13	0	No

Notes:

1. Some states define populations with EJ concerns based on demographic characteristics (e.g., low-income, minority, and limited English proficiency) as well as by other environmental or health indicators (e.g., DACs in New York or Distressed Municipalities in Connecticut).
2. NOAA Fisheries' Community Social Vulnerability Indicators were used to evaluate potential EJ populations in the geographic analysis area that also have a high level of "fishing engagement" or "fishing reliance" (NOAA Fisheries 2019). Fishing engagement indicates that there is a relatively large amount of commercial or recreational fishing activity in the area (e.g., based on permits, fish dealers, etc.), whereas fishing reliance is a measure of the amount of commercial or recreational fishing in relation to the population size of a community.

Massachusetts

As shown in Table 5.2-3, there are a number of federal and state EJ communities in the counties of Bristol, Essex, Dukes, and Nantucket. Figure 5.2-2 shows the EJ communities and tribal areas in Bristol County near the Massachusetts OECC and Horseneck Beach Landfall Site, along the potential Massachusetts onshore cable routes, onshore substation site envelopes, and POIs, and near three ports that will potentially be used. Most of the EJ block groups in Bristol County that may be impacted by Vineyard Northeast-related activities are located around the larger cities of New Bedford and Fall River. In Essex County, there are EJ communities around Salem Harbor, a potential port (see Figure 5.2-3). In Dukes County, EJ communities are also present in Vineyard Haven and Aquinnah (see Figure 5.2-4). As shown in Figure 5.2-4, EJ communities in Aquinnah, including Native American tribes, are within the PAPE for direct visual effects from the offshore facilities. On Nantucket, EJ communities are found in the south-central region; portions of these communities are within the PAPE for direct visual effects from the offshore facilities (see Figure 5.2-5).

As shown on Figure 5.2-6, there are EJ areas with high commercial fishing engagement in New Bedford and Fairhaven (Bristol County) and in Gloucester (Essex County). In Gloucester and Newburyport (Essex County), there are areas of high commercial and recreational fishing engagement that overlap with a few EJ communities. No EJ areas overlapped with any areas with high reliance on commercial or recreational fishing.

[redacted]

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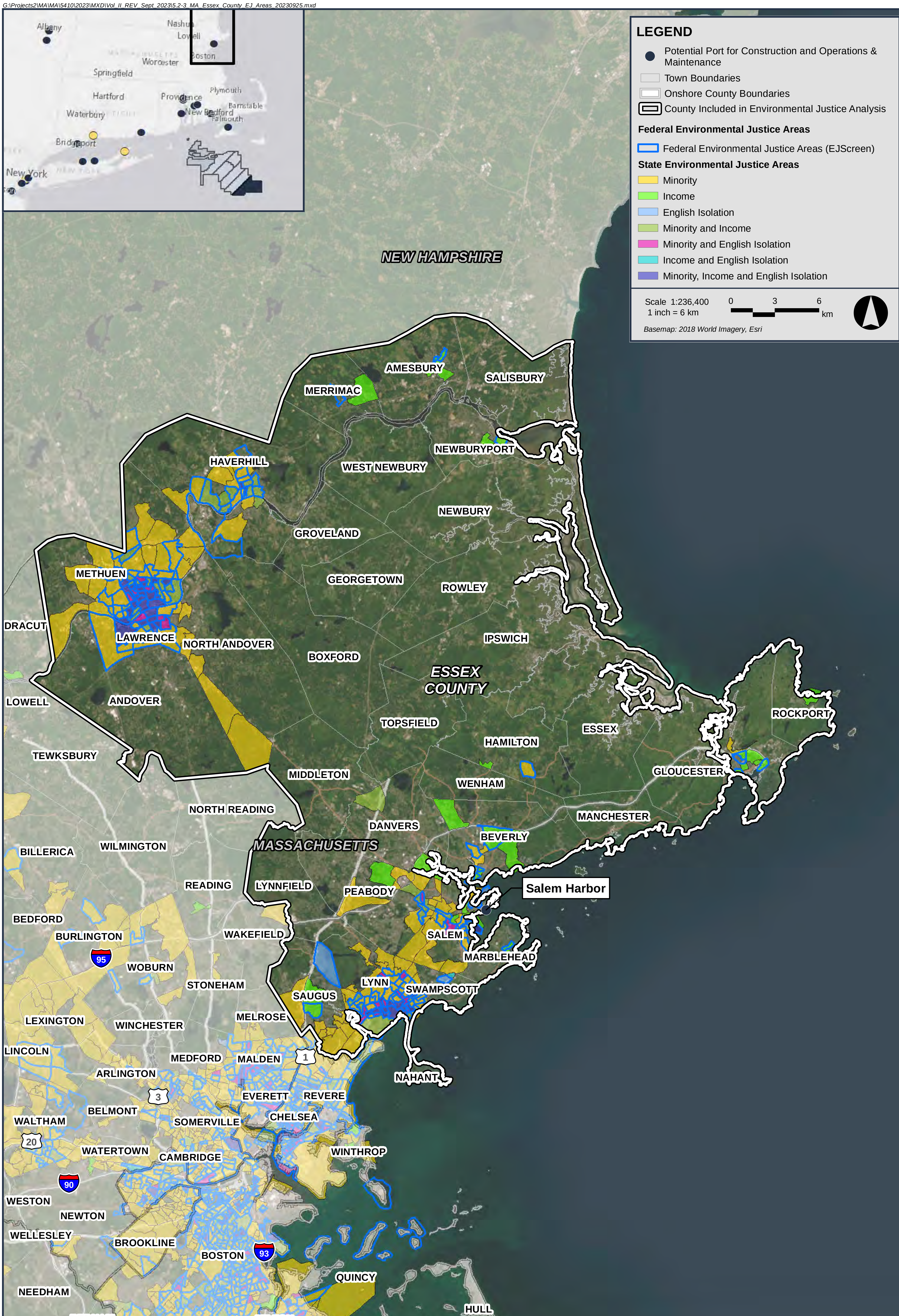

Figure 5.2-3
Essex County, Massachusetts
Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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Figure 5.2-4
Dukes County, Massachusetts
Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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Figure 5.2-5
Nantucket County, Massachusetts
Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

[redacted]

Connecticut

In Connecticut, there are EJ communities in the counties of New London, Fairfield, and New Haven (see Table 5.2-3). In New London County, there are EJ or distressed communities near the Connecticut OECC and the potential landfall sites, along the Connecticut onshore cable routes, [redacted] and POI, and around the New London State Pier, which is one of the potential ports (see Figure 5.2-7). In New London County, there are also five tribal areas near the onshore facilities ([redacted]). In the counties of New Haven and Fairfield, there are EJ and distressed communities near the ports of New Haven and Bridgeport, respectively (see Figure 5.2-8). A few EJ areas (two block groups) overlap with areas of high recreational fishing engagement in Waterford (New London County), as shown on Figure 5.2-9. No EJ areas overlapped with any areas with high commercial or recreational fishing reliance.

New York

The total number of EJ communities and Native American tribes in New York counties containing ports that may be used for Vineyard Northeast (Suffolk, Kings, Richmond, Rensselaer, and Albany Counties) are listed in Table 5.2-3 and shown in Figures 5.2-10 through 5.2-12. As shown in Figures 5.2-10 through 5.2-12, EJ communities are mostly located in the larger cities of New York and Albany, with others scattered throughout the counties. Some ports are near EJ communities but not within an EJ community (e.g., Port Jefferson Harbor, Shoreham). The Connecticut OECC also passes through Suffolk County waters in proximity to EJ communities (see Figure 5.2-10).

EJ areas overlap with areas of high recreational fishing engagement in Brooklyn (Kings County) and near Port Jefferson Harbor (Suffolk County), and with areas of high recreational and commercial fishing engagement in Montauk and Hampton Bays (Suffolk County) (see Figure 5.2-13). No EJ areas overlapped with any areas with high commercial or recreational fishing reliance.

Rhode Island

Vineyard Northeast activities may occur in ports in Providence County and/or Washington County. The EJ communities and Native American tribes in these counties are summarized in Table 5.2-3 and shown in Figure 5.2-14. As shown in Figure 5.2-14, EJ communities are mostly located around Providence, with others scattered throughout the counties. There are a few EJ communities (by the federal definition) in North Kingstown and Narragansett (Washington County) that have high commercial fishing engagement (see Figure 5.2-15). Some EJ communities in Narragansett also have high recreational fishing engagement. One tribal area in Charlestown (Washington County) overlapped with an area of high recreational fishing engagement. No EJ areas overlapped with any areas with high reliance on commercial or recreational fishing.

[redacted]

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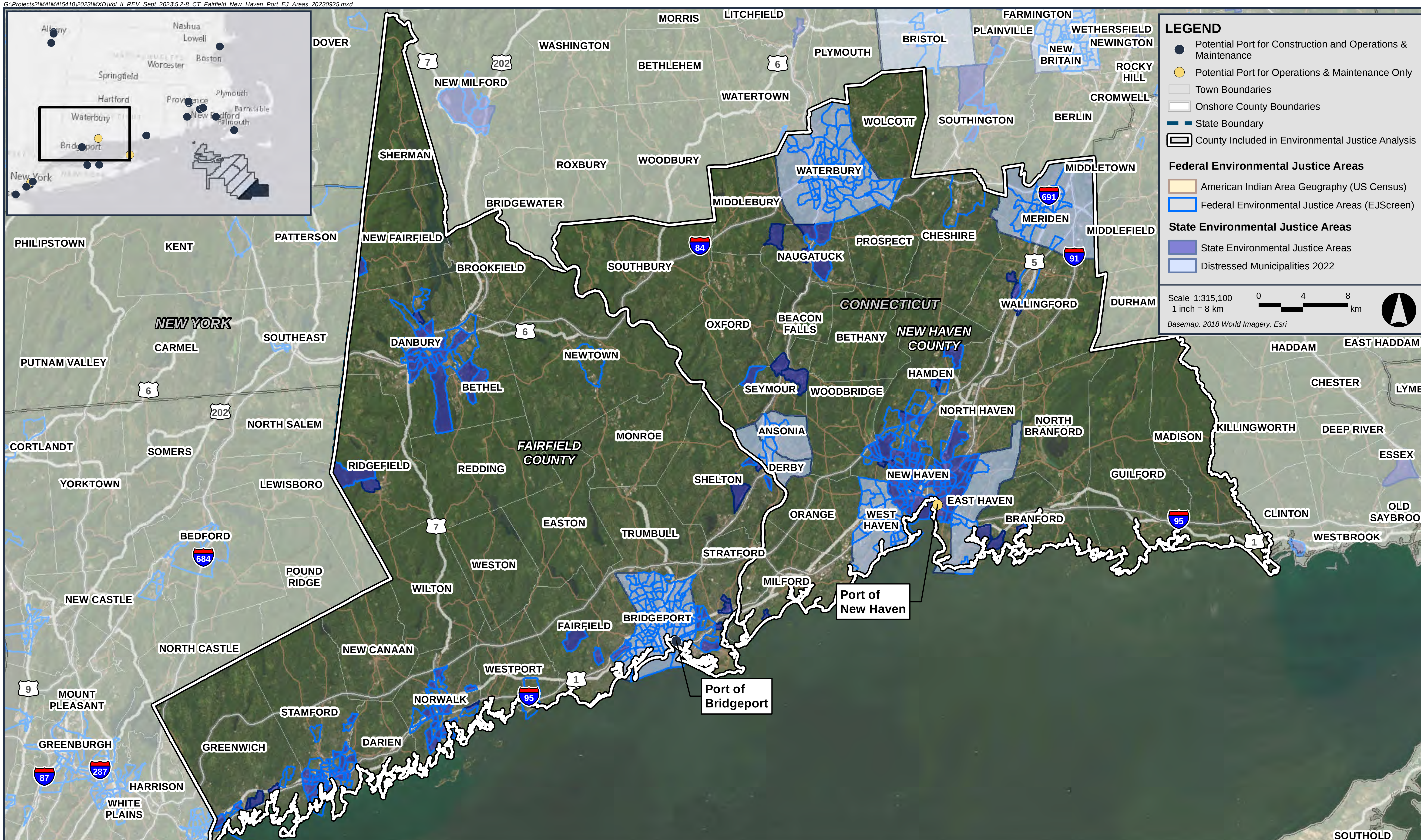

Figure 5.2-8
Fairfield County and New Haven County, Connecticut
Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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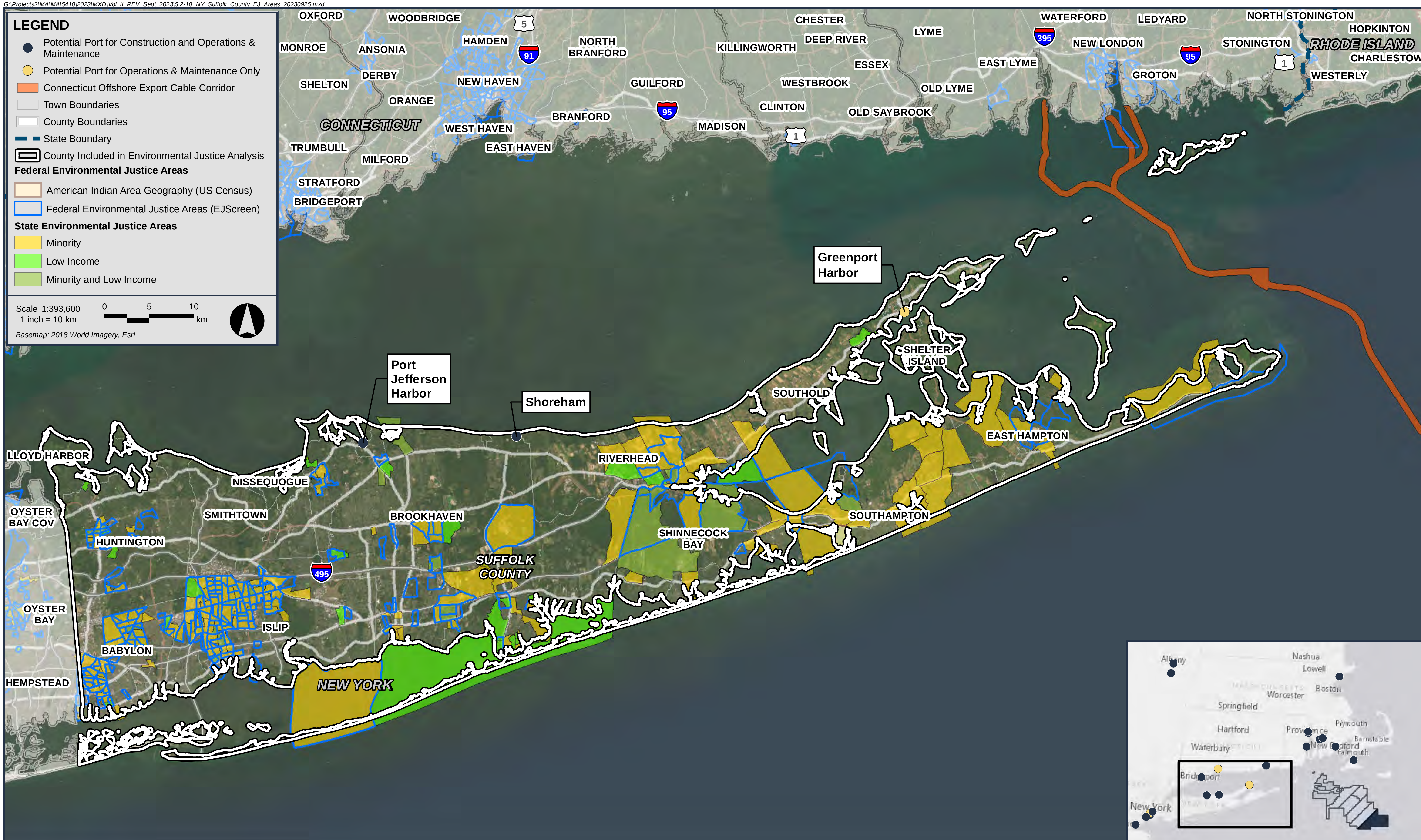

Figure 5.2-10
Suffolk County, New York
Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

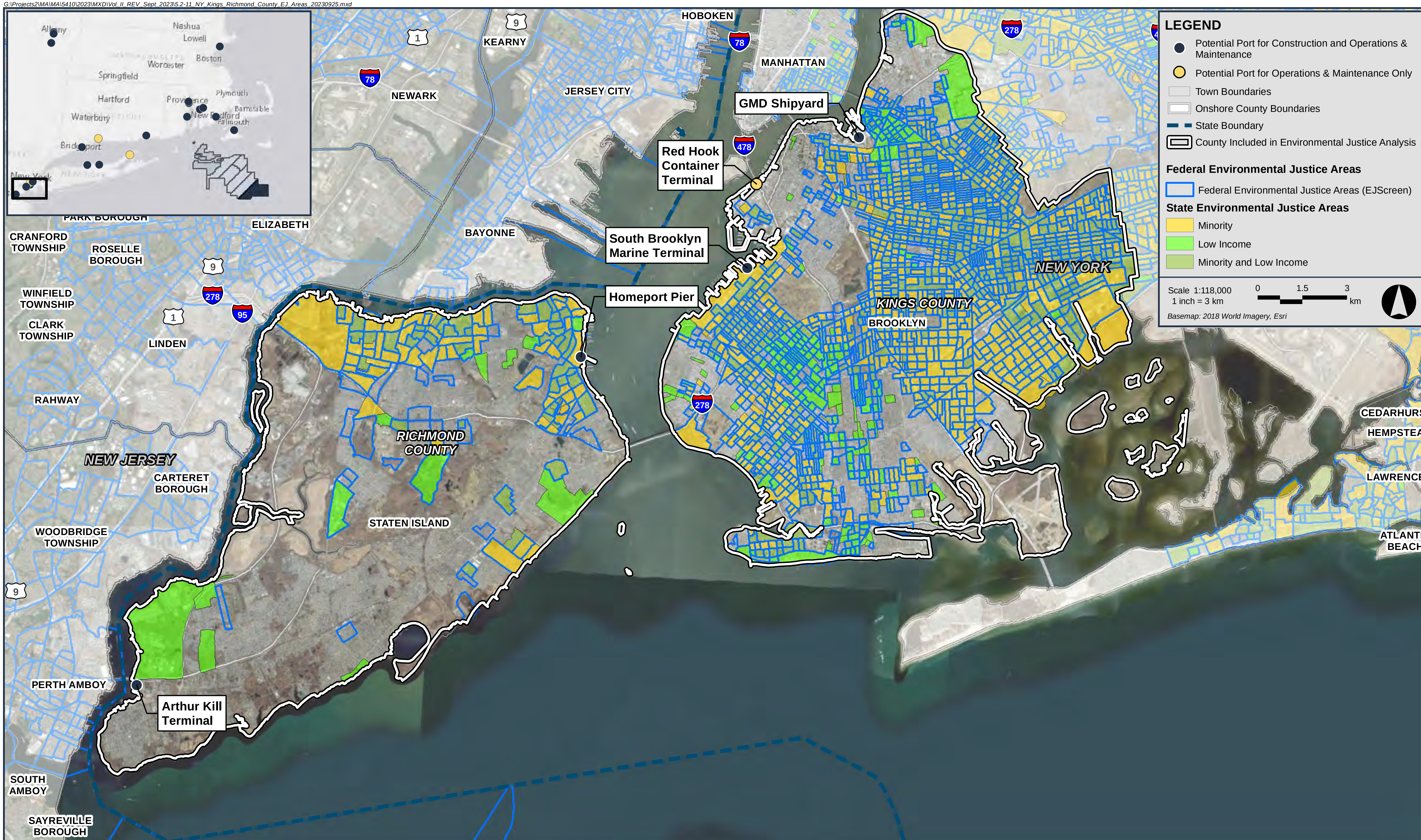

Figure 5.2-11

Richmond County and Kings County, New York

Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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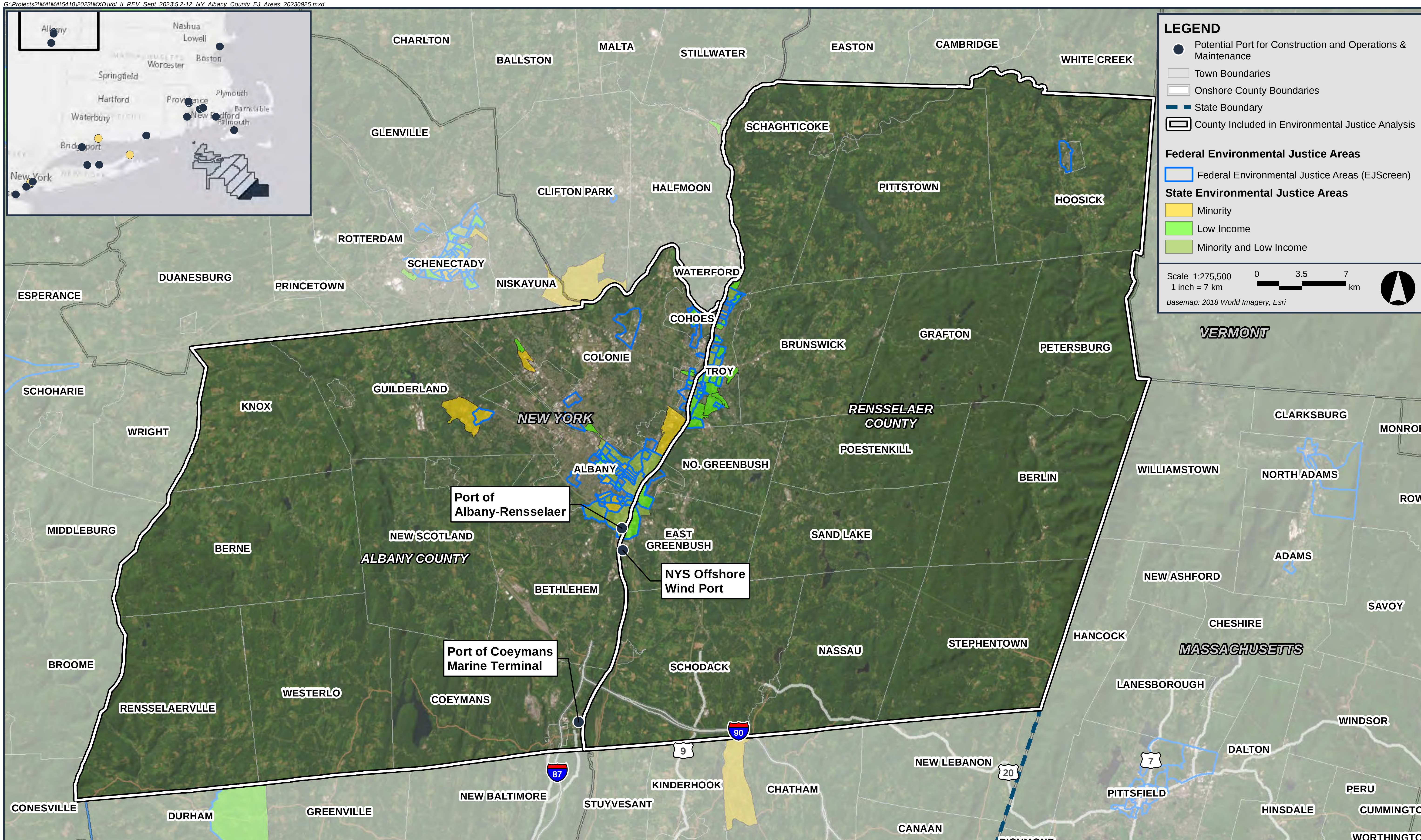

Figure 5.2-12
Albany County and Rensselaer County, New York
Environmental Justice Communities and Native American Tribes

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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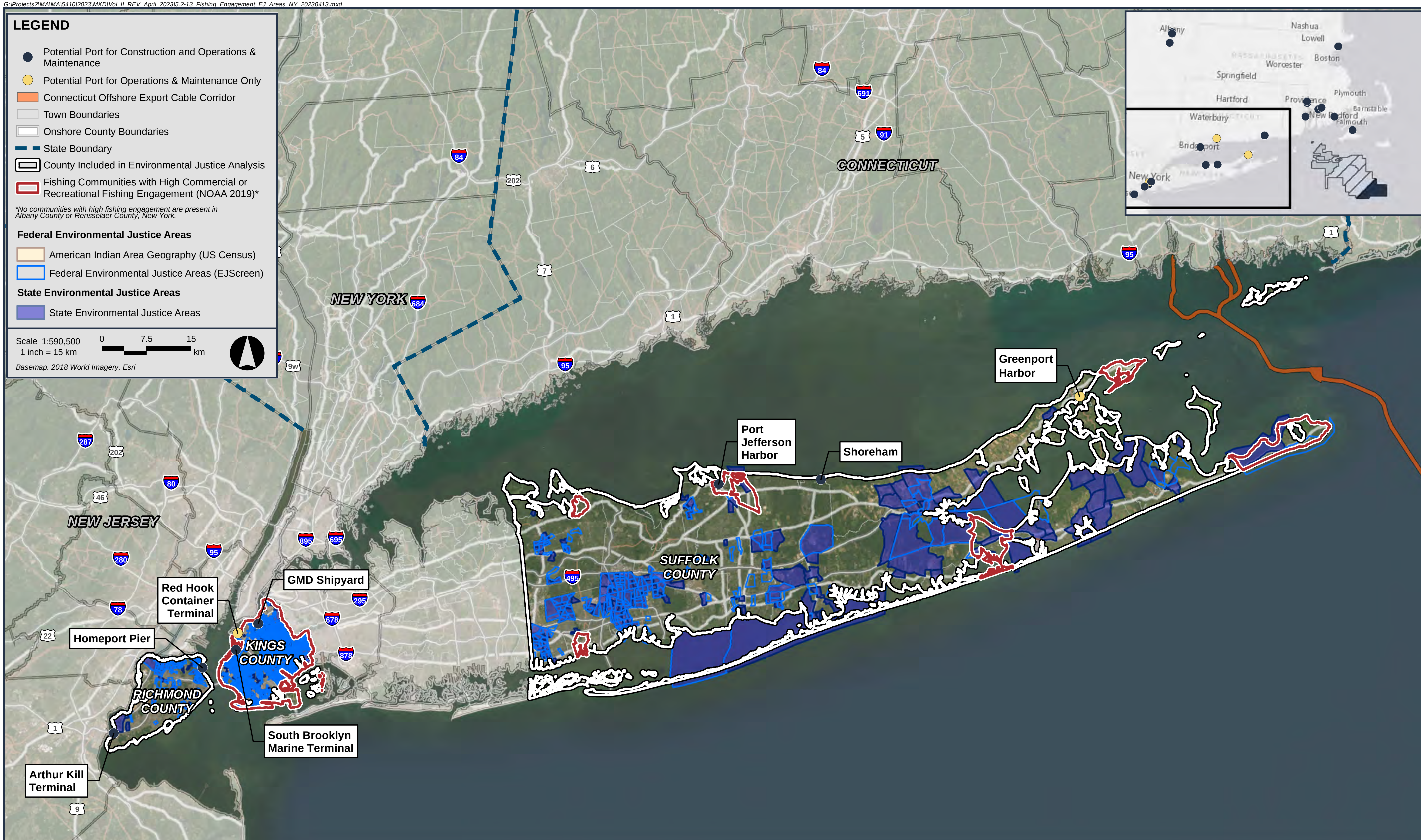

Figure 5.2-13
New York High Fishing Engagement Communities within the Geographic Analysis Area

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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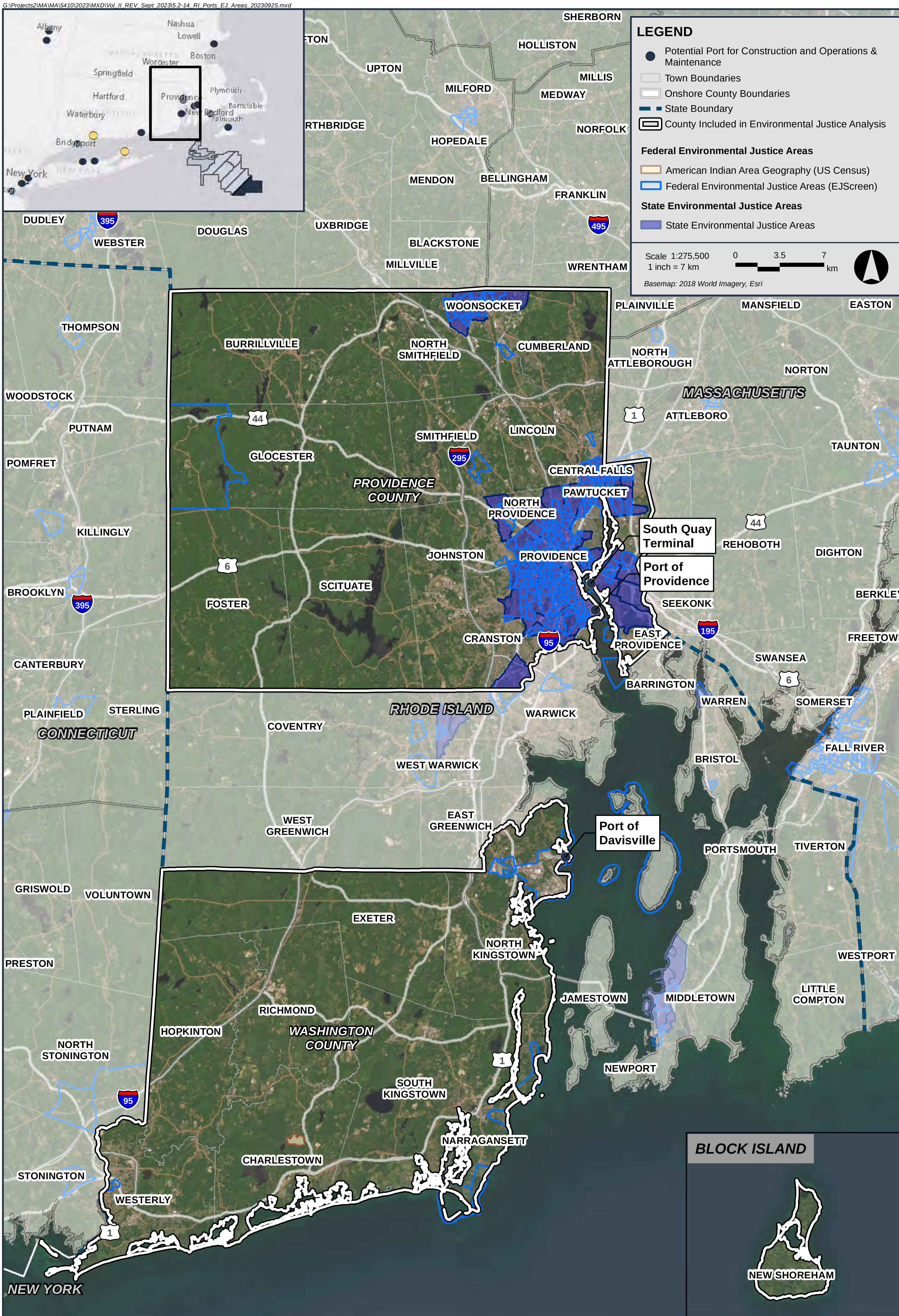

Figure 5.2-14

Providence County and Washington County, Rhode Island Environmental Justice Communities and Native American Tribes

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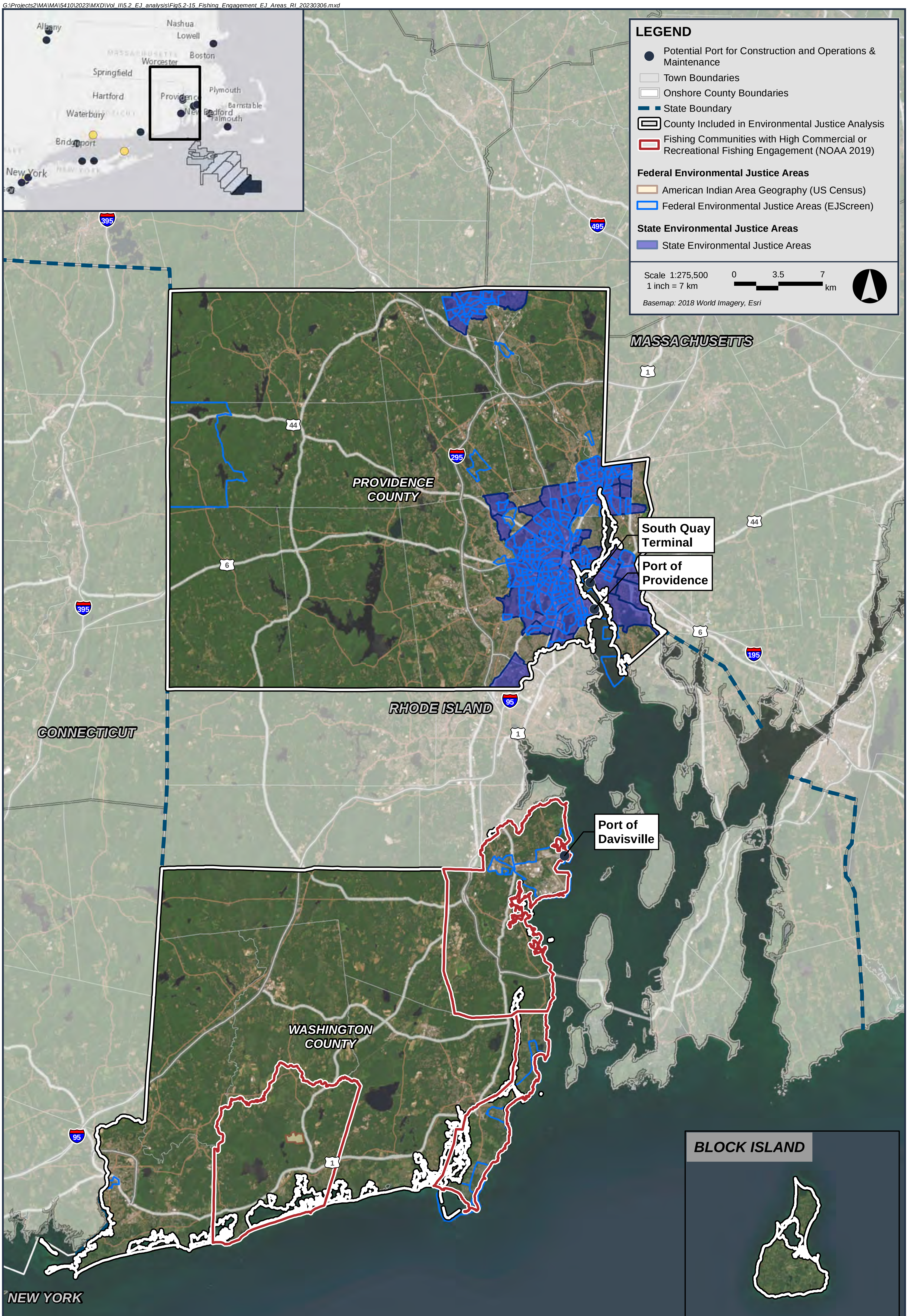

Figure 5.2-15
Rhode Island High Fishing Engagement Communities within the Geographic Analysis Area

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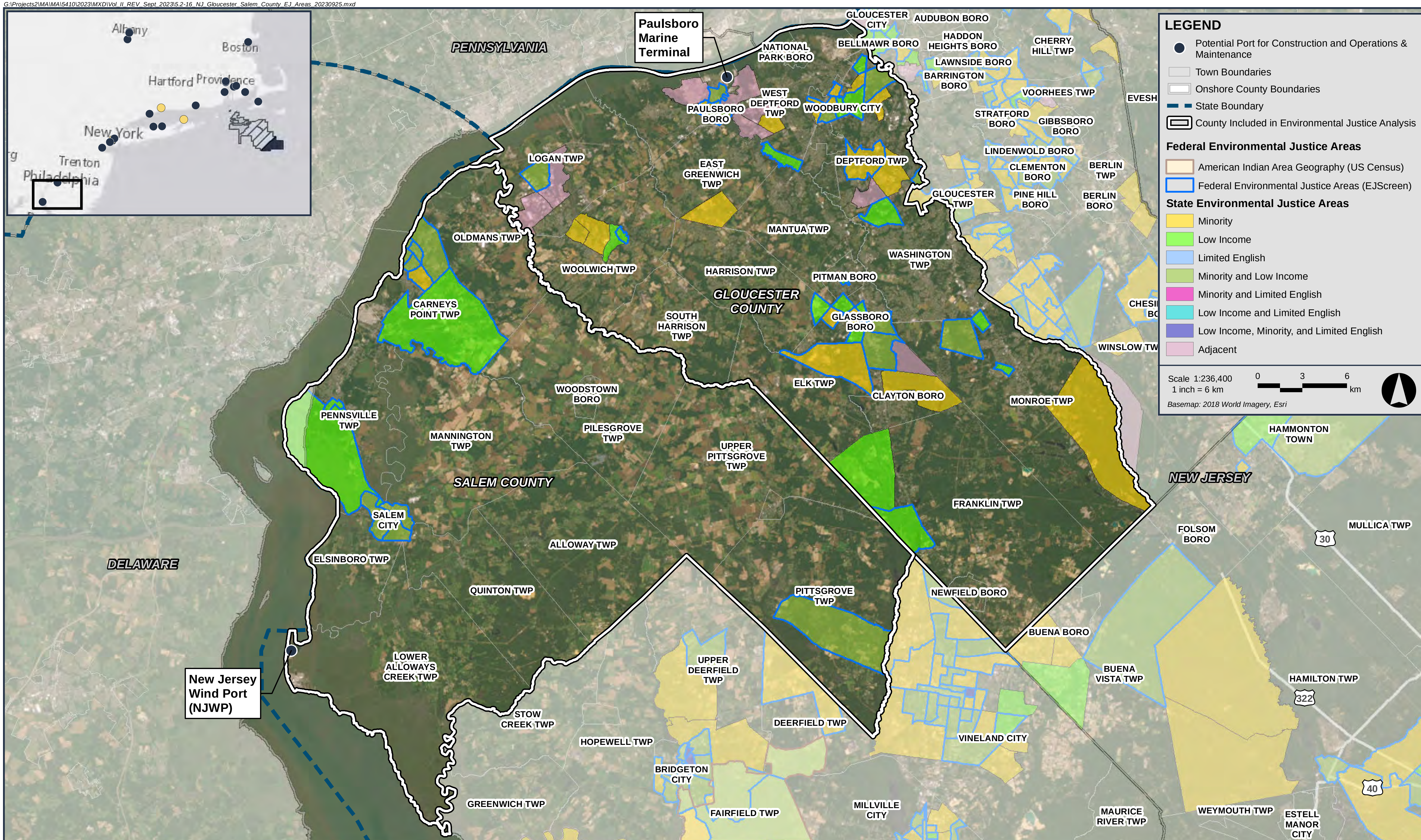

Figure 5.2-16
Salem County and Gloucester County, New Jersey
Environmental Justice Communities and Native American Tribes

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New Jersey

Table 5.2-3 and Figure 5.2-16 summarize the EJ communities in the counties of Gloucester and Salem, which contain ports that may be used for Vineyard Northeast. No EJ areas overlap with any areas with high engagement or reliance on commercial or recreational fishing.

5.2.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect EJ communities during the construction, O&M, and/or decommissioning of Vineyard Northeast are presented in Table 5.2-4.

Table 5.2-4 Impact Producing Factors for Environmental Justice Communities

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Workforce Initiatives and Economic Activity	•	•	•
Port Utilization	•	•	•
Onshore Construction and Maintenance Activities	•	•	•
Noise	•		•
Housing	•		•
Presence of Structures	•	•	•

Potential effects to EJ communities were assessed using the maximum design scenario for Vineyard Northeast as described in Section 1.5.

5.2.2.1 Workforce Initiatives and Economic Activity

Vineyard Northeast is expected to result in significant long-term economic benefits, including considerable new employment opportunities. The Proponent anticipates hiring a diverse workforce across a range of professions during development, construction, O&M, and decommissioning. Potential jobs are related to fabrication, component assembly, other construction and installation tasks, and maintenance of the offshore facilities. The expected number of jobs created during construction and throughout the operational life of Vineyard Northeast are significant and are further detailed in Section 5.1.

The Proponent is committed to ensuring that EJ communities receive appropriate economic benefits from Vineyard Northeast. The Proponent will make reasonable efforts to hire from within host communities (i.e., the communities in which onshore facilities are located) and adjacent EJ communities. The Proponent also anticipates that it will develop workforce initiatives, including initiatives specifically targeting EJ communities, that are designed to educate, recruit, mentor, and train residents for careers in the offshore wind industry. To support these goals, the Proponent expects to implement a collaborative, flexible, and community-led workforce development framework that: (1) advances workforce and training initiatives that are aligned with Vineyard Northeast's workforce needs and timelines; (2) is tailored to the communities it aims to benefit; and (3) is implemented by the Proponent and local partners. This framework is expected to include a hiring plan and youth education initiatives that will raise awareness, enable hiring and training directly from local host communities and EJ populations, and provide a pathway for the next generation to access careers in offshore wind. The hiring plan will describe Vineyard Northeast's workforce needs, along with associated education, training, and certification requirements, identify partnerships with existing programs and organizations to train the necessary workforce, and outline how the Proponent will prioritize hiring and training directly from host communities and adjacent EJ communities. The youth education initiatives and programming will provide opportunities that allow youth to meaningfully connect with and learn about the offshore wind industry. The Proponent is committed to working cooperatively with educational institutions and others to further develop training and educational opportunities for students and residents of the Onshore Development Area. The Proponent also expects to host and participate in workforce events and career fairs to inform residents about job opportunities during the development, construction, and O&M of Vineyard Northeast.

Additionally, the Proponent anticipates that it will pursue contracts with local suppliers, including minority-owned businesses. The Proponent will also continue to identify opportunities to increase participation of businesses located in EJ communities, Women-Owned Business Enterprises, and Service-Disabled Veteran-Owned Businesses in the offshore wind supply chain. The increase in job opportunities and related economic growth for local businesses that serve the expanding offshore wind industry are expected to benefit EJ communities that are in the vicinity of the Onshore Development Area.

To inform stakeholders of the potential opportunities and impacts from Vineyard Northeast, the Proponent plans to engage with the public, including potential EJ population groups, in meaningful ways. The Proponent's approach to tribal and stakeholder outreach for Vineyard Northeast is described in Section 8 of COP Volume I. The Proponent recognizes that local communities and stakeholders have different needs when it comes to receiving information and participating in the offshore wind development process. For that reason, the Proponent employs an array of methods to disseminate information and engage with interested community stakeholders while also evaluating and adapting approaches to ensure the effectiveness of community outreach efforts. As discussed in Section 8.5 of COP Volume I, the Proponent's outreach efforts are expected to include holding information sessions in a public space as well as sponsoring and staffing information tables at community, environmental, and fisheries-related events. These events will be advertised on the Proponent's website,[68] via social media, press releases, and other media, and through in-person outreach. The Proponent's public engagement efforts suggest that stakeholders, particularly EJ

[68] See: https://www.vineyardoffshore.com/.

communities, often support clean energy projects that address climate change and want developers to provide clear, concise information on jobs, economic development, and supply chain opportunities.

Additional community and environmental benefits from Vineyard Northeast that are also expected to benefit local EJ communities are described in Section 2. As the development of Vineyard Northeast progresses, additional commitments are expected, and this section will be updated as needed.

5.2.2.2 Port Utilization

As described further in Sections 3.10 and 4.4 of COP Volume I, Vineyard Northeast has identified several existing and planned ports that may be used for construction and/or O&M. Each port under consideration for Vineyard Northeast is either located in an industrial waterfront area with sufficient existing infrastructure or where another entity may develop such infrastructure by the time construction or O&M proceeds. The Proponent has identified a wide range of potential staging ports due to the uncertainty in Vineyard Northeast's construction schedule and the expected demand for ports by other offshore wind developers in the coming years. Only a subset of the potential ports identified would be used to stage components. The combination of staging ports used during construction will depend on the final construction schedule as well as the availability and capability of each port to support staging activities.

Vineyard Northeast activities at ports will be typical of marine industrial uses and may result in temporary increases in traffic, noise, and air emissions from support vehicles and vessels. The marine industrial activities at these ports are not anticipated to disproportionally affect EJ communities. Further, port utilization may result in additional employment opportunities in EJ communities as described in Section 5.2.2.1.

5.2.2.3 Onshore Construction and Maintenance Activities

Onshore construction and maintenance activities related to Vineyard Northeast's onshore facilities in Massachusetts and Connecticut may temporarily result in increased traffic, noise, dust, and/or air emissions (noise is discussed further in Section 5.2.2.4). The Proponent anticipates that construction equipment utilized for onshore cable installation activities will be similar to those used during typical public works projects (e.g., road resurfacing, storm sewer installation, transmission line installation). Onshore construction activities may temporarily impact residents, tourists, and businesses near these activities, including EJ and non-EJ populations (see Figures 5.2-2 and 5.2-7).

The Proponent anticipates that it will develop a Construction Management Plan (CMP) that will list construction best management practices to minimize the effects of onshore construction. The Proponent will use the CMP to guide contractors during construction. The Proponent will also work with municipalities to develop the onshore construction schedule and hours in accordance with local ordinances. The timing of onshore construction activities will be coordinated with state and local agencies to avoid seasons or times of peak usage and to align with planned public works projects, where feasible, to minimize traffic disruption. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.

During construction and decommissioning, the Proponent anticipates an increase in construction and support vehicle traffic in portions of the Onshore Development Area. To avoid and minimize traffic impacts during onshore construction activities, the Proponent will develop a Traffic Management Plan (TMP) prior to construction and will coordinate the timing of activities with state and local agencies. Signage, lane restrictions, police details, and other appropriate traffic management measures will be used to maintain traffic flow, and traffic management will always be coordinated with municipal officials. The Proponent anticipates utilizing various methods of public outreach prior to and during all phases of Vineyard Northeast to keep residents, business owners, and officials updated on the construction schedules, vehicular access, lane closures, detours, and other traffic management information.

Overall, it is expected that any disruptions from onshore construction and maintenance activities will be temporary and localized to the immediate work area. Areas and/or infrastructure disturbed by installation activities will be restored following completion. EJ populations are not anticipated to be disproportionally impacted by these short-term activities.

5.2.2.4 Noise

Similar to construction activities for typical public works projects, Vineyard Northeast's onshore construction activities may generate temporary and intermittent increases in noise levels within the Onshore Development Area. Noise may also be generated from activities at ports, but is not expected to differ significantly from noise that is already generated by these ports. Some noise may also be generated at the onshore substations, and mitigation (e.g., sound attenuation walls) will be implemented to mitigate potential noise impacts, if needed.

The Proponent is committed to minimizing noise-related impacts to communities in the Onshore Development Area, including EJ communities. Construction hours will be developed in accordance with local noise ordinances. Construction equipment will be operated such that construction-related noise levels will comply with applicable local, state, and federal requirements. Mitigation measures to limit noise from construction equipment (e.g., using quieter equipment, assuring the functionality of equipment, adding mufflers or noise-reducing features, using temporary noise barriers) will be utilized as needed. Potential impacts to EJ and non-EJ communities are not anticipated to differ and would be intermittent and short term.

5.2.2.5 Housing

No adverse housing effects on EJ communities are anticipated from Vineyard Northeast construction, O&M, and decommissioning. Any housing needs are anticipated to be met by the local housing markets. More details are presented in Section 5.1.

5.2.2.6 Presence of Structures

As discussed further in Sections 5.3 and 5.4, the presence of Vineyard Northeast's wind turbine generators (WTGs), electrical service platform(s) (ESP[s]), and booster station (if used) may affect commercial and recreational fishing, which may, in turn, affect low-income and minority workers and tribal communities who rely on these industries. During O&M of Vineyard Northeast, the Lease Area and OECCs will be open to marine traffic, and no permanent vessel restrictions are proposed. The proposed layout is expected to facilitate safe navigation through the Lease Area and accommodate traditional fishing patterns and activities. However, some fishermen may opt to reroute transits around the Lease Area, resulting in a slight increase in vessel transit time (see Section 5.4). Depending on the construction or O&M activity, the Proponent may request that mariners give a wide berth to active work sites or construction and maintenance vessel(s) through the issuance of Offshore Wind Mariner Updates. Additionally, the Proponent may request that the US Coast Guard (USCG) establish temporary safety zones, per 33 CFR Part 147, that extend 500 m (1,640 feet [ft]) around each WTG, ESP, and booster station during construction and certain maintenance activities (see Section 8.4 of COP Volume I for additional details). The presence of these safety zones would temporarily preclude fishing activities in the immediate vicinity of the structures and may cause fishermen to slightly alter their navigation routes to avoid the active work sites. However, the safety zones would be limited in size and duration and would not affect the entire Lease Area at any given time.

As described in Section 5.4, a limited portion of the offshore cables may require cable protection. Cable protection will be designed and installed to minimize interfering with bottom fishing gear to the maximum extent practicable and fishermen will be informed of exactly where cable protection exists. Nevertheless, there remains a possibility that bottom fishing gear may snag on cable protection resulting in gear damage, lost fishing time, and associated economic losses.

If these potential impacts result in a decrease in revenue, employment, and income for low-income and minority workers in marine-based industries or affect those who rely on subsistence fishing, the EJ communities described in Section 5.2.1.3 (particularly in the New Bedford area, which has both a larger EJ population and high commercial fishing engagement) may be affected. However, it is not expected that EJ communities will bear disproportionately high or adverse impacts, especially when considering the measures that the Proponent will implement to avoid, minimize, and mitigate potential impacts to recreational and commercial fishing, which are described in Sections 5.3 and 5.4, respectively. In addition, Vineyard Northeast's foundations, scour protection, and cable protection (if used) may attract fish species to new structured habitat, resulting in increases in biodiversity and abundance of fish (see Section 4.6). The expected fish aggregation and artificial reef effects of the structures could result in an increase in certain types of recreational fishing in the Lease Area, which may provide future business opportunities (e.g., for recreational fishing).

The PAPE for direct visual effects overlaps with a limited number of EJ communities (see Section 5.2.1.4). On Martha's Vineyard, the PAPE for direct visual effects from the offshore facilities overlaps with Wampanoag, Aquinnah trust land and the EJ area at Oak Bluffs (see Figure 5.2-4). On Nantucket, most of the EJ communities, except for one, overlap with the offshore PAPE for direct visual effects (see Figure 5.2-5). The direct visual effects from the offshore facilities will primarily be associated with the presence of the WTGs, as the maximum height of the ESP(s) and booster station is much less than the WTGs and all offshore cables will be underwater and not visible. The sheer distance of Vineyard Northeast from the nearest coastal vantage point—greater than 49.1 km (30.5 mi) from the closest WTG—serves to minimize visibility of the offshore facilities from EJ communities. The potential visual impacts from Vineyard Northeast generally affect both EJ and non-EJ communities equally and therefore do not constitute a disproportionate impact. Vineyard Northeast is also applying important mitigation techniques such as using colors that are compatible with the marine landscape and using an Aircraft Detection Lighting System (ADLS) or similar system to control aviation obstruction lights (subject to BOEM approval), to minimize visual impacts to the maximum extent practicable (see Section 6.1 for a description of proposed measures to reduce visual impacts). In addition, the presence of structures in the Lease Area may provide additional recreational opportunities by creating sightseeing interest (see Section 5.3).

The onshore PAPE for direct visual effects is related to the onshore substation and a potential segment of overhead transmission lines in Bristol County, Massachusetts (see Figure 5.2-2) as well as the onshore substation in New London County, Connecticut (see Figure 5.2-7). Although some EJ communities in these counties may be impacted, the potential effects to EJ and non-EJ communities are the same, so no disproportionate impacts are expected. To minimize effects, the onshore substation sites will have a perimeter access fence and may include sound attenuation walls, if necessary. Substation construction may require initial clearing and grading of the entire site, but the periphery of the site (outside the security fencing) will be restored and revegetated (if required). To minimize visual effects, vegetative buffers for visual screening may be installed, if needed.

5.2.2.7 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to EJ communities during Vineyard Northeast are summarized below:

- The Proponent is committed to ensuring that EJ communities receive economic benefits from Vineyard Northeast and intends to develop hiring plans and workforce initiatives that target EJ communities.

- The Proponent plans to engage with the public, including potential EJ populations, in meaningful ways, such as holding information sessions and sponsoring/staffing information tables at public events. The Proponent will consider accessibility when scheduling and hosting events to ensure that EJ populations have the opportunity to meaningfully participate.

- The Proponent anticipates that it will develop a CMP that will list construction best management practices to minimize the effects of onshore construction.

- Construction equipment will be operated such that construction-related noise levels will comply with applicable local, state, and federal requirements. Mitigation measures to limit noise will be utilized as needed, such as sound attenuation walls at the onshore substation sites.

- The Proponent will work with municipalities to develop the onshore construction schedule and hours in accordance with local ordinances. The timing of onshore construction activities will be coordinated with state and local agencies to avoid seasons or times of peak usage and to align with planned public works projects, where feasible, to minimize disruption.

- The Proponent will develop a TMP prior to construction and will coordinate the timing of activities with state and local agencies.

- The Proponent anticipates utilizing various methods of public outreach prior to and during all phases of Vineyard Northeast to keep residents, business owners, and officials updated on the construction schedule and traffic management information.

- The proposed layout is expected to accommodate traditional fishing patterns and activities.

- The amount of cable protection will be limited. Cable protection will be designed and installed to minimize interfering with bottom fishing gear to the maximum extent practicable and fishermen will be informed of areas where cable protection exists.

- Subject to BOEM approval, the Proponent will use an ADLS or similar system that automatically turns on and off aviation obstruction lights in response to the detection of aircraft, which substantially minimizes the effect of nighttime lighting.

- To minimize visual effects from the onshore substation sites, vegetative buffers for visual screening may be installed, if needed.

Considering these and other measures described in Sections 5.1, 5.3, 5.4, 6.1, and 6.2, it is not expected that EJ communities will bear disproportionately high or adverse impacts or receive disproportionately low benefits from Vineyard Northeast.

Furthermore, as described in Section 3.1.2.2, Vineyard Northeast will generate clean, renewable energy that will significantly reduce air emissions from the regional electric grid by displacing electricity produced by fossil fuel power plants. Recent studies on redlined communities[69] have shown that fossil fuel power plants are disproportionately sited in these communities, resulting in poor air quality and impacting land use patterns (e.g., causing lower housing values). Levy (2023) notes that these inequalities lead to multiple environmental and social burdens on these communities. Similarly, Cushing et al. (2023) found that the siting of fossil fuel power plants in EJ communities contributed to disproportionate air pollution exposure burdens. Thus, EJ communities, in particular, will benefit from the reduction in fossil fuel power plant emissions that are expected as a result of Vineyard Northeast's clean, renewable energy.

5.3 Recreation and Tourism

This section addresses the potential impacts and benefits of Vineyard Northeast on recreation and tourism in the Onshore Development Area and Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to recreation and tourism during the construction, operation, and decommissioning of Vineyard Northeast.

A Seascape, Landscape, and Visual Impact Assessment is provided in Appendix II-J and is summarized in Section 6.1. Commercial fisheries and for-hire recreational fishing impacts are assessed in Section 5.4.

5.3.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. For the purposes of assessing effects to recreation and tourism, the Offshore Development Area also includes the waters in which Vineyard Northeast-related vessels and equipment may operate.

The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut. With respect to recreation and tourism, the Onshore Development Area includes the cities, towns, and communities in which Vineyard Northeast's onshore facilities may be located. Each port facility being considered for construction or operations and maintenance (O&M) is either located within an industrial waterfront area with sufficient existing infrastructure or where another entity may develop such infrastructure by the

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[69] Redlining is a term used to describe racism related to real estate and is derived from historic government maps that identified (in red) predominantly Black neighborhoods that were considered to be risky investments. These communities, which are largely minority communities, are considered to be EJ communities.

time construction proceeds. As a result, the use of ports is not expected to impact recreation and tourism and is not discussed further in this section. Port utilization is discussed further in Sections 3.10 and 4.4.1 of COP Volume I.

The following analysis relies upon recreation and tourism data and analyses compiled by state economic authorities in Massachusetts and Connecticut. United States (US) Census Bureau Economic Census data are also used to quantify recreation and tourism in the Onshore Development Area. The National Oceanic and Atmospheric Administration (NOAA) has provided the Proponent with recreational fishing data for the Offshore Development Area and makes data on recreational fishing within the Lease Area publicly available at: https://www.fisheries.noaa.gov/resource/data/socioeconomic-impacts-atlantic-offshore-wind-development.

5.3.1.1 Massachusetts Onshore Development Area

The Massachusetts Onshore Development Area (which consists of the landfall site, onshore cable routes, onshore substation site envelopes, and potential POIs) is located within the municipalities of Westport, Fall River, and Somerset, which are in Bristol County (see Figure 5.3-1). Bristol County encompasses approximately 1,432 square kilometers (km^2) (553 square miles [mi^2]) of the southeastern Massachusetts mainland to the west of Cape Cod. Bristol County's coastline is comprised largely of two bays: Mount Hope Bay, in the upper reaches of Narragansett Bay and extending into the Taunton River, and the southwesterly portions of Buzzard's Bay. Westport, Fall River, and Somerset are in the southwesterly corner of Bristol County. Detailed descriptions of Bristol County can be found in Section 5.1.

In 2017, Bristol County's recreation and tourism sectors were supported by an estimated 49 facilities offering short-term accommodations; collectively, these facilities generated approximately $83.8 million in annual revenue and employed 894 individuals. Bristol County had approximately 1,266 food and drink establishments generating approximately $1.2 billion in annual sales and employing 21,685 individuals (US Census Bureau 2017). There were 211 arts, entertainment, and recreation establishments in Bristol County, generating approximately $238.1 million in revenue (US Census Bureau 2017). In 2019, domestic visitors to Bristol County spent approximately $523.5 million, which supported approximately 3,300 jobs and resulted in approximately $10.6 million in local tax receipts (Massachusetts Office of Travel and Tourism 2020).

Offshore export cables installed within the Massachusetts OECC will transition onshore at the Horseneck Beach Landfall Site shown on Figure 5.3-2. The Horseneck Beach Landfall Site is located in a portion of a paved parking area within Horseneck Beach State Reservation, a state-owned facility in Westport, Massachusetts that is managed by the Massachusetts Department of Conservation and Recreation (DCR) (Mass.gov 2022). According to DCR (2012), Horseneck Beach State Reservation is well known for its active surf and provides saltwater-based recreational opportunities that include swimming, fishing, and boating. It is one of the most

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Figure 5.3-2
Horseneck Beach Landfall Site

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highly visited ocean beach facilities in the DCR system and includes a lifeguarded beach facility with associated infrastructure (e.g., comfort stations, elevated boardwalks, concession stand, and a centralized Beach Services Building with a first aid station). A campground with 100 partially paved sites, ten water hookups, a comfort and dumping station, sports courts, and access to an unguarded beach are also part of the Reservation. Horseneck Beach State Reservation is seasonally staffed, and facilities are accessible to the paying public from May 14 through October 30.

As shown on Figure 5.3-2, to the northwest of the Horseneck Beach Landfall Site and on the southern end of the Norman Edward Fontaine Bridge (Rt. 88), the Massachusetts Division of Fish and Game maintains a boat ramp offering free public access to the Westport River and connected waterways. The Westport Yacht Club and the F. L. Tipp & Sons boat yard and marina are also located on the Westport River to the northwest of the Horseneck Beach Landfall Site.

As described further in Section 3.8 of COP Volume I, the onshore cables will follow one of the onshore cable routes shown on Figure 5.3-1 from the Horseneck Beach Landfall Site to reach the Pottersville POI, the Brayton Point POI, or the Bell Rock POI. The routes primarily follow town/city roads, portions of state highways, a bike path, and/or utility rights-of-way (ROWs). Additionally, the routes are in proximity to conservation lands that provide walking/hiking trails and support both passive and active recreational opportunities.

5.3.1.2 Connecticut Onshore Development Area

The Connecticut Onshore Development Area (which consists of the potential landfall sites, onshore cable routes, onshore substation site envelope, and POI) is located within the municipalities of East Lyme, Groton, Ledyard, Montville, New London, and Waterford, which are in New London County (see Figure 5.3-3). New London County encompasses approximately 1,722 km^2 (665 mi^2) of southeastern Connecticut along the Connecticut Sound. A detailed description of New London County can be found in Section 5.1.

In 2017, New London County's recreation and tourism sectors were supported by an estimated 84 facilities offering short-term accommodations; collectively, these facilities generated approximately $2.1 million in annual revenue and employed 14,585 individuals. New London County had approximately 666 food and drink establishments generating approximately $705,000 in annual sales and employing 11,267 individuals. (US Census Bureau 2017). There were 134 arts, entertainment, and recreation establishments in New London County, generating approximately $183,500 in revenue (US Census Bureau 2017). In 2015, visitors to New London County spent approximately $2.2 billion, which supported approximately 18,444 jobs and resulted in approximately $336.1 million in state and local tax receipts (Tourism Economics 2017).

Offshore export cables installed within the Connecticut OECC would transition onshore at one of the following landfall sites shown on Figure 5.3-4:

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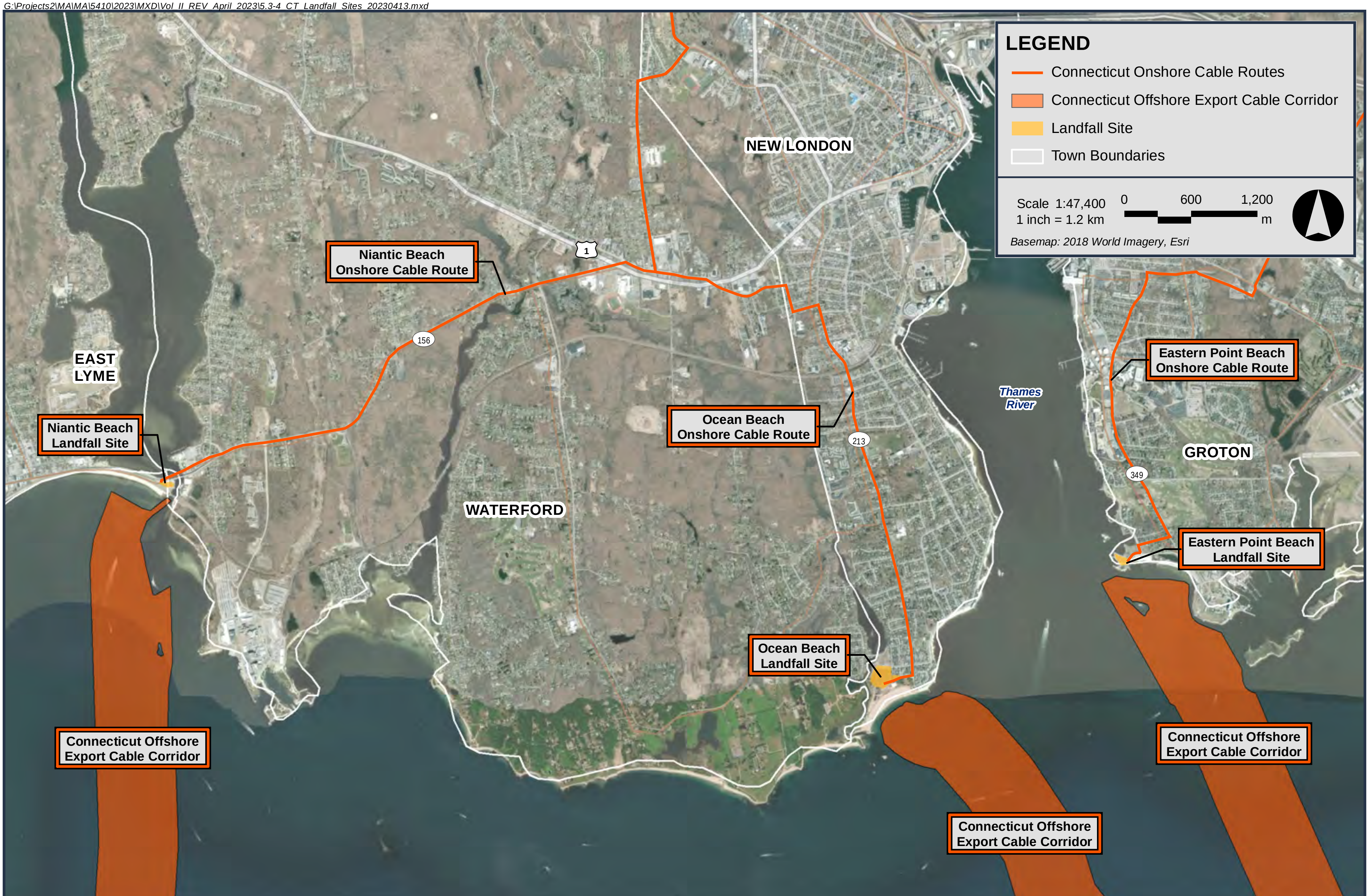

Figure 5.3-4
Connecticut Landfall Sites

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- **Ocean Beach Landfall Site:** The Ocean Beach Landfall Site is located in a portion of a paved parking area within Ocean Beach Park in New London, Connecticut, on the western shore of the mouth of the Thames River. Ocean Beach Park is a for-fee public recreation facility owned by the City of New London and managed under contract by a third party. Ocean Beach Park includes a beach, boardwalk, swimming pool, bathhouse, miniature golf course, arcade, banquet facility, and food court, among other amenities (Ocean Beach Park c2017).

- **Eastern Point Beach Landfall Site:** The Eastern Point Beach Landfall Site is located in a portion of a paved parking area on Eastern Point in Groton, Connecticut. The beach is a day-use public beach that operates from mid-June through Labor Day and is managed by the City of Groton's Parks and Recreation Department (City of Groton 2022). Eastern Point Beach features a public beach and associated bathhouse, recreation facilities (e.g., playground), and open space as well as private residences to the north and east.

- **Niantic Beach Landfall Site:** The Niantic Beach Landfall Site is located in a paved parking area at Niantic Beach in East Lyme, Connecticut. The town-managed beach includes a boardwalk, bathhouse, fishing jetty, and volleyball courts. The beach is lifeguarded from Memorial Day to Labor Day and a beach pass is required to access the beach during that time period (Town of East Lyme CT 2022). The beach is abutted by Route 156 and train tracks. To the north of Niantic Beach is the Town of East Lyme's Cini Memorial Park. Across the mouth of the Niantic River is the Town of Waterford's Mago Point Park, which includes a fishing pier and recreational boating facilities.

5.3.1.3 Offshore Development Area

Recreational boating, fishing, swimming, diving, and wildlife viewing are seasonally important recreational activities within the Offshore Development Area. Offshore whale watching also occurs within the Offshore Development Area, particularly on the waters between Montauk Point and Cox Ledge, south of Block Island and well outside the Lease Area. According to the 2012 Northeast Recreational Boater Survey (Starbuck and Lipsky 2013), recreational boating activity varies seasonally, with peak boating season occurring between May and September. Starbuck and Lipsky (2013) estimated that approximately 560,000 boating trips occurred within ocean and coastal waters of New England states during 2012. Approximately 72.3% of those trips were attributed to vessels registered in Massachusetts and Connecticut. Data from the 2012 Northeast Boater Survey identifying recreational boating routes and recreational boating density are presented in Figure 5.3-5.

The majority of recreational boating in the Offshore Development Area occurs within 5.5 kilometers (km) (3 nautical miles [NM]) of shore and within state waters (Starbuck and Lipsky 2013). Although recreational boaters may transit the Lease Area, there are no known concentrated or significant navigational routes for recreational boaters within the Lease Area (see Appendix II-G).

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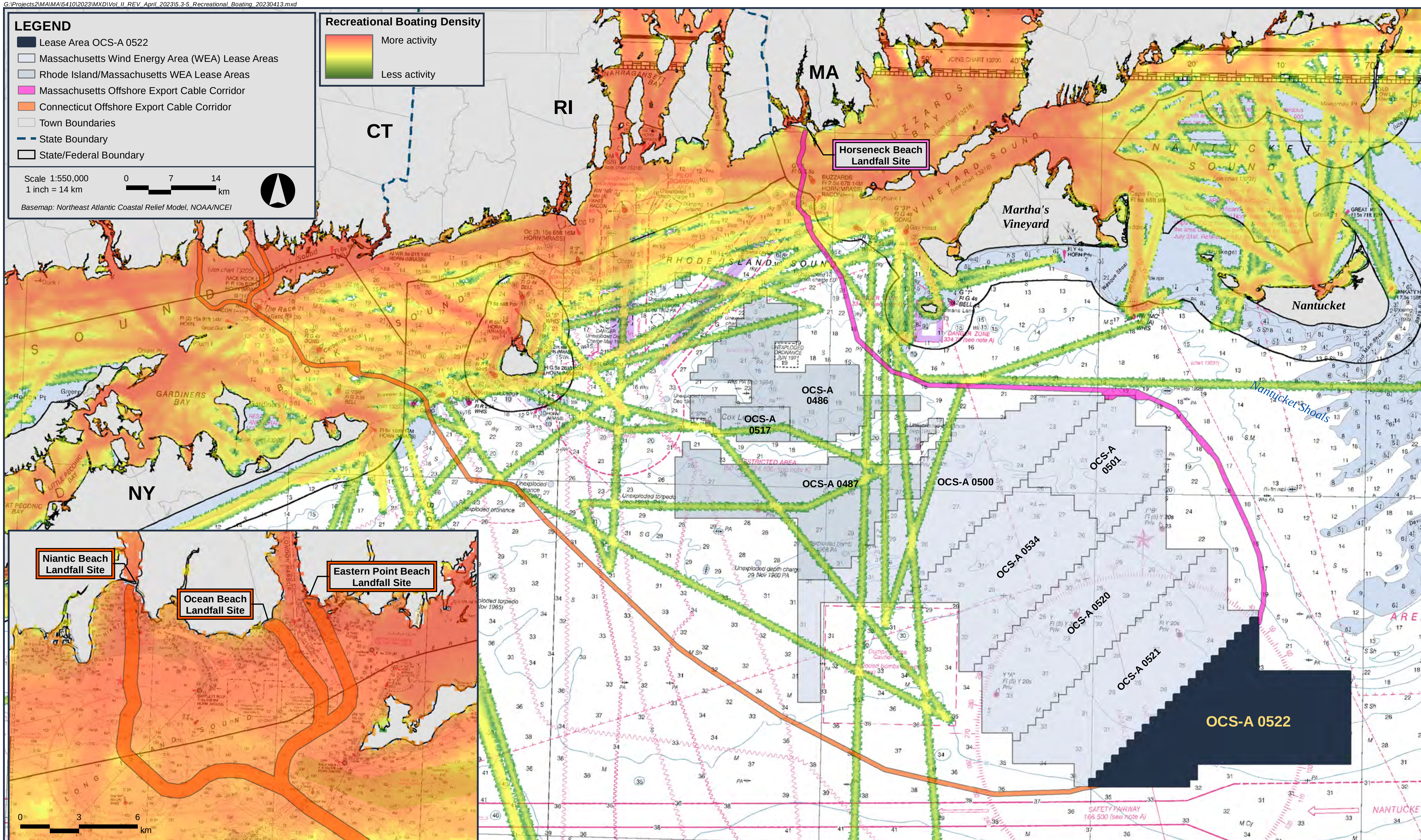

Figure 5.3-5
Recreational Boating Density

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As noted by Starbuck and Lipsky (2013), the majority of recreational activities such as canoeing, kayaking, and paddle boarding occurs in more sheltered waters and predominantly within 1.6 km (1 mile [mi]) of the coastline. Along the OECCs, nearshore recreational boating (e.g., canoeing and kayaking) is most likely to occur in areas close to the landfall sites and is less likely to occur farther offshore and within the Lease Area. Potential routes of offshore long-distance sailboat races could transit the OECCs and Lease Area. However, the preferred vessel routing for these events varies greatly based on weather, wind direction and velocity, tides, and other factors.

Recreational Fishing

Recreational fishing is a popular activity in the waters of the Offshore Development Area. Survey results presented in Starbuck and Lipsky (2013) indicate that approximately 43% of recreational boating trips originating from Massachusetts and Connecticut were associated with recreational fishing. Recreational boating trips increase substantially in the warmer weather months of June, July, and August (Starbuck and Lipsky 2013) and recreational fishing effort data from NOAA (MRIP 2022) indicates that those months correspond with the highest number of angler trips in Massachusetts and Connecticut. However, the timing of migratory species' "run" through the Offshore Development Area likely also influences the timing of recreational fishing effort.

From 2017 to 2021, there have been approximately 10.8 million recreational angler trips (i.e., charter boats, party boats, rental/private boats, and shore boats) in Massachusetts and Connecticut waters (MRIP 2022). During those same years, an annual average of approximately two million angler trips occurred in Massachusetts and approximately 178,000 angler trips occurred in Connecticut. Saltwater fishing tournaments are also held during the summer months in waters throughout the Offshore Development Area. The tournaments target a variety of species including Atlantic cod (*Gadus morhua*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), haddock (*Melanogrammus aeglefinus*), tuna (*Thunnus*), and fluke (*Paralichthys dentatus*) (RI CRMC 2010). Information about for-hire recreational fishing is provided in Section 5.4.

Much of the recreational fishing effort is concentrated in nearshore waters, far inshore from the Lease Area, which is approximately 46 km (29 mi) from Nantucket. The Bureau of Ocean Energy Management (BOEM) estimated that only approximately 1.0% of the nearly 1.9 million private angler trips occurring in Massachusetts between 2007 and 2012 occurred within 1.6 km (1 mi) of the Massachusetts Wind Energy Area (MA WEA) (Kirkpatrick et al. 2017). Substantially fewer numbers of private angler trips, if any, originating in Connecticut occurred within 1.6 km (1 mi) of the MA WEA. During that same time period, recreational angler trips occurring within 1.6 km (1 mi) of the MA WEA most frequently originated from harbors in Massachusetts, while few, if any, angler trips originated from Connecticut (Kirkpatrick et al. 2017).

Numerous highly migratory fish species, such as tunas, billfish, mahi mahi (*Coryphaena hippurus*), and sharks are present in the offshore waters in southern New England. Kneebone and Capizzano (2020) collected baseline information on recreational fishing within the MA WEA and the adjacent Rhode Island/Massachusetts WEA (RI/MA WEA) by: (1) surveying recreational fishermen from the private (angling category) and charter/headboat sectors on their recreational fishing efforts over the past five years, and (2) analyzing available data on recreational fishing effort over recent decades. The study determined that recreational fishing effort for highly migratory species is widespread throughout southern New England and that the greatest recreational fishing effort occurs west of the MA WEA and RI/MA WEA (i.e., west of the Lease Area) in the waters south and east of Montauk Point and Block Island (Kneebone and Capizzano 2020).

5.3.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect recreation and tourism during the construction, O&M, and/or decommissioning of Vineyard Northeast are presented in Table 5.3-1.

Table 5.3-1 Impact Producing Factors for Recreation and Tourism

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Vessel Activity	•	•	•
Presence of Structures		•	
Onshore Construction and Maintenance Activities	•	•	•
Noise	•	•	•

Potential effects to recreation and tourism were assessed using the maximum design scenario for Vineyard Northeast's onshore and offshore facilities as described in Section 1.5.

5.3.2.1 Vessel Activity

Construction and support vessels will be present within the Lease Area and along the OECCs during pre-installation, installation, maintenance, and decommissioning activities. Vessel traffic associated with Vineyard Northeast is not anticipated to represent a significant increase over the current levels of vessel traffic within the Offshore Development Area. Navigation and vessel traffic are further discussed in Section 5.6 and Appendix II-G.

The Proponent will work to inform recreational boaters and recreational fishermen of planned vessel activities during construction, maintenance, and decommissioning. The Proponent will provide Offshore Wind Mariner Updates and coordinate with the US Coast Guard (USCG) to issue Notices to Mariners (NTMs) advising other vessel operators of planned offshore activities. The Vineyard Northeast website will be regularly updated to provide information about activities occurring in the Offshore Development Area.

Depending on the activity, the Proponent may request that mariners give a wide berth to active work sites or construction and maintenance vessel(s) through the issuance of Offshore Wind Mariner Updates. Additionally, the Proponent may request that the USCG establish temporary safety zones, per 33 CFR Part 147, that extend 500 meters (m) (1,640 feet [ft]) around each wind turbine generator (WTG), electrical service platform (ESP), and booster station (if used) during construction and certain maintenance activities (see Section 8.4 of COP Volume I for additional details). The presence of these safety zones would temporarily preclude recreational boating and fishing activities in the immediate vicinity of the structures and may cause boaters and recreational fishermen to slightly alter their navigation routes to avoid the active work sites. However, the safety zones would be limited in size and duration and would not affect the entire Lease Area at any given time.

5.3.2.2 Presence of Structures

The onshore cables and associated vaults at the landfall sites and along the onshore cable routes are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs. In most instances, underground trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) to avoid impacts to those features. However, the northern crossing of the Taunton River [redacted] may require a segment of overhead transmission lines.[70] During O&M, the facilities will be regularly monitored, and repairs or maintenance will be conducted promptly. If onshore cable repairs are required, the cables would typically be accessed through manholes installed at the splice vaults and transition vaults, thereby avoiding and minimizing interference with recreation and tourism. The Proponent also intends to prioritize industrial/commercial onshore substation sites to minimize effects to the surrounding area.

The presence of structures in the Lease Area may provide additional recreational opportunities by creating sightseeing interest. A study of Delaware beachgoers found that 45% of respondents would likely take a tour boat to see an offshore wind facility (Lilley et al. 2010). A 2019 study examined potential impacts from the Block Island Wind Farm on the vacation rental market in Block Island, Rhode Island. The study observed that Block Island vacation rental rates increased in the summer relative to other Southern New England tourist destinations and concluded that offshore wind farms may attract tourists (Carr-Harris and Lang 2019).

During O&M of Vineyard Northeast, the Lease Area and OECCs will be open to marine traffic, and no permanent vessel restrictions are proposed. As described in Section 2.3 of COP Volume I, WTG and ESP positions within the Lease Area will be oriented in fixed east-to-west

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70 As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

rows and north-to-south columns with 1 NM (1.9 km) spacing between positions. The 1 x 1 NM WTG/ESP layout is consistent with the USCG's recommendations contained in the Massachusetts and Rhode Island Port Access Route Study (MARIPARS) published in the Federal Register on May 27, 2020 (USCG-2019-0131). Although the majority of recreational vessel traffic occurs closer to shore, the proposed spacing will facilitate safe navigation through the Lease Area.

If maintenance activities are required, the Proponent may request that mariners give a wide berth to active work sites or maintenance vessel(s) through the issuance of Offshore Wind Mariner Updates and may request that the USCG establish temporary safety zones that extend 500 m (1,640 ft) around the WTGs, ESP(s), and booster station (if used), as described in Section 5.3.2.1. However, it is expected that many maintenance activities in the Lease Area will not require in-water work but will instead be based from the structures themselves. A detailed Navigation Safety Risk Assessment (NSRA) for Vineyard Northeast is included as Appendix II-G and additional discussion of navigational impacts and the presence of structures in the Offshore Development Area is provided in Section 5.6.

As described in Section 5.6, to aid marine navigation, the WTGs, ESP(s), booster station (if used), and their foundations will be equipped with marine navigation lighting, marking, and signaling in accordance with USCG and BOEM guidance. Each WTG, ESP, and booster station will be maintained as a Private Aid to Navigation (PATON). The Proponent will work with the USCG, BOEM, and the Bureau of Safety and Environmental Enforcement (BSEE) to determine the appropriate marine lighting, marking, and signaling scheme for the proposed offshore facilities, including the number, location, and type of Automatic Identification System (AIS) transponders and Mariner Radio Activated Sound Signals (MRASS). The Proponent expects to provide a detailed lighting, marking, and signaling plan to BOEM, BSEE, and USCG prior to construction of the offshore facilities. Further information on marine navigation lighting and marking can be found in the NSRA (see Appendix II-G). The Proponent will coordinate with USCG and NOAA to ensure that the WTGs, ESP(s), and booster station (if used) are identified on nautical charts.

It is anticipated that foundations may function as fish aggregating devices by providing additional structure for species that prefer hard/complex bottom, thereby improving the recreational fishing experience within the Lease Area (BOEM 2012). As described in Section 4.6, the addition of foundations and cable protection (if used) may attract fish species to new structured habitat, resulting in increases in biodiversity and abundance of fish (Riefolo et al. 2016; Raoux et al. 2017). Degraer et al. (2020) also note that the addition of WTGs in this type of environment may provide shelter and food for some finfish species (e.g., Atlantic cod and black sea bass) that have demonstrated, in studies of other offshore wind installations, spending some part of their lifecycle closely associated with WTGs. There is also evidence that WTG reef habitats and the resources they provide increase the growth and condition of juvenile Atlantic cod and whiting-pout (*Trisopterus luscus*) (Reubens et al. 2013), which is consistent with observations near deep-water offshore wind farms (Løkkeborg et al. 2002; Hille

Ris Lambers and ter Hofstede 2009). Degraer et al. (2020) also noted that species production may increase as a result of new habitat that enhances settlement, survival, and/or growth or may save energy (Schwartzback et al 2020).

In the event that WTGs aggregate or increase productivity of recreationally targeted species, based on the intensity of recreational fishing within the Lease Area and its geographic scale, neither congestion effects nor gear conflicts are expected.

5.3.2.3 Onshore Construction and Maintenance Activities

Onshore construction and maintenance activities may result in temporary impacts at the landfall sites, along onshore cable routes, and/or at onshore substation sites. The onshore cables are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs, although, as noted above, the northern crossing of the Taunton River [redacted] may require a segment of overhead transmission lines. The Proponent anticipates that construction equipment utilized for onshore cable installation activities will be similar to those used during typical public works projects (e.g., road resurfacing, storm sewer installation, transmission line installation).

The Proponent anticipates that it will develop a Construction Management Plan (CMP) that will list construction best management practices to minimize the effects of onshore construction. The Proponent will use the CMP to guide contractors during construction. The Proponent will also work with municipalities to develop the construction schedule and hours in accordance with local ordinances. The timing of onshore construction activities will be coordinated with state and local agencies to avoid seasons or times of peak usage and to align with planned public works projects, where feasible, to minimize disruption. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day. Areas and/or infrastructure disturbed by installation activities will be restored following completion.

During construction and decommissioning, the Proponent anticipates an increase in construction and support vehicle traffic in portions of the Onshore Development Area. To avoid and minimize traffic impacts during onshore construction activities, the Proponent will develop a Traffic Management Plan (TMP) prior to construction and will coordinate the timing of activities with state and local agencies. Signage, lane restrictions, police details, and other appropriate traffic management measures will be used to maintain traffic flow, and traffic management will always be coordinated with municipal officials. The Proponent anticipates utilizing various methods of public outreach prior to and during the all phases of Vineyard Northeast to keep residents, business owners, and officials updated on the construction schedules, vehicular access, lane closures, detours, and other traffic management information, local parking availability, emergency vehicle access, construction crew movement and parking, laydown areas, staging, and equipment delivery, nighttime or weekend construction, and road repaving. The Proponent will coordinate with the local police and emergency service departments prior to the commencement of any work.

To protect public health and safety during the installation or decommissioning of the onshore cables, short-term access restrictions to parks/conservation areas along the onshore cable routes may be implemented in the area immediately surrounding work activities. Similarly, construction at the landfall sites may temporarily limit pedestrian access to discrete areas of the landfall sites. Additionally, shore-based recreational activities (e.g., swimming) at the landfall sites may be temporarily displaced during construction or decommissioning; however, onshore construction at the landfall sites is planned to occur outside of Memorial Day to Labor Day to avoid or minimize potential impacts.

During O&M, periodic maintenance may be required. If onshore cable repairs are required, the cables would typically be accessed through manholes installed at the splice vaults and transition vaults thereby minimizing impacts to recreation and tourism.

The Proponent anticipates that temporary and minor impacts on ambient air quality from onshore construction vehicles will be limited to areas adjacent to active construction, maintenance, or decommissioning activities. Potential impacts include construction vehicle or equipment emissions and possibly the generation of fugitive dust during construction. Such emissions are expected to be similar to other onshore construction projects.

5.3.2.4 Noise

Onshore cable installation and decommissioning activities (and, to a lesser extent, maintenance activities) may generate temporary noise levels that are periodically audible along the onshore cable routes. Construction equipment may also generate noise at the landfall sites, onshore substations, and staging and maintenance areas. The Proponent anticipates that construction equipment utilized for cable installation activities will be similar to that used during typical public works projects. Horizontal directional drilling (HDD) is expected to be used at the landfall sites and may result in temporarily elevated noise levels.

Although intermittent increases in noise levels are expected within the Onshore Development Area, primarily during construction, the Proponent is committed to minimizing these impacts. As noted above, onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day, which will minimize the effects of the HDD noise. Construction hours will be developed in accordance with local noise ordinances. Construction equipment will be operated such that construction-related noise levels will comply with applicable local, state, and federal requirements. Mitigation measures to limit noise (such as using quieter equipment, assuring the functionality of equipment, adding mufflers or noise-reducing features, using temporary noise barriers) will be utilized as needed. The onshore substations will be designed to comply with applicable sound level limits and will include sound level mitigation (e.g., sound attenuation walls) as needed.

Noise generated by offshore construction activities may affect recreational fishing activities by impacting recreationally-important species. For example, pile driving and low-intensity noise from dredging or increased vessel traffic may cause recreationally targeted species to temporarily avoid the immediate vicinity of the construction activities (Kirkpatrick et al. 2017). However, any species affected by construction and installation activities are anticipated to return to the area soon after construction and installation noises cease (Bergstrom et al. 2014). Potential water quality, noise, and other impacts to species targeted by recreational fishing vessels are described in Section 4.6.

5.3.2.5 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to recreation and tourism during Vineyard Northeast are summarized below:

- The Proponent will provide Offshore Wind Mariner Updates and coordinate with the USCG to issue NTMs advising other vessel operators of planned offshore activities. Depending on the activity, the Offshore Wind Mariner Update may request that mariners give a wide berth to the work site or construction and maintenance vessel(s). The Vineyard Northeast website will be regularly updated to provide information about vessel activities occurring in the Offshore Development Area.

- The Proponent may request that the USCG establish temporary safety zones, per 33 CFR Part 147, that extend 500 m (1,640 ft) around each WTG, ESP, and booster station (if used) during construction and certain maintenance activities. The safety zones would be limited in size and duration and would not affect the entire Lease Area at any given time.

- The 1 x 1 NM layout is consistent with the USCG's recommendations contained in the MARIPARS.

- The WTGs, ESP(s), booster station (if used), and their foundations will be equipped with marine navigation lighting, marking, and signaling in accordance with USCG and BOEM guidance. Each WTG, ESP, and booster station will be maintained as a PATON. The Proponent will coordinate with USCG and NOAA to ensure that the WTGs, ESP(s), and booster station (if used) are identified on nautical charts.

- Construction equipment will be operated such that construction-related noise levels will comply with applicable local, state, and federal requirements and mitigation measures to limit noise will be utilized as needed. The onshore substations will be designed to comply with applicable sound level limits and will include sound level mitigation as needed.

- Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.

- The Proponent anticipates that it will develop a CMP that will list construction best management practices to minimize the effects of onshore construction.

- The Proponent will develop a TMP prior to construction and will coordinate the timing of activities with state and local agencies.
- The Proponent anticipates utilizing various methods of public outreach prior to and during all phases of Vineyard Northeast to keep residents, business owners, and officials updated on the construction schedule and traffic management information.

5.4 Commercial Fisheries and For-Hire Recreational Fishing

This section addresses the potential impacts of Vineyard Northeast on commercial fisheries and for-hire recreational fishing in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to commercial fisheries and for-hire recreational fishing during the construction, operation, and decommissioning of Vineyard Northeast.

Information presented in this section is supplemented by Appendix II-F, which provides further analysis of the potential economic exposure of commercial fisheries to Vineyard Northeast, and Appendix II-G, which includes the Navigation Safety Risk Assessment (NSRA) and provides further analysis of commercial fishing vessel operations in the Offshore Development Area.

5.4.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. This section provides an overview of fishing fleets, fishing ports, fishing vessel activity, and the estimated value of commercial landings from within the Offshore Development Area.

To assess and characterize commercial fishing and to develop baseline estimates of the economic value of commercial fishing, this section uses several data sources and reports that provide information on commercial fishing activities within the Offshore Development Area:

- Maps of fishing activity based on vessel monitoring system (VMS)[71] data and vessel trip reports (VTRs)[72] developed for the Northeast Regional Ocean Council (NROC) and the Mid-Atlantic Council on the Ocean (MARCO),

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[71] Concepts and methodology for development of the VMS data are described in Fontenault (2018).

[72] Concepts and methodology for development of the VTR data are described in St. Martin (2008).

- VTR-based spatial representation of commercial fishing intensity and revenue developed by the Bureau of Ocean Energy Management (BOEM),[73]
- Estimates of the commercial fisheries revenue developed by National Oceanic and Atmospheric Administration (NOAA) Fisheries for the Lease Area (NOAA Fisheries 2023a) and for the OECCs (NOAA Fisheries 2023b),[74] and
- Automatic identification system (AIS) data were queried to establish estimates of commercial fishing vessel traffic.

To characterize for-hire recreational fishing activity in the Offshore Development Area, this analysis uses data from the NOAA Fisheries report of socioeconomic impacts of Atlantic offshore wind development (NOAA Fisheries 2023c) and two regional for-hire fisheries assessments (Hutt and Silva 2015, Kneebone and Capizzano 2020).

Based on these data sources, the following sections present estimates of the economic value of commercial fishing activity in the Offshore Development Area. These values represent the economic "exposure" of commercial fishing in the Lease Area and OECCs. The estimated economic exposure presented below does not represent the absolute value of income from commercial fishing in the Offshore Development Area because, as shown in Appendix II-F, an economic impact analysis considers many additional factors, including the costs incurred to harvest species.

Because of the large geographic range of many commercially harvested species, commercial fisheries are typically regional in nature and vessels participating in these fisheries may operate from ports located throughout the Atlantic coastline. Based on currently available data, it is understood that vessels operating within Offshore Development Area do so predominantly from the commercial fishing ports identified in the following sections. Vessels operating from other ports may also have some presence in the Offshore Development Area; however, they are not expected to have meaningful economic exposure to Vineyard Northeast. The Proponent anticipates working with federal and state agencies as well as environmental, fisheries, and local community stakeholders to further develop estimates of economic exposure of commercial fisheries and for-hire recreational fisheries within the Offshore Development Area.

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[73] Concepts and methodology for development of these data are described in NOAA Tech Memo NE-229 (DePiper 2014).

[74] Data from these sources were processed by NOAA Fisheries following the methods described in Kirkpatrick et al. (2017) and DePiper (2014).

Many environmental and regulatory factors contribute to the productivity of commercial fishing areas and, as a result, the locations of commercial fishing efforts are highly variable. Restrictions limiting fishing activity for certain species and changes to the habitat and prey of commercial species can give an incomplete picture of the potential value of fishery resources available in the Offshore Development Area. Fisheries management impacts commercial fisheries through the management of sustainable fish stocks and measures to reduce impacts on important habitat and protected species. Measures to manage the duration of fishing seasons, quotas, and closed areas, can also reduce or increase the size of available landings to commercial fisheries. The following analysis summarizes historic fishing values and effort in the Offshore Development Area and cannot account for ecological change, climate change, commercial fishing pressures, and interannual changes in populations of commercially harvested species. As stated in the NOAA Fisheries Draft Northeast Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy in 2022–2024, climate change impacts such as warming ocean temperature can manifest changes in species distribution, abundance, productivity, natural mortality, growth rates, and predator-prey interactions of commercially harvested species (NOAA Fisheries 2021).Therefore, estimates of fisheries exposure do not necessarily capture the complete economic value of resources in the Offshore Development Area. Nonetheless, the Proponent will continue to meet with fishermen to solicit additional information on fishing efforts in the Lease Area and OECCs, and to ensure that the most accurate and relevant information regarding each of the fisheries in the Offshore Development Area is incorporated into the planning and design of Vineyard Northeast.

5.4.1.1 Lease Area OCS-A 0522

Data summarizing commercial fishing activity, revenue exposure, and landings within the Lease Area are available from NOAA Fisheries (NOAA Fisheries 2023a). These data include annualized landings and revenue by species, gear type, and fishery management plan as well as by port and state and were used to identify the primary commercial fisheries, ports, and states potentially affected by development in the Lease Area (NOAA Fisheries 2023a).

The data summarized in Tables 5.4-1 through 5.4-6 are based on NOAA Fisheries' analysis of combined data from VTRs and dealer reports submitted by vessels with federal permits. Values reported in these tables have been deflated to 2021 dollars to aid in comparison across the 14 years of data.

Table 5.4-1 provides the annual landed weight and value of all species harvested within the Lease Area between 2008 and 2021. Additional information on adjustments made for lobster and Jonah crab landings by vessels that land only these two species and do not file VTRs can be found below.

Table 5.4-1 Commercial Landings from the Lease Area by Year, 2008–2021

Year	Landings (lbs)	Value (2021 dollars)
2008	215,176	$214,864
2009	200,664	$310,409
2010	858,545	$309,680
2011	79,315	$111,306
2012	95,608	$130,030
2013	149,018	$166,685
2014	167,495	$208,863
2015	179,599	$208,800
2016	164,394	$191,863
2017	209,880	$254,395
2018	353,568	$454,734
2019	390,499	$521,371
2020	407,908	$472,372
2021	283,804	$454,785
Average Annual	268,248	$286,440

Notes:
1. NOAA Fisheries (2023a)
2. Values have been deflated to 2021 dollars.

The 14-year average annual weight and value of the 15 most valuable species landed in the Lease Area are shown in Table 5.4-2. These 15 species account for approximately 90% of the average annual value from the Lease Area.

Table 5.4-2 Commercial Landings from the Lease Area by Species, 2008–2021

Species	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
Jonah Crab	86,955	$80,236	28%
American Lobster	5,443	$29,480	10%
Summer Flounder	8,839	$26,602	9%
Longfin Squid	17,889	$26,180	9%
Sea Scallop	2,085	$19,746	7%
Scup	24,115	$17,967	6%
Golden Tilefish	3,725	$15,224	5%
Monkfish	8,630	$14,252	5%

Table 5.4-2 Commercial Landings from the Lease Area by Species, 2008–2021 (Continued)

Species	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
Silver Hake	11,808	$8,774	3%
Skates	14,975	$8,339	3%
Atlantic Herring	43,588	$4,251	1%
Butterfish	4,195	$3,006	1%
Rock Crab	4,274	$2,645	1%
Shortfin Squid	3,398	$1,908	1%
Black Sea Bass	461	$1,489	1%
All Others	27,867	$26,341	9%
Total	268,248	$286,440	-

Notes:

1. NOAA Fisheries (2023a)
2. Values have been deflated to 2021 dollars.

The 14-year average annual weight and value of the 10 most valuable species managed under Fishery Management Plans (FMPs) in the Lease Area are shown in Table 5.4-3. These FMPs account for approximately 91% of the average annual value landed from the Lease Area.

Table 5.4-3 Commercial Landings from the Lease Area by Fishery Management Plan, 2008–2021

Fishery Management Plan	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
ASMFC FMP	92,468	$109,966	38%
Summer Flounder, Scup, Black Sea Bass	33,415	$46,058	16%
Mackerel, Squid, and Butterfish	26,232	$31,351	11%
Sea Scallop	2,085	$19,746	7%
Tilefish	3,728	$15,232	5%
Monkfish	8,630	$14,252	5%
Small-Mesh Multispecies	12,942	$9,220	3%
Skates	14,975	$8,339	3%
Atlantic Herring	43,588	$4,251	2%

Table 5.4-3 Commercial Landings from the Lease Area by Fishery Management Plan, 2008–2021 (Continued)

Fishery Management Plan	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
Northeast Multispecies	481	$850	0.3%
All Others	29,704	$27,175	10%
Total	268,428	$286,440	-

Notes:
1. NOAA Fisheries (2023a)
2. Values have been deflated to 2021 dollars.
3. The Atlantic States Marine Fisheries Commission (ASMFC) FMP includes the following species: American lobster, cobia, Atlantic croaker, black drum, red drum, menhaden, NK sea bass, NK seatrout, spot, striped bass, tautog, Jonah crab, and pandalid shrimp.

The 14-year average annual weight and value of the five most common gear types in the Lease Area are shown in Table 5.4-4. These five gear types account for approximately 86% of average annual value landed from the Lease Area.

Table 5.4-4 Commercial Landings from the Lease Area by Gear Type, 2008–2021

Gear Type	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
Lobster Pot	95,895	$112,003	39%
Bottom Trawl	69,290	$85,685	30%
Gillnet (sink)	21,905	$21,279	7%
Longline (bottom)	3,808	$14,377	5%
Scallop Dredge	1,441	$13,352	5%
All Others	75,925	$39,784	14%
Total	268,264	$286,481	-

Notes:
1. NOAA Fisheries (2023a)
2. Values have been deflated to 2021 dollars.

The 14-year average annual weight and value of the three most exposed states in the Lease Area are shown in Table 5.4-5. These states account for approximately 88% of the average annual value landed from the Lease Area.

Table 5.4-5 Commercial Landings from the Lease Area by State, 2008–2021

State	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
Massachusetts	160,990	$141,791	50%
Rhode Island	82,856	$86,040	30%
New York	10,602	$23,715	8%
All Others	13,626	$34,666	12%
Total	268,074	$286,212	-

Notes:
1. NOAA Fisheries (2023a)
2. Values have been deflated to 2021 dollars.

The 14-year average annual weight and value of the five most exposed ports in the Lease Area are shown in Table 5.4-6. These five ports account for approximately 75% of the average annual value landed from the Lease Area.

Table 5.4-6 Commercial Landings from the Lease Area by Port, 2008–2021

Port	Average Annual Landings (lbs)	Average Annual Value (2021 dollars)	Percentage of Average Annual Lease Area Value
New Bedford, MA	117,597	$101,769	36%
Point Judith, RI	47,900	$47,819	17%
Newport, RI	25,546	$30,285	11%
Montauk, NY	9,946	$21,736	8%
Chatham, MA	10,707	$12,155	4%
All Others	56,375	$72,447	25%
Total	268,071	$286,211	-

Notes:
1. NOAA Fisheries (2023a)
2. Values have been deflated to 2021 dollars.

The VMS- and VTR-based mapping made available by NROC and MARCO qualitatively characterize the density of commercial fishing vessel activity within the Multispecies, monkfish, herring, sea scallop, surf clam/ocean quahog, mackerel, and squid fisheries, and within the bottom trawl, dredge, gillnet, longline, and pots and traps fisheries. The maps were used to characterize commercial fishing effort in the Lease Area.

Figures 5.4-1 through 5.4-6 depict a standardized density of commercial fishing vessel activity within the VMS dataset, including: Multispecies, monkfish, herring, scallop, surf clam/ocean quahog, and squid. As noted above, these maps are based on VMS data for the years 2015 to 2016 and use vessel speed data to differentiate between transiting vessels and vessels actively

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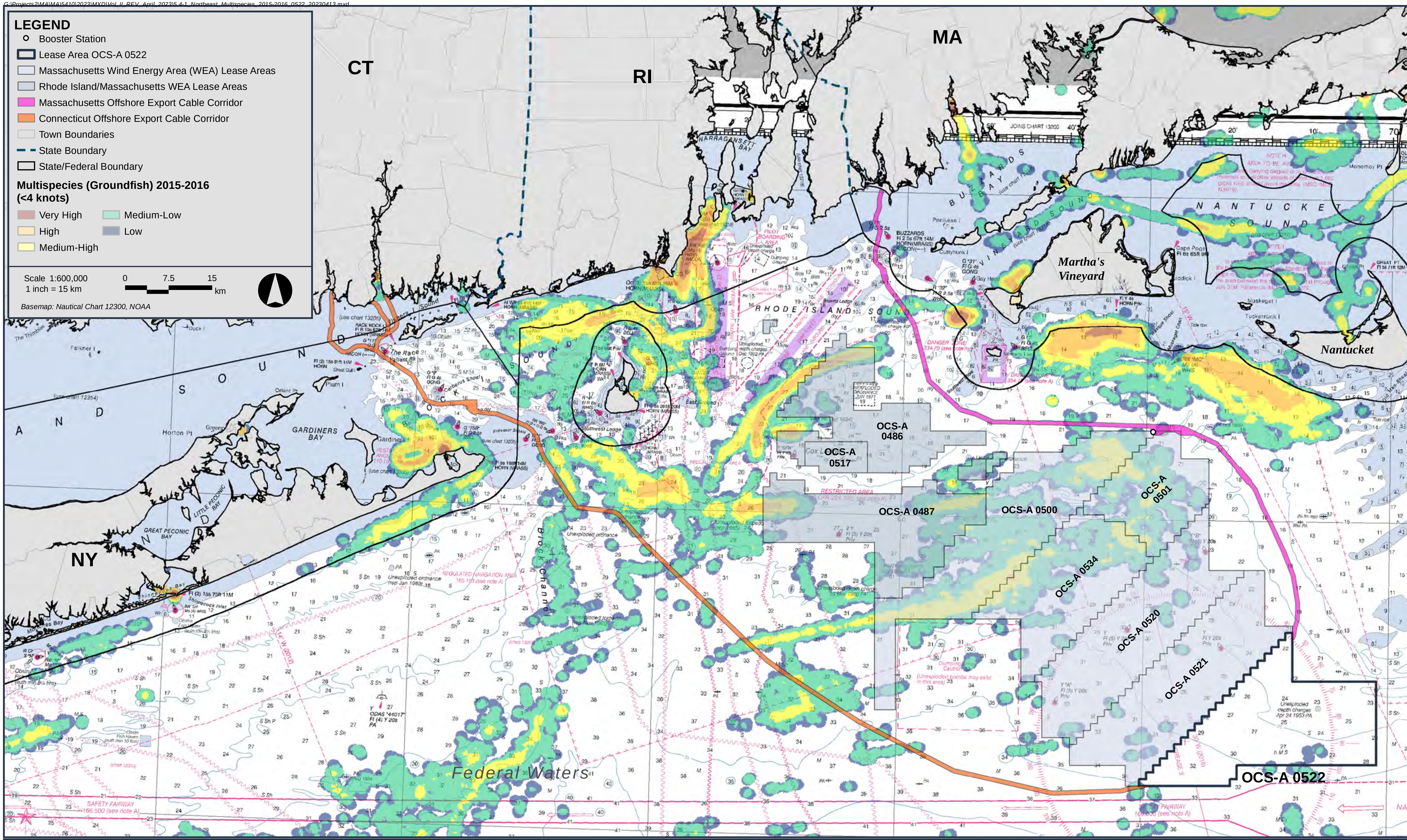

Figure 5.4-1
(VMS) Northeast Multispecies 2015-2016 (<4 knots) Commercial Fishing Density

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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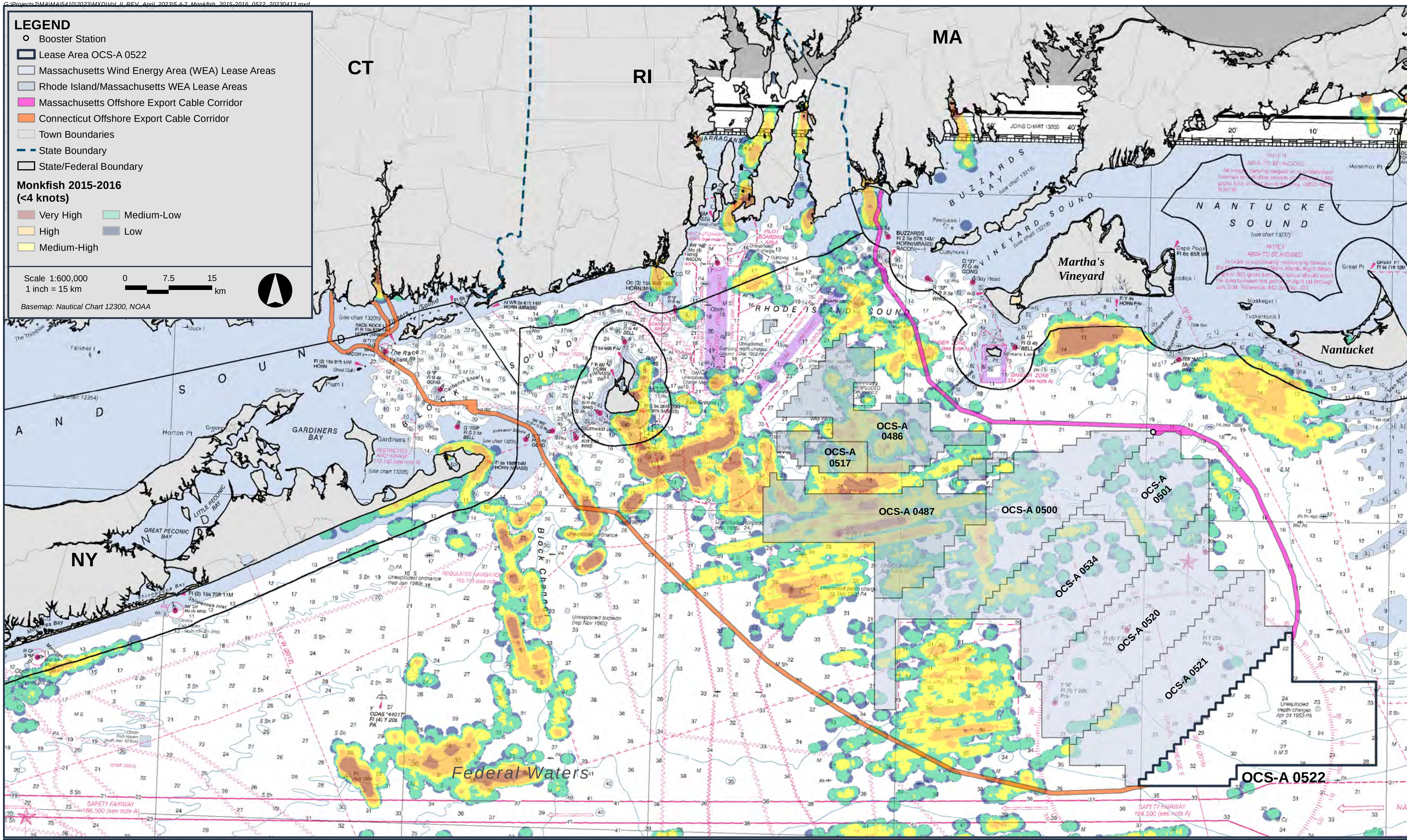

Figure 5.4-2
(VMS) Monkfish 2015-2016 (<4 knots) Commercial Fishing Density

VINEYARD NORTHEAST
VINEYARD OFFSHORE

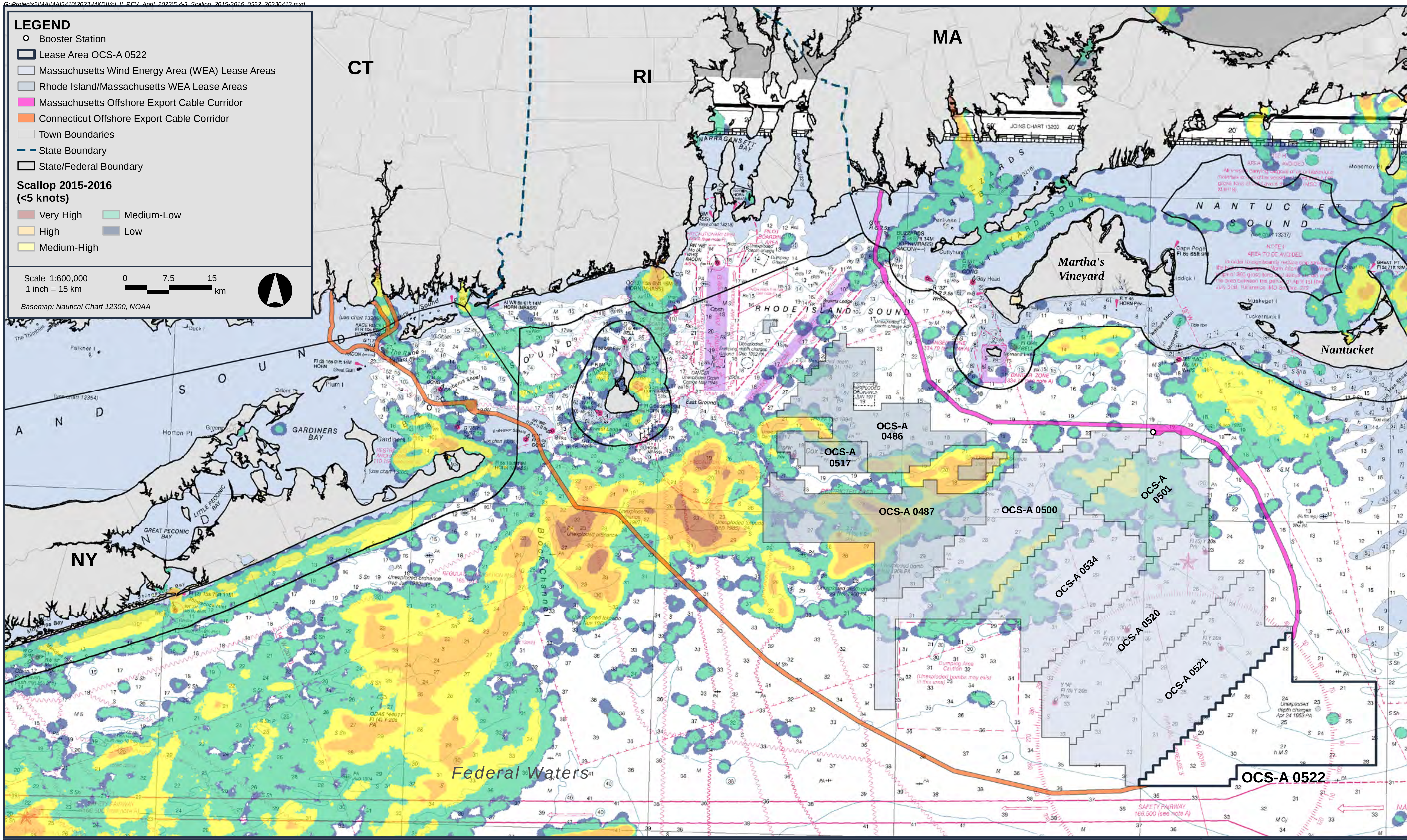

Figure 5.4-3
(VMS) Scallop 2015-2016 (<5 knots) Commercial Fishing Density

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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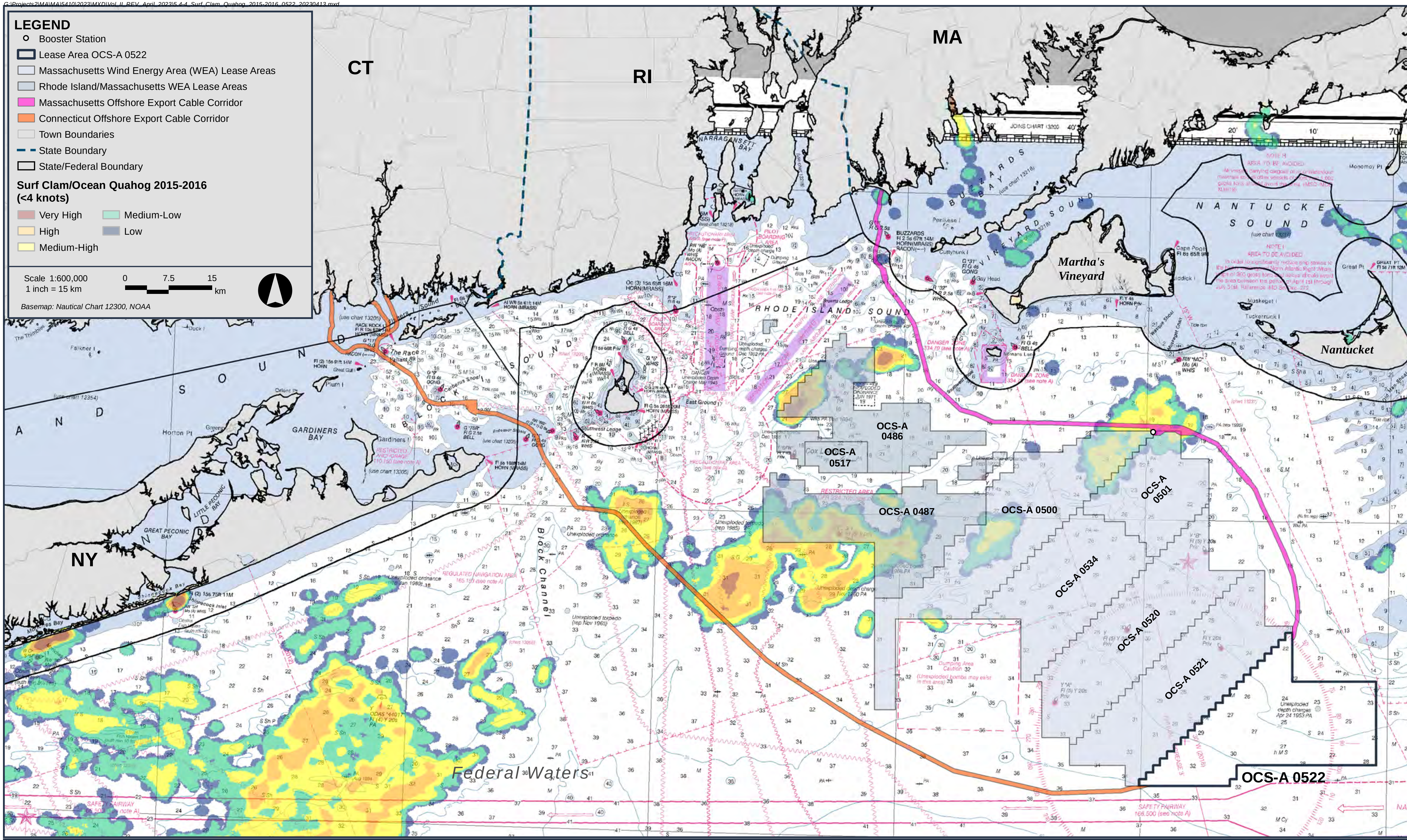

Figure 5.4-4
(VMS) Surf Clam/Ocean Quahog 2015-2016 (<4 knots) Commercial Fishing Density

VINEYARD NORTHEAST
VINEYARD OFFSHORE

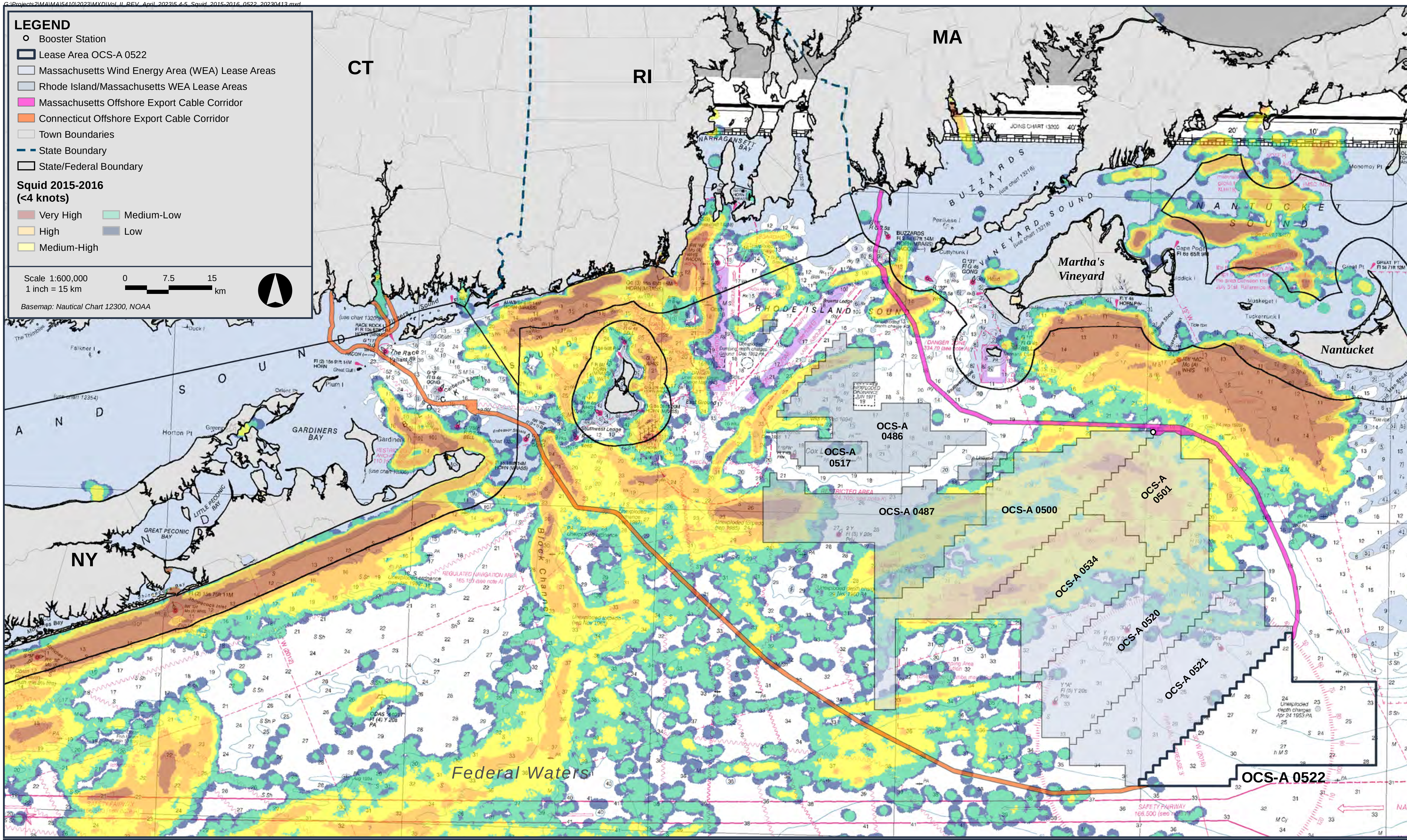

Figure 5.4-5
(VMS) Squid 2015-2016 (<4 knots) Commercial Fishing Density

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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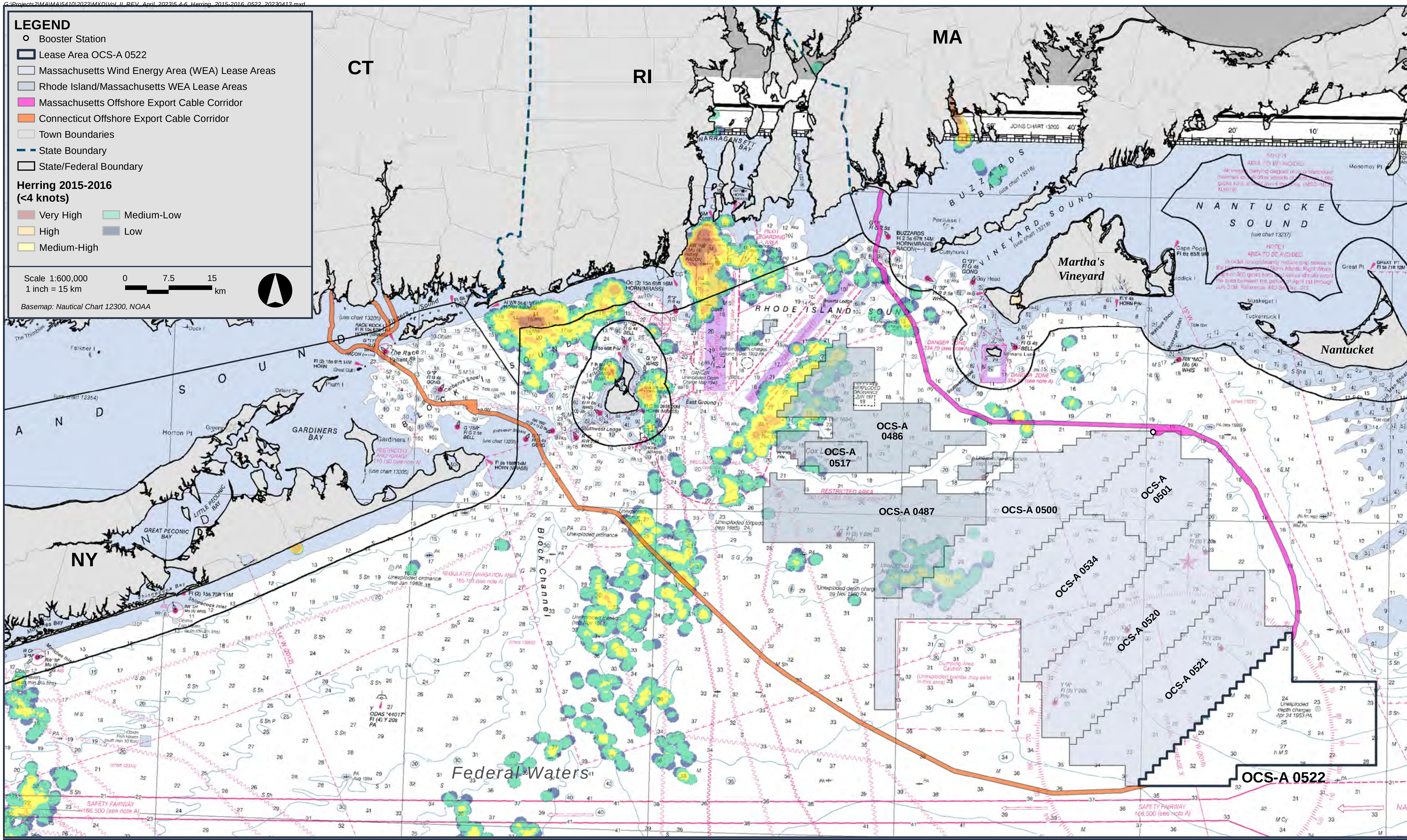

Figure 5.4-6
(VMS) Herring 2015-2016 (<4 knots) Commercial Fishing Density

VINEYARD NORTHEAST
VINEYARD OFFSHORE

engaged in fishing. A speed threshold of <4 or 5 knots is considered indicative of fishing activity, but may also capture vessels transiting (such as within navigation channels) or other non-fishing activities (e.g., processing landings at sea). The VMS-based analysis indicates very little presence in the Lease Area of vessels participating in those fisheries.

Figures 5.4-7 through 5.4-18 are VTR-based maps depicting the bottom trawl, dredge, gillnet, longline, and pots and traps fisheries (excluding lobster). It is important to note that the VMS figures (see Figures 5.4-1 through 5.4-6) depict relative vessel density between 2015 and 2016, while the VTR figures are aggregated, separately, for 2006 to 2010 and 2011 to 2015. The VTR-based analysis also indicates very little presence in the Lease Area of vessels participating in those fisheries.

To support the Kirkpatrick et al. (2017) analysis of socioeconomic exposure of commercial fisheries to wind energy development in the United States (US) Atlantic and to improve upon the spatial precision of self-reported VTR fishing locations, BOEM developed a revenue-intensity raster dataset using fishery dependent landings data (BOEM 2020). Revenue intensity rasters use VTR data merged with at-sea fisheries observer data to aid in the development of statistical models to generate predictions for the spatial footprint of fishing reported on a VTR (Kirkpatrick et al. 2017). Similar to the other data sources used to quantify commercial fishing intensity in the Offshore Development Area, the revenue intensity rasters provide a geographic representation of commercial fishing intensity and revenue. Figure 5.4-19 through Figure 5.4-23 depict the annual revenue intensity for all Fishery Management Plans. As shown by these figures, the areas of greatest revenue intensity are located outside the Lease Area.

The estimates of the economic value of fishing activity based on NOAA Fisheries (2022) data during the years 2008-2021 indicate that the average annual value of landings for all species within the Lease Area is approximately $286,440. Jonah crab and American lobster, predominantly pot fisheries, are the most valuable species in the Lease Area, which account for approximately 38% of the average annual landings in the Lease Area.

Species harvested from the Lease Area are predominantly landed in Massachusetts and Rhode Island, and to a lesser extent, New York. Landings from the Lease Area within those states are predominantly at the ports of New Bedford, Massachusetts; Point Judith and Newport, Rhode Island; and Montauk, New York.

Quantitative Assessment of Fishing Vessel Traffic

To quantify fishing effort, AIS data were queried to establish estimates of commercial fishing vessel traffic within the Lease Area. These vessel counts are believed to capture larger commercial fishing vessels that are required to operate an AIS Class B device, such as the bottom trawl vessels over 20 m (65 ft) in length characterized by the mapping of VTR data shown in Figures 5.4-9 and 5.4-10. As described in the NSRA included in Appendix II-G, the

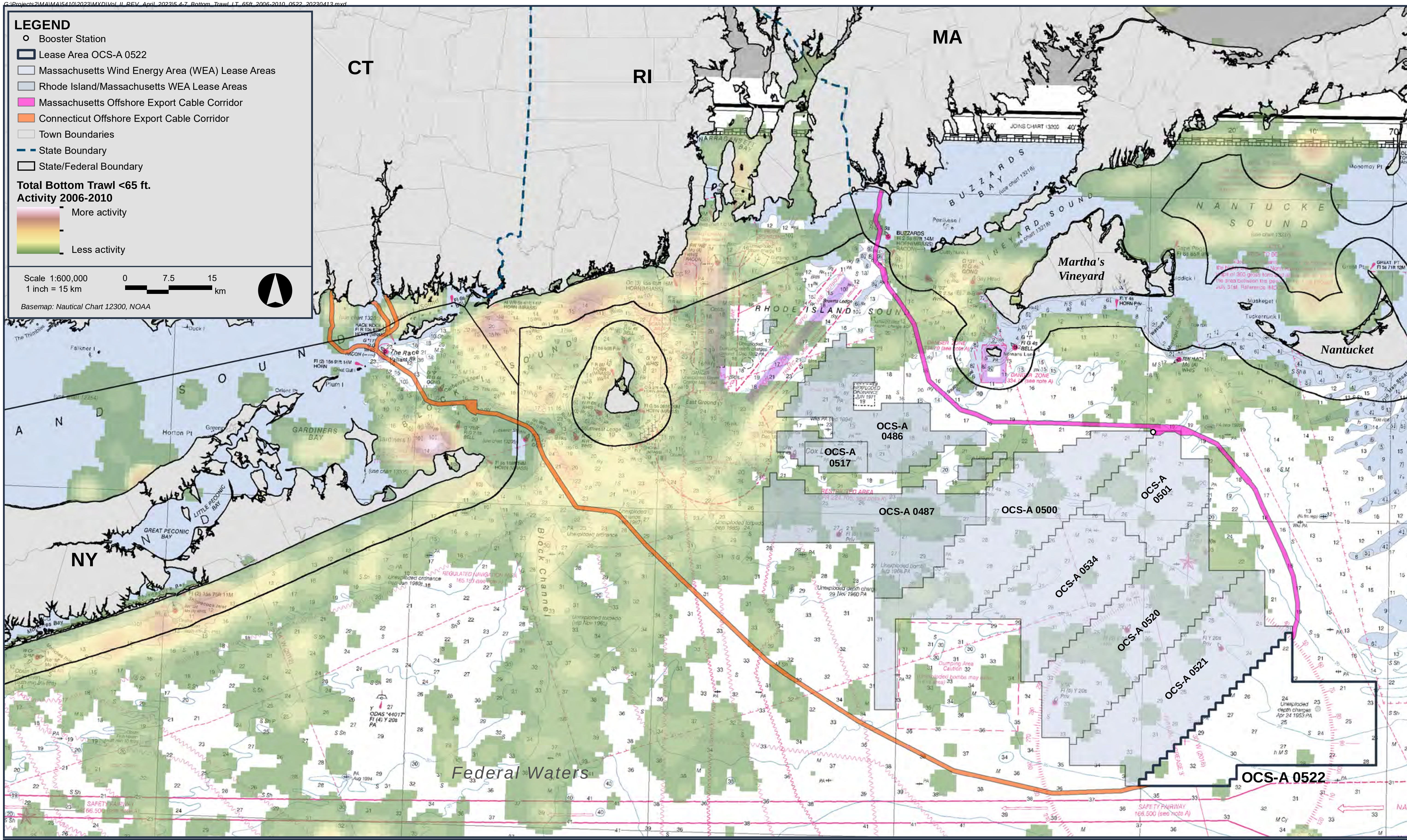

Figure 5.4-7
(VTR) Bottom Trawl (Vessel <65 ft.) 2006–2010

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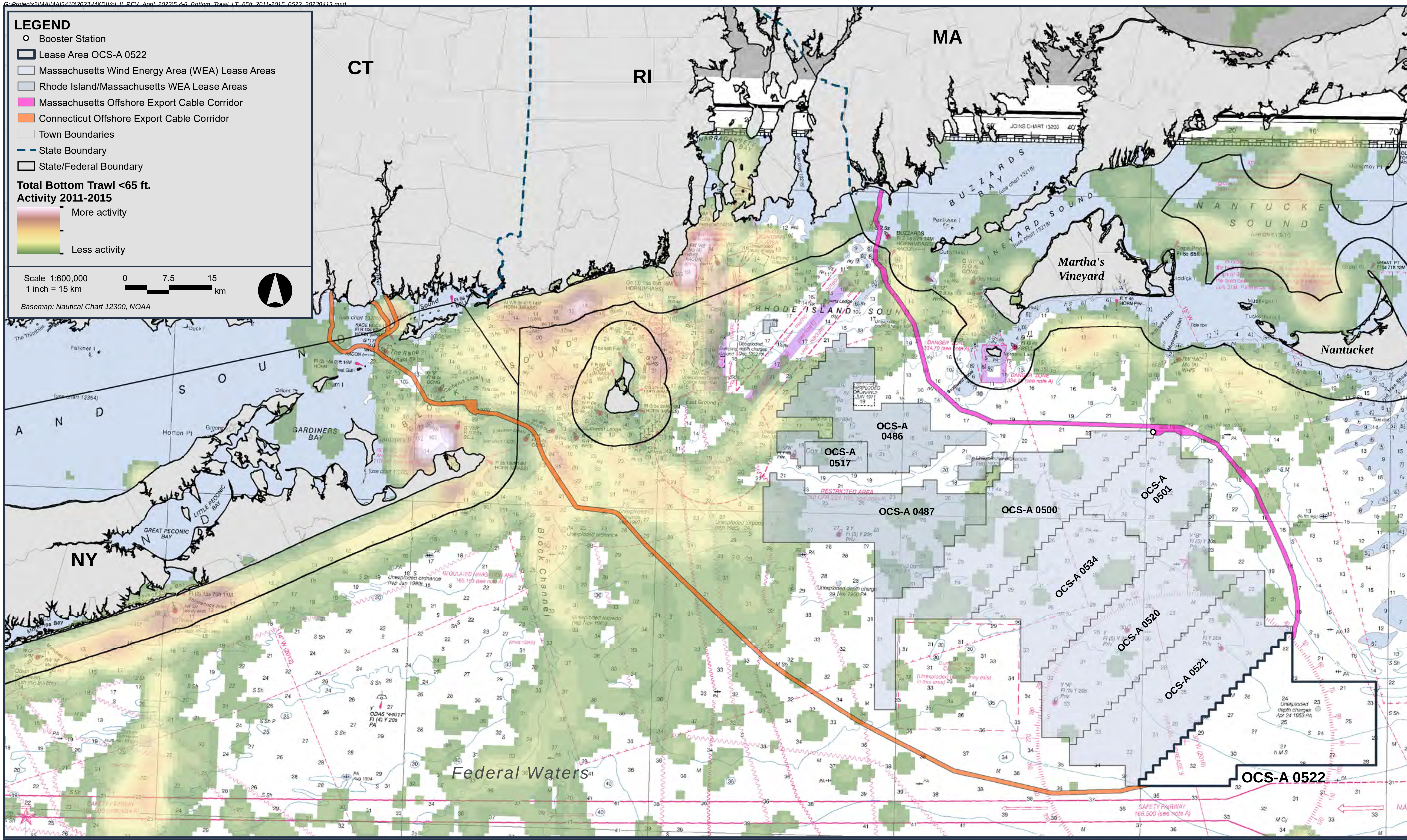

Figure 5.4-8
(VTR) Bottom Trawl (Vessel <65 ft.) 2011–2015

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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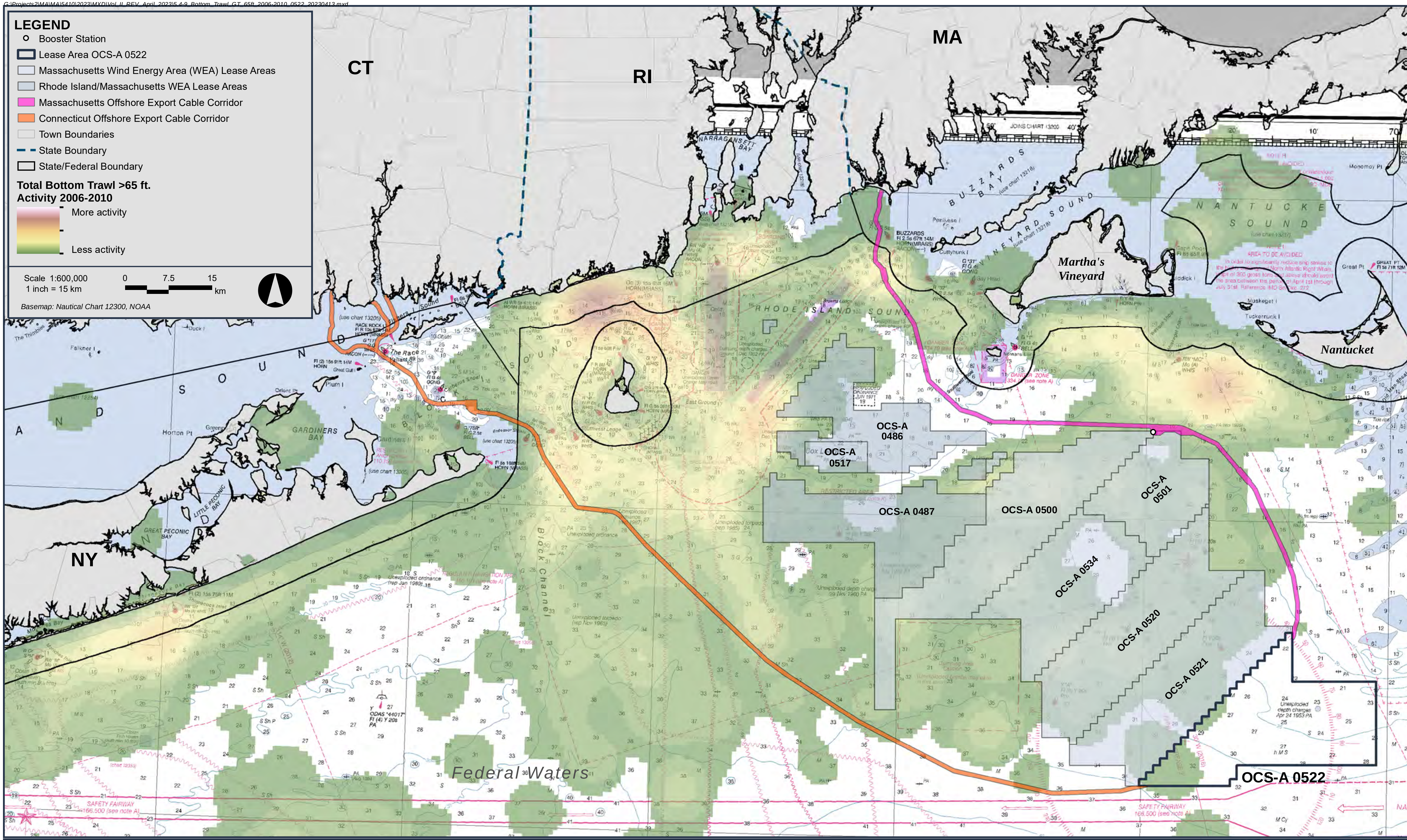

Figure 5.4-9
(VTR) Bottom Trawl (Vessel >65 ft.) 2006–2010

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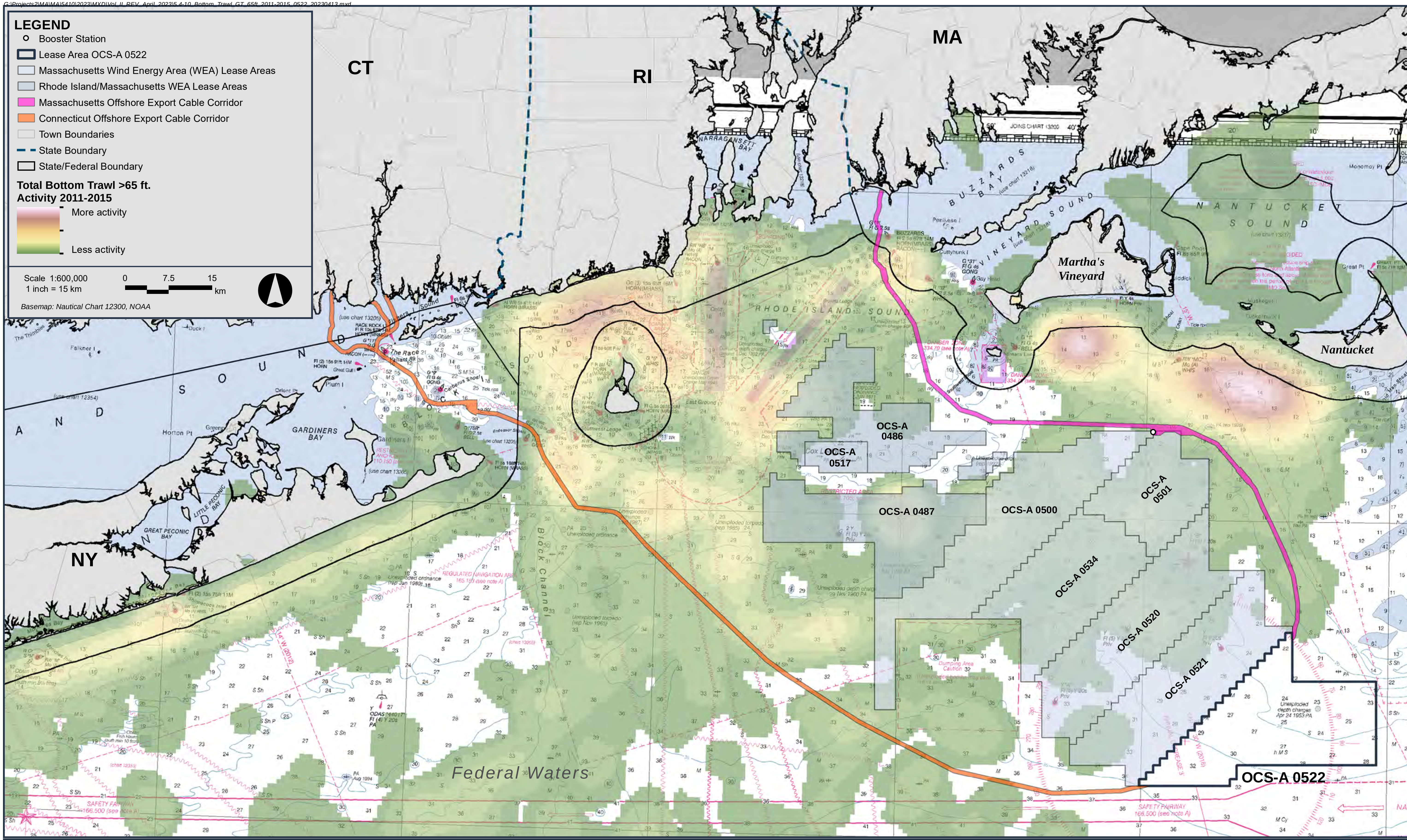

Figure 5.4-10
(VTR) Bottom Trawl (Vessel >65 ft.) 2011–2015

VINEYARD NORTHEAST
VINEYARD OFFSHORE

G:\Projects2\MA\MA5410\2023\MXD\Vol_II_REV_April_2023\5.4-11_Dredge_2006-2010_0522_20230413.mxd

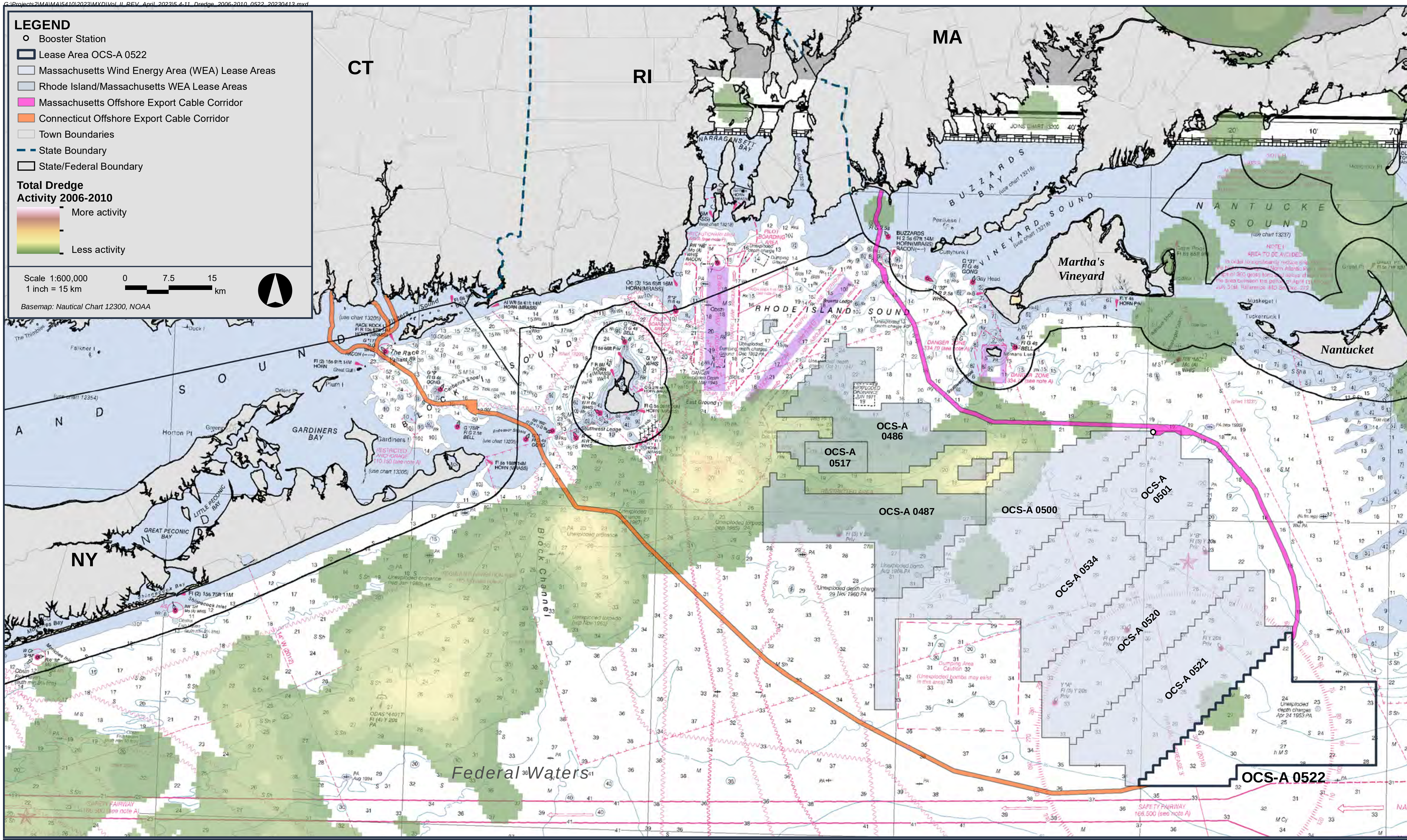

Figure 5.4-11
(VTR) Dredge 2006–2010

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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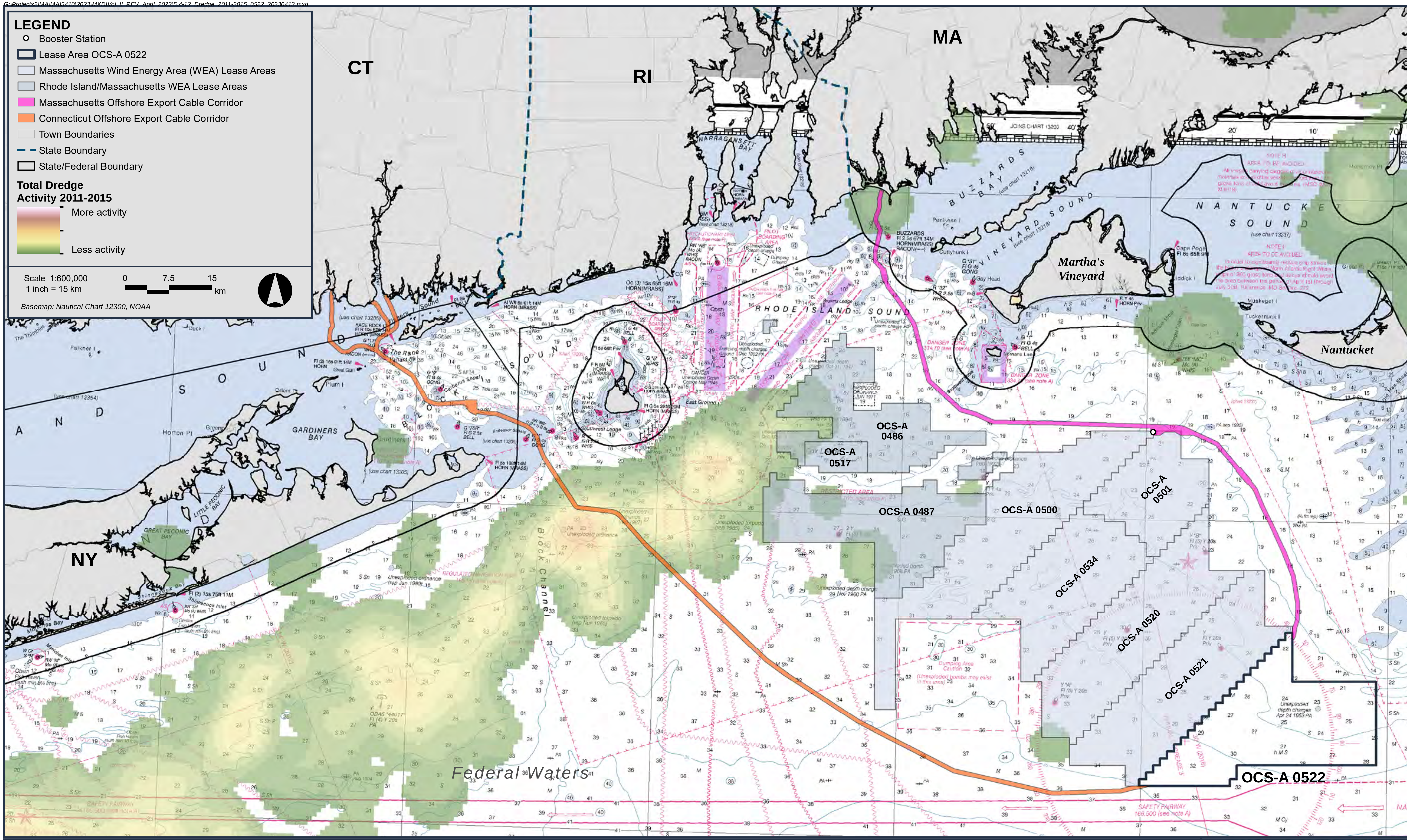

Figure 5.4-12
(VTR) Dredge 2011–2015

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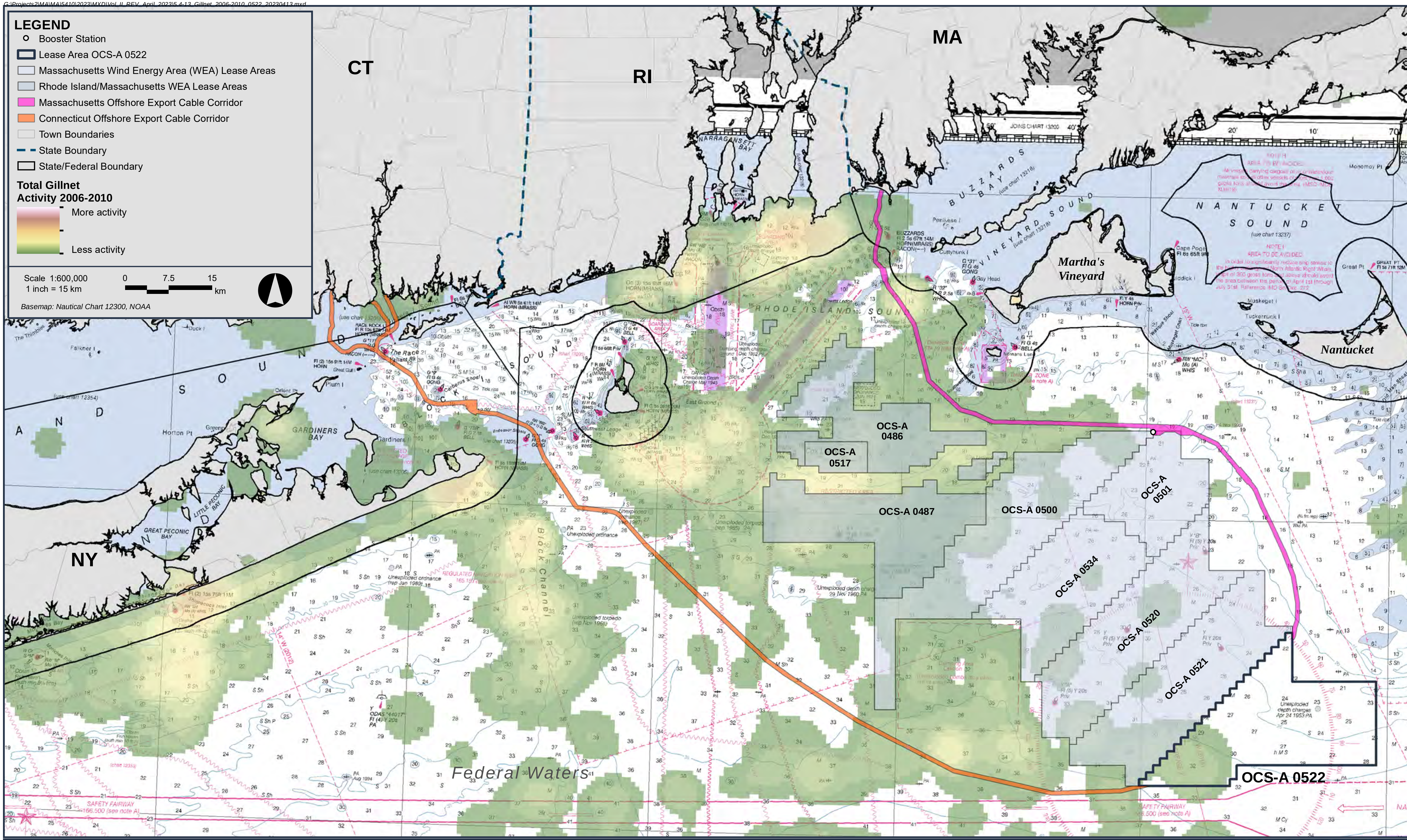

Figure 5.4-13
(VTR) Gillnet 2006–2010

VINEYARD NORTHEAST
VINEYARD OFFSHORE

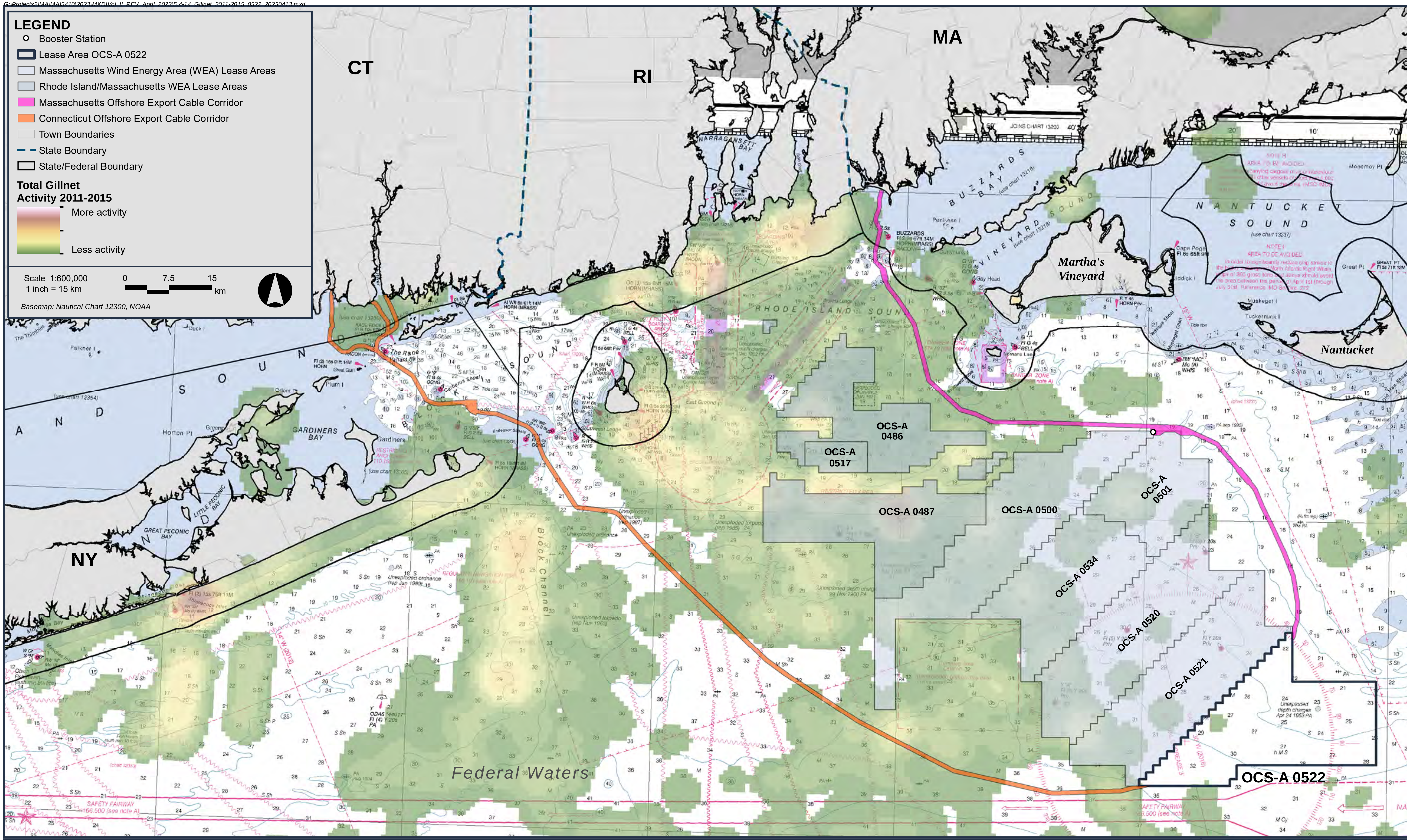

Figure 5.4-14
(VTR) Gillnet 2011–2015

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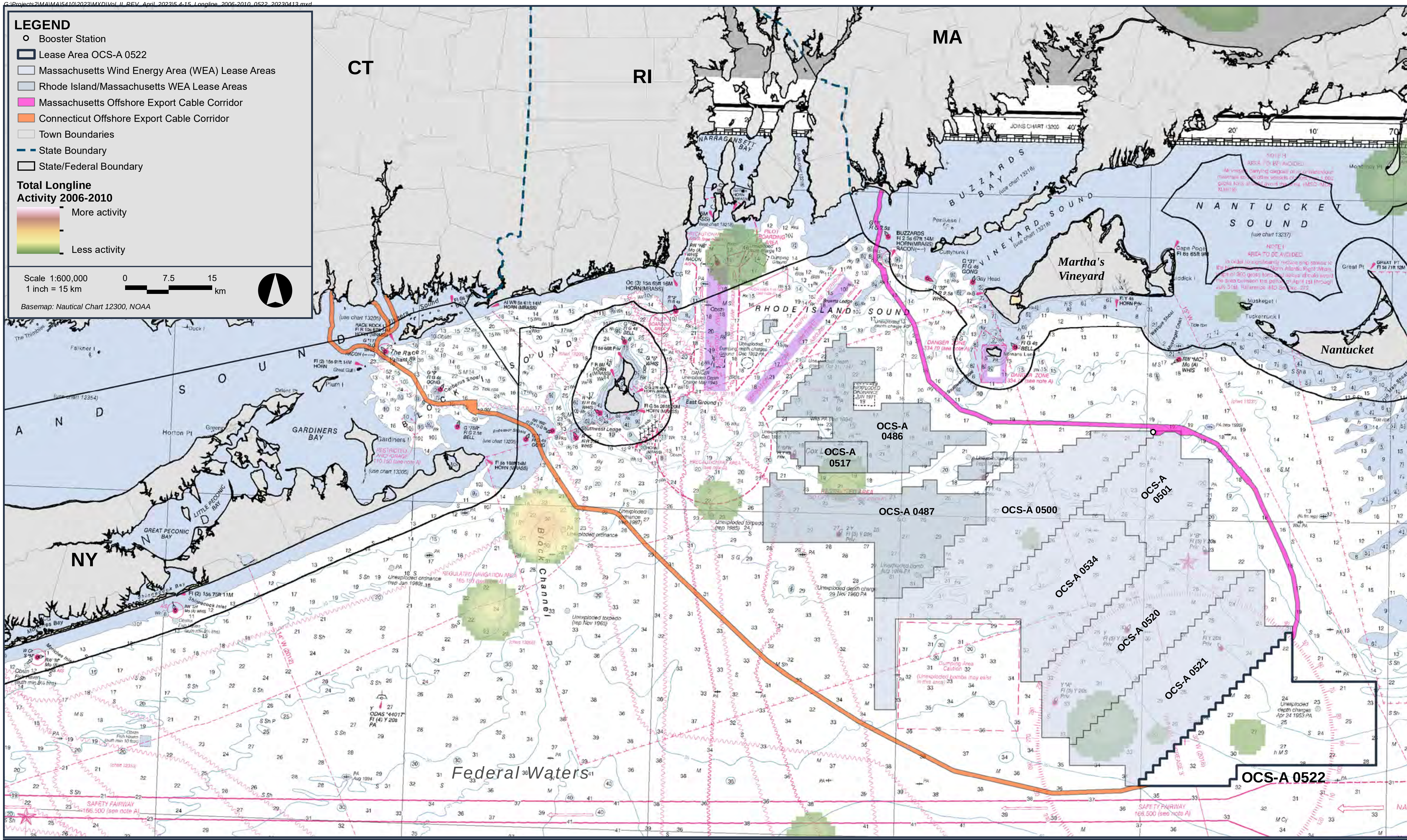

Figure 5.4-15
(VTR) Longline 2006–2010

VINEYARD NORTHEAST
VINEYARD OFFSHORE

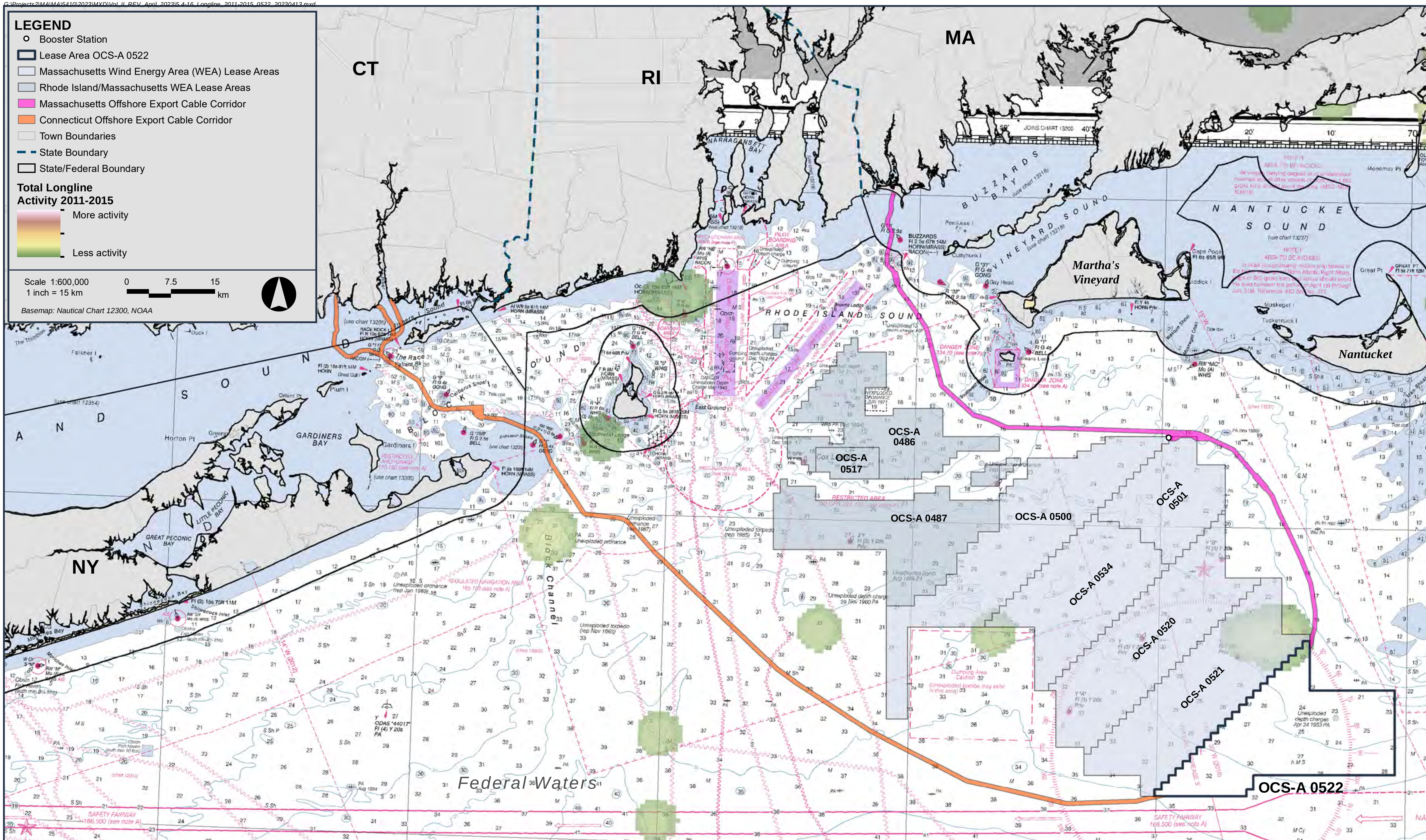

Figure 5.4-16
(VTR) Longline 2011–2015

VINEYARD NORTHEAST

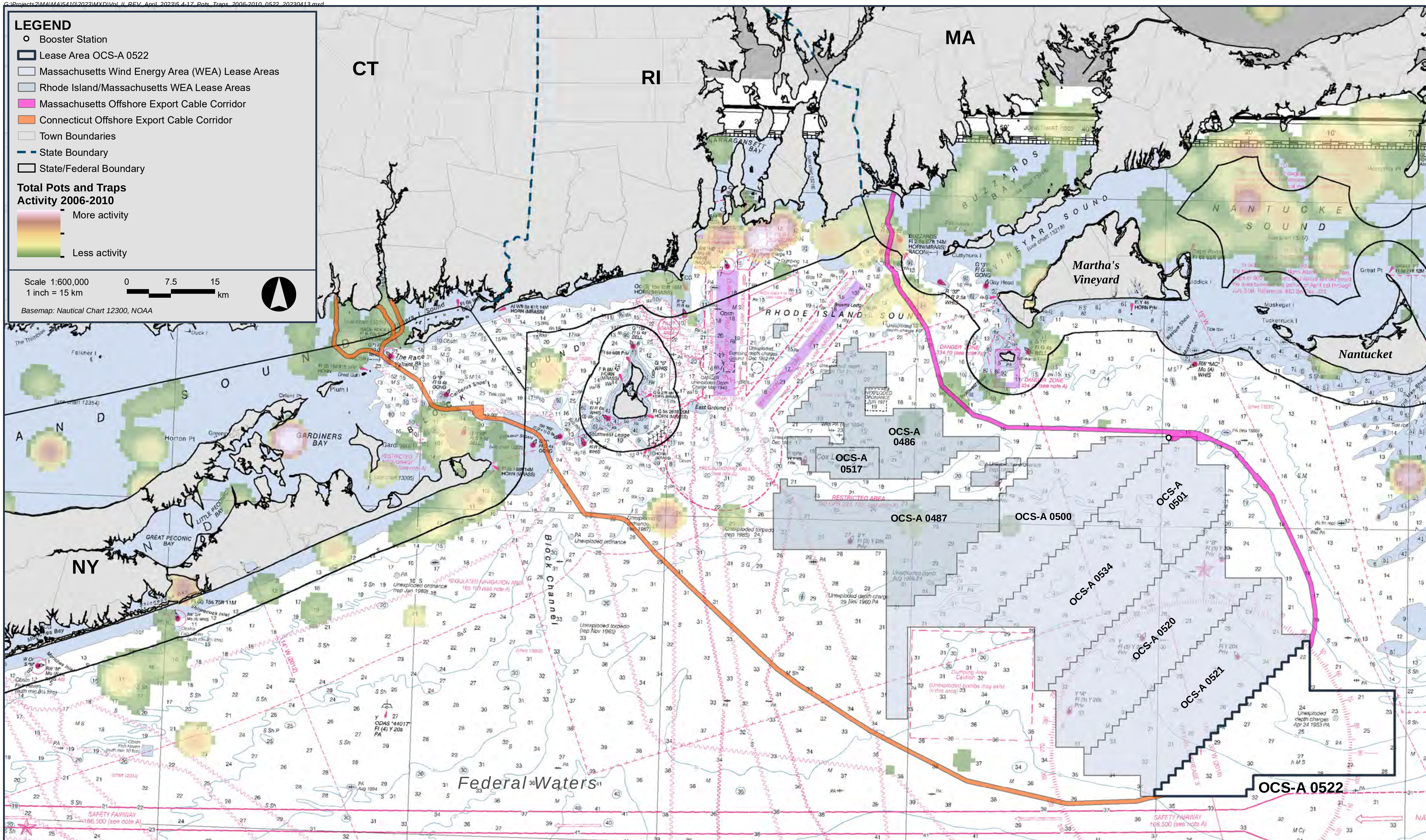

Figure 5.4-17
(VTR) Pots and Traps 2006–2010

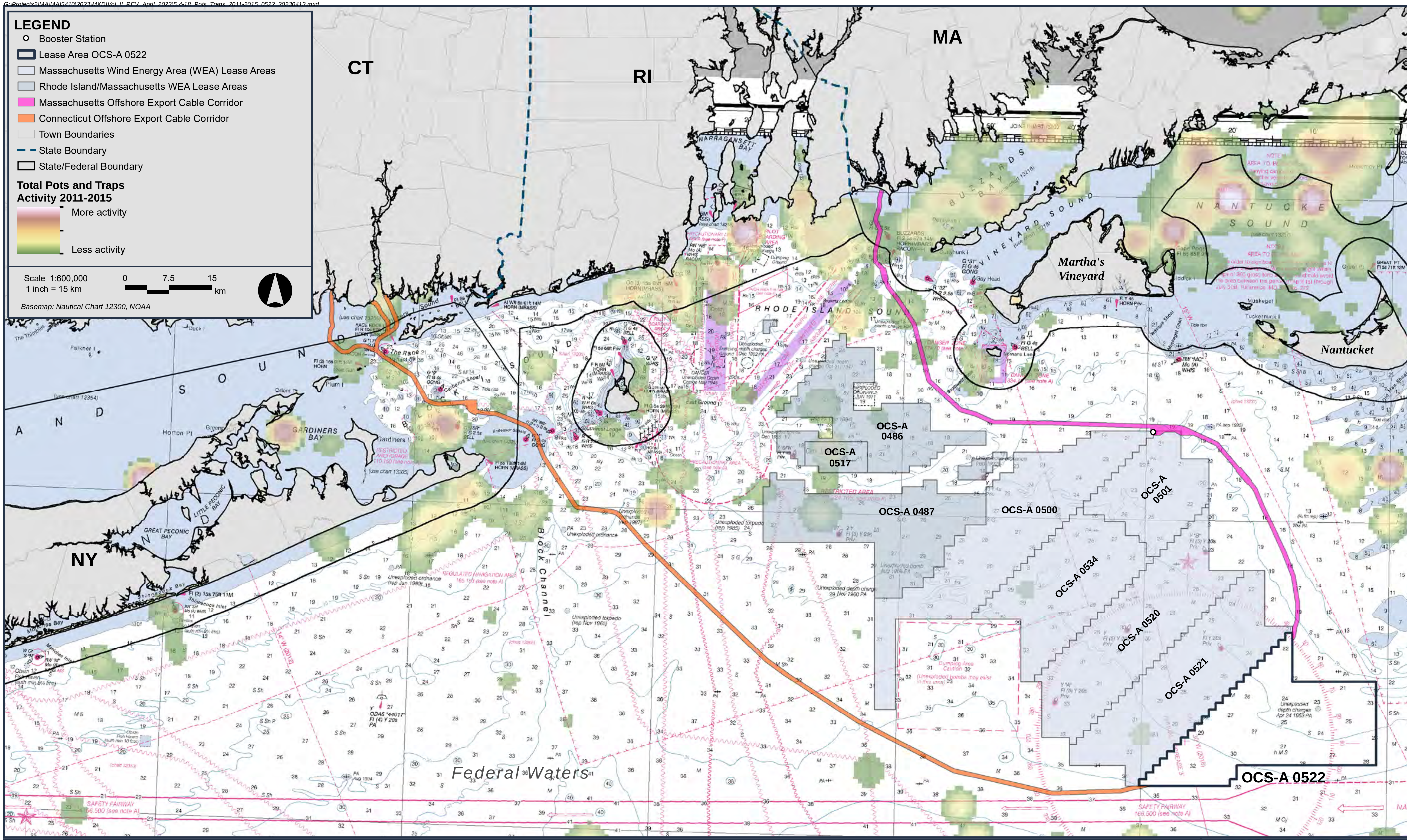

Figure 5.4-18

(VTR) Pots and Traps 2011–2015

VINEYARD NORTHEAST
VINEYARD OFFSHORE

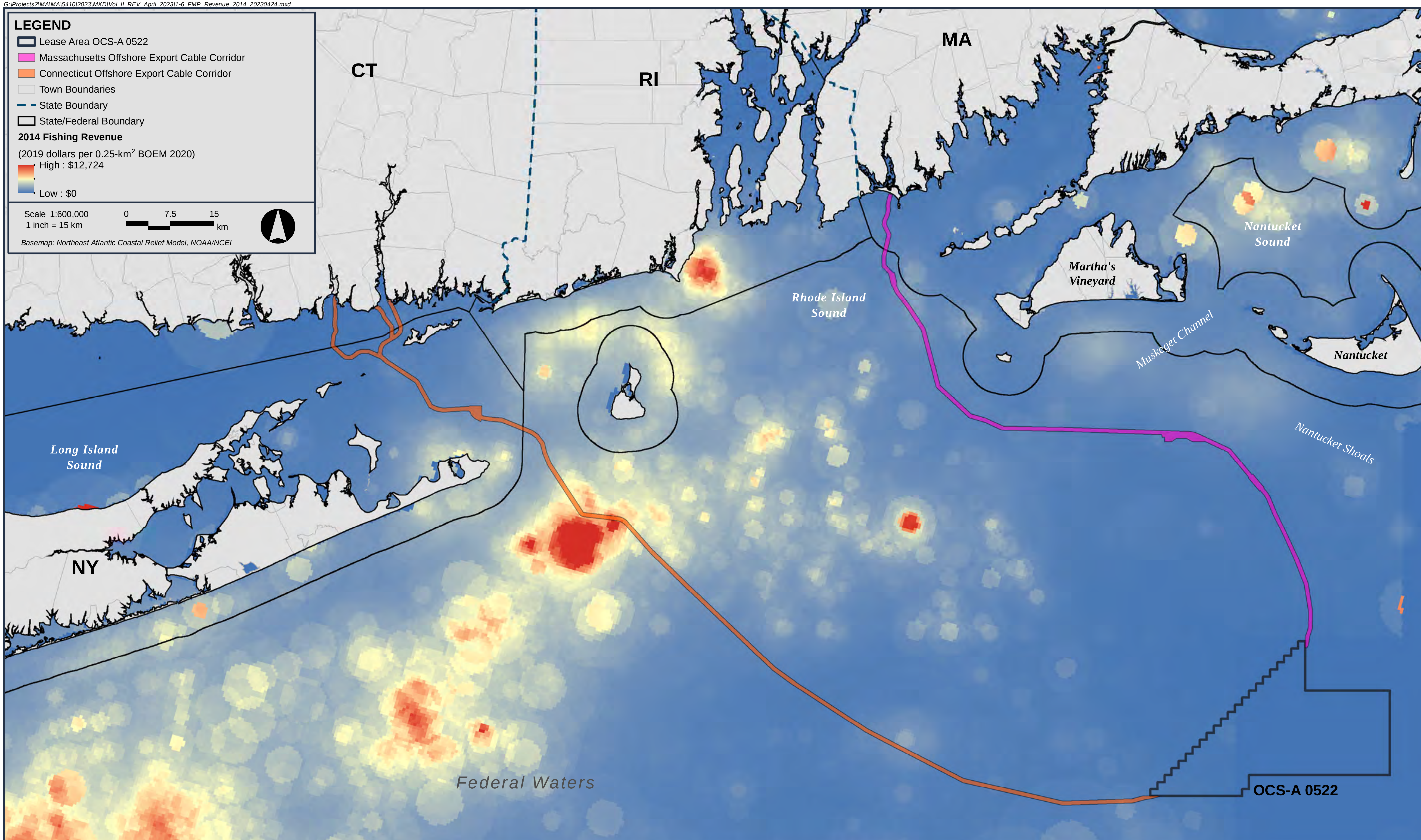

Figure 5.4-19
Fishing Revenue Density, All Fishery Management Plans, 2014

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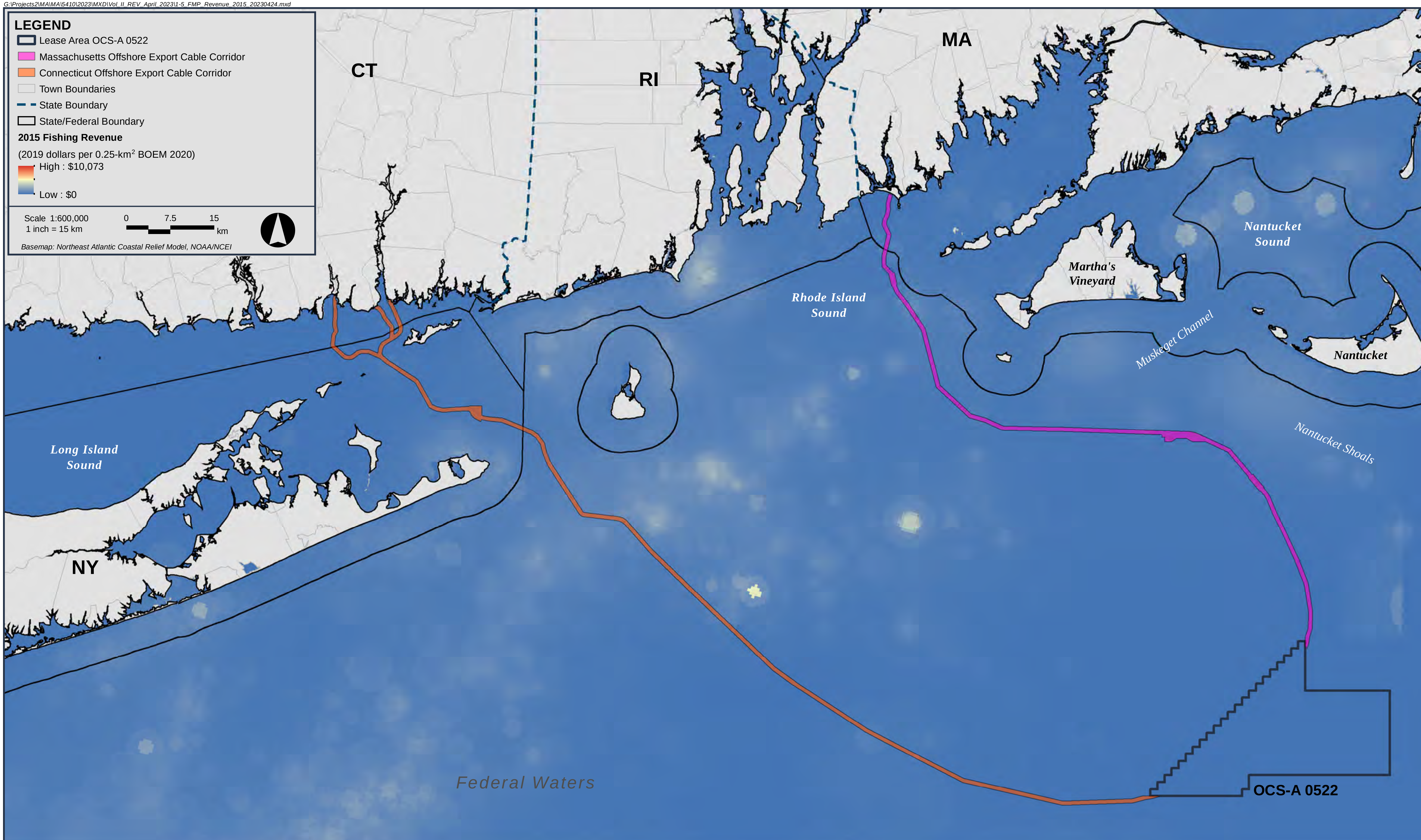

Figure 5.4-20

Fishing Revenue Density, All Fishery Management Plans, 2015

VINEYARD NORTHEAST

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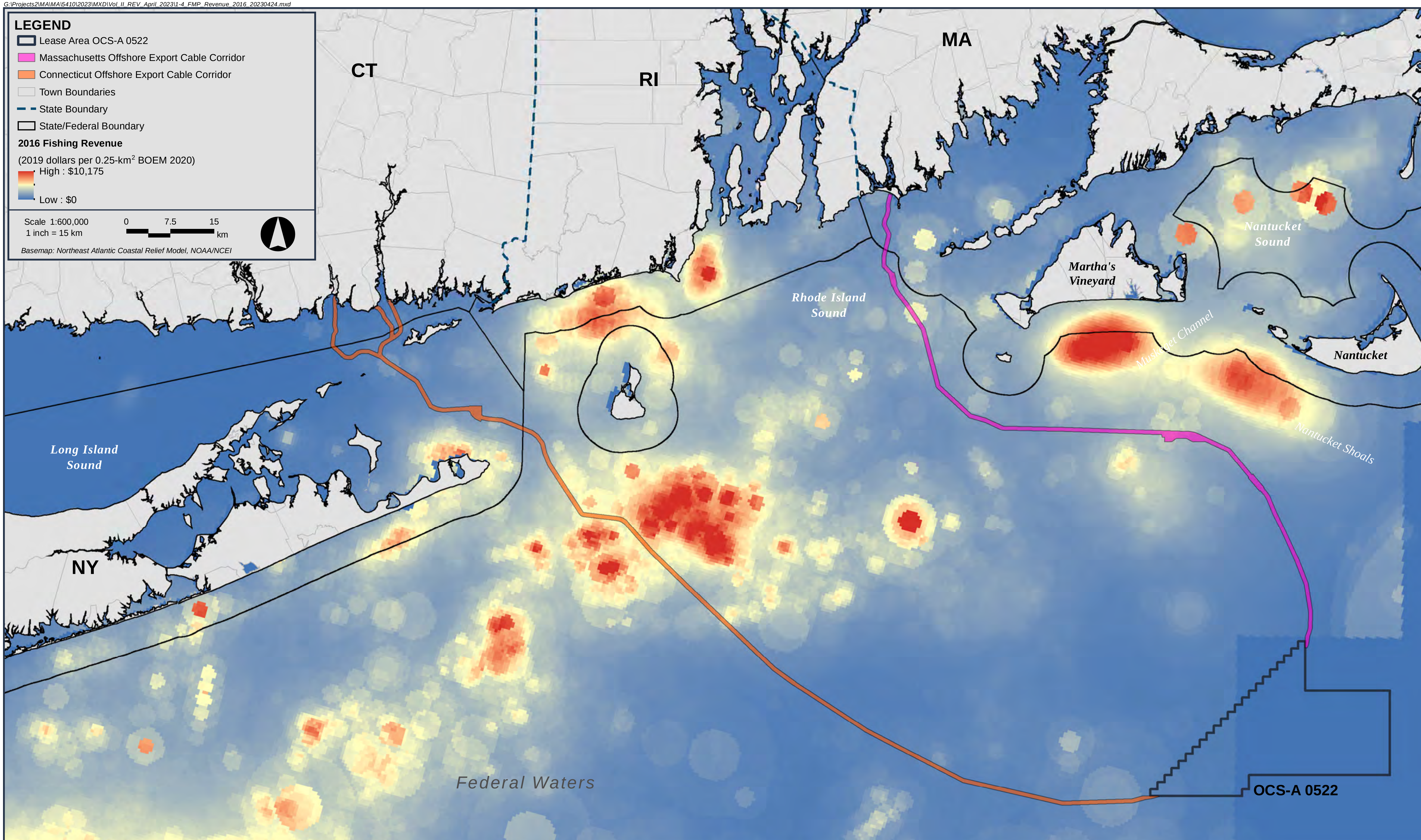

Figure 5.4-21

Fishing Revenue Density, All Fishery Management Plans, 2016

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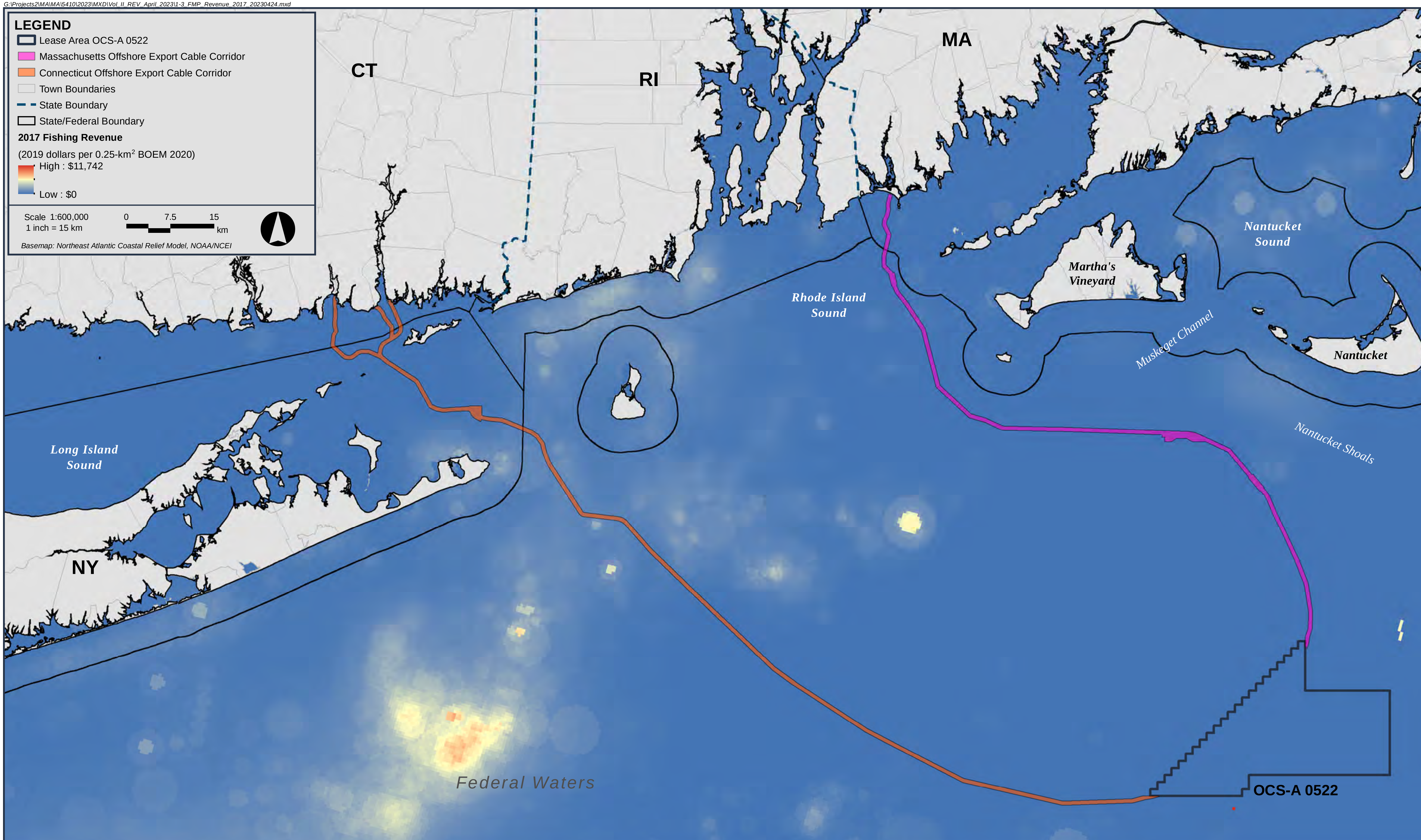

Figure 5.4-22

Fishing Revenue Density, All Fishery Management Plans, 2017

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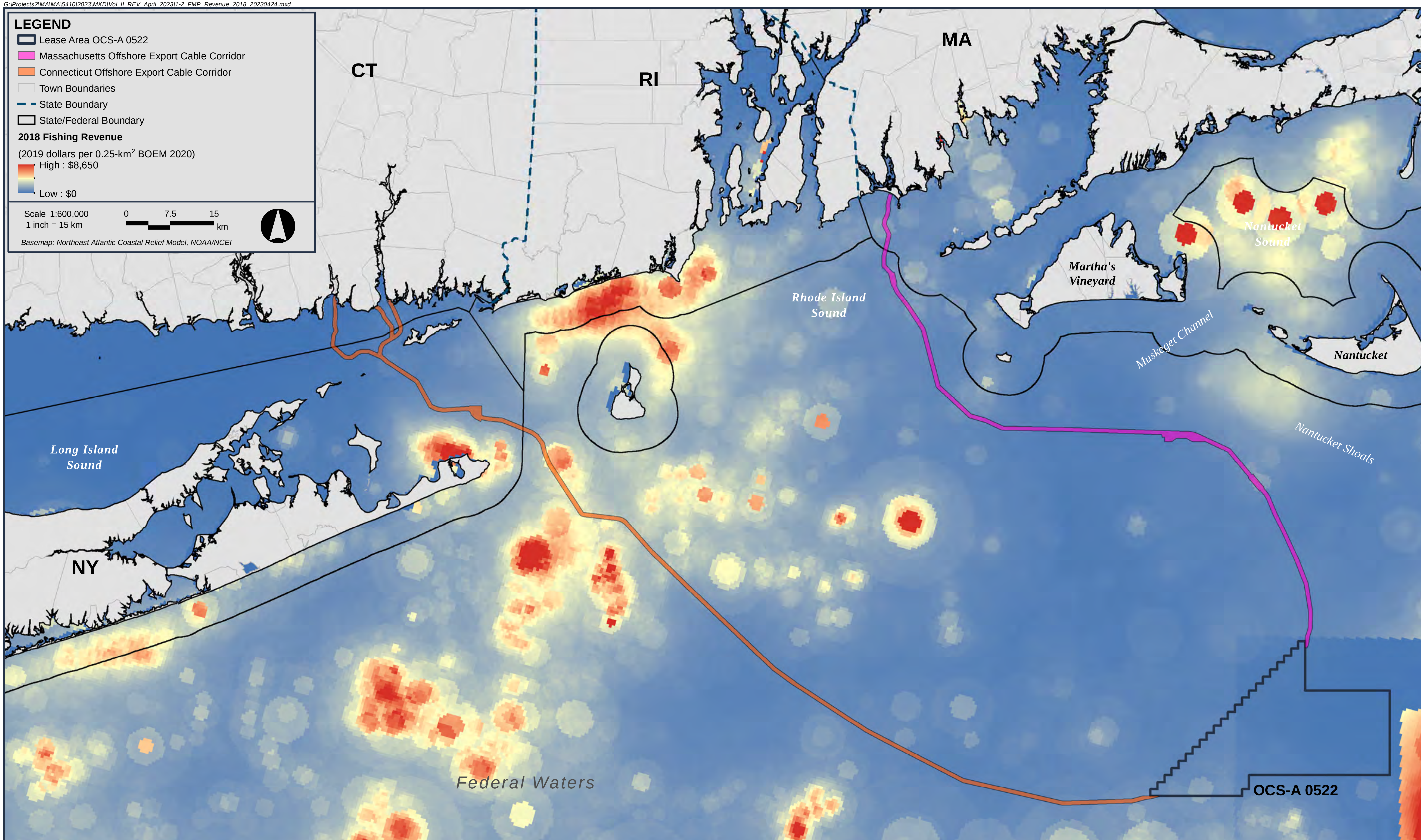

Figure 5.4-23
Fishing Revenue Density, All Fishery Management Plans, 2018

AIS data show that historical vessel traffic levels within the Lease Area are relatively low, with only 4.5 fishing vessels entering the AIS analysis area per day (on average) during the peak summer months. Table 5.4-7 identifies the number of commercial fishing vessels operating within the Lease Area from 2016 to 2021 based on AIS data and broken down by vessel speed. Vessel speed reported by AIS data may indicate whether a vessel is fishing (≤four knots) or transiting (>four knots). Commercial fishing vessels are assumed to operate at vessels speeds up to four knots when mobile gear is deployed. When these vessels are transiting an open water area, they are assumed to operate at speeds greater than four knots. Table 5.4-7 shows that during 2016–2021 fishing vessels entered the Lease Area an average of 990 times per year but were engaged in fishing in the Lease Area on just 69 (7%) of those trips. During those years, the number of fishing trips in the Lease Area per month averaged over 10 during only two months (August and September). See Appendix II-G for additional details on the AIS based traffic survey for the Lease Area.

Adjustments for Lobster and Jonah Crab

To provide a basis for estimating full economic exposure, VTR records used to develop annual fishing values need to be adjusted to account for lobster and Jonah crab landings by vessels that land only these two species and do not file federal VTRs. In addition to VTR-reported landings of these two species, federal fishing permit data are available that show how many pots are permitted to fish for lobster and Jonah crab in Lobster Management Area 2 (LMA 2) and Lobster Management Area 3 (LMA 3). The northerly portion of the Lease Area is located within LMA 2/3 Overlap and the southerly portion of the Lease Area is located in LMA 3. From the federal permit data, it is possible to identify the number of pots permitted to vessels that file VTRs and to vessels that do not file VTRs. These numbers provide a measure of potential fishing effort on these two species in LMA 2 and LMA 3 by both VTR and non-VTR vessels. Based on the assumptions listed below, the annual landed value of lobster and Jonah crab in the Lease Area per permitted pot for vessels that do file VTRs was used to impute the annual landed value of those two species per permitted pot for vessels that do not file VTRs.

Federal fishing permit data for 2022 show that 143,548 pots are permitted to harvest lobster in LMA 2 and LMA 3. Of these 143,548 permitted pots, 103,051 pots or 72% of all permitted pots in LMA 2 and LMA 3, are permitted to vessels that target species other than lobster and Jonah crab and therefore file VTRs that include the value of their landings of lobster and Jonah crab. The remaining 40,497 pots or 28% of all permitted pots, are deployed from vessels that only possess permits to target lobster and Jonah crab, which are not required to file VTRs.

Table 5.4-7 Average AIS Fishing Vessel Traffic through the Lease Area (2016–2021)

	Monthly Average												
Average (2016–2021)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual Average Total (Unique Vessels)**
Number of Unique Fishing Vessels (fishing)	1.5	0.3	1.5	1.8	3.5	3.2	3.8	5.3	9.7	3.8	2.0	1.6	29.0
Number of Unique Fishing Vessel Transits (fishing)	1.7	1.0	1.7	2.2	4.3	5.2	7.5	13.3	20.3	5.8	3.2	2.0	69.2
Number of Unique Fishing Vessels (transiting)	14.7	14.3	19.8	41.3	55.0	59.7	62.7	57.3	41.3	32.4	25.0	20.0	198.6
Number of Unique Fishing Vessel Transits (transiting)	28.8	28.5	40.3	95.2	126.0	128.2	137.8	137.0	85.3	63.4	46.2	33.0	966.3
Number of Unique Fishing Vessels (all)	14.8	14.3	20.0	41.3	55.0	59.7	62.8	57.7	43.3	33.0	25.2	20.2	200.9
Number of Unique Fishing Vessel Transits (all)	29.2	28.7	40.5	95.2	126.8	129.3	139.8	141.7	95.2	65.8	47.4	33.6	989.9

Notes:

1. Data source is Baird 2022.
2. Analysis has been completed to separate transiting fishing vessels and those fishing vessels that are likely to be fishing (≤4 knots (kts) fishing, >4 kts transiting).
3. Transiting and actively fishing tracks can be doubly counted.

NOAA Fisheries (2022) data shows the 14-year total value of fish harvested in the Lease Area by vessels that filed VTRs included $412,719 worth of lobster, an average annual value of $29,480, and $1,123,301 worth of Jonah crab, an average annual value of $80,236. Average annual fishing revenue from both species, therefore, is $109,716. The average annual lobster and Jonah crab revenues per pot permitted in LMA 2 and LMA 3 to vessels that file VTRs is $1.07. This value is based on the average annual fishing revenue from both species ($109,716) and the 103,051 pots permitted to vessels that file VTRs for these species.

If the characteristics of lobster and Jonah crab fishing by vessels that file VTRs were identical to those of vessels that do not file VTRs, the $1.07 in annual lobster and Jonah crab revenues in the Lease Area per permitted pot for vessels that file VTRs could be applied equally to pots permitted to vessels that do not file VTRs. However, information received from Massachusetts state lobster fishery experts indicated that vessels that fish only for lobster and Jonah crab and do not file VTRs are more dedicated to fishing for those two species than vessels that harvest those two species along with other species and do file VTRs. That feedback indicated that compared with vessels that do file VTRs, vessels that do not file VTRs are likely to: (1) actively fish a higher percentage of permitted pots, (2) deploy a higher percentage of active pots in the Lease Area, and (3) achieve higher catch rates and annual revenues per active pot.

To account for these factors the annual value of lobster and Jonah crab harvested by non-VTR vessels in the Lease Area is estimated here by assuming that pots permitted to non-VTR vessels are: 25% more active, spend 25% more active fishing time in the Lease Area, and generate 25% more fishing revenues than pots permitted to vessels that file VTRs. In effect, these assumptions result in $2.08 as an estimate of revenues generated in the Lease Area per pot permitted to non-VTR vessels. ($1.07 x 1.25 x 1.25 x 1.25). The 40,497 pots permitted to non-VTR vessels, therefore, are estimated to generate approximately $84,211 in annual lobster and Jonah crab revenues from the Lease Area that are not included in fishing revenues reported in NOAA Fisheries (2022).[75] Therefore, the average annual fishing revenues generated in the Lease Area during 2008–2021, adjusted to account for unreported lobster and Jonah crab landings, equal $370,651. This represents an estimate of the annual economic exposure of commercial fisheries if all commercial fishing revenues from the Lease Area were lost for a full year and not recouped by fishing effort shifting from the Lease Area to other fishing areas. See Appendix II-F for additional details of the estimated economic exposure of commercial fisheries in the Lease Area.

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[75] Note this adjustment method is conservative and likely results in a high estimate of the annual lobster and Jonah crab revenues from the Lease Area that are not included in fishing revenues reported in the NOAA Fisheries data (NOAA Fisheries 2023a).

5.4.1.2 Massachusetts OECC and Connecticut OECC

The data summarized below are based on NOAA Fisheries' analysis of combined data from VTRs and dealer reports submitted by vessels with federal permits from 2008 to 2021 (NOAA Fisheries 2023b). Based on the NOAA Fisheries data, annual fishing revenues in the Massachusetts OECC during 2008–2021 averaged \$2,294 per km^2, and ranges from \$3,308 to \$3,429 per km^2 in the Connecticut OECC depending on which landfall approach is used.[76]

Commercial fishing will be precluded in the OECCs only in areas around where pre-installation and cable installation activities are underway and will not be precluded or impaired in the rest of the OECCs where cable installation is either planned or has been completed. The five most valuable species landed in the Massachusetts OECC are longfin squid, lobster, summer flounder, sea scallop, and Atlantic herring. The five most valuable species landed in the Connecticut OECC are sea scallop, summer flounder, scup, lobster, and skates (NOAA Fisheries 2023b). Table 5.4-8 provides the estimates of economic exposure in the Massachusetts OECC and the Connecticut OECC during construction. See Appendix II-F for a detailed description of potential economic exposure in the OECCs.

Table 5.4-8 Estimate of Commercial Fishing Economic Exposure in the Massachusetts OECC and Connecticut OECC During Construction

OECC	Average Annual Fishing Revenues per km²	Fishing Preclusion Area (km²)	Construction Period (% of year)	Economic Exposure During Construction
Massachusetts OECC	\$2,294	3.14	183	\$13,182
Connecticut OECC Using Eastern Point Beach Approach	\$3,420	3.14	175	\$18,793
Connecticut OECC Using Ocean Beach Approach	\$3,429	3.14	175	\$18,842
Connecticut OECC Using Niantic Beach Approach	\$3,308	3.14	175	\$18,177

Note:
1. NOAA Fisheries (2023b)

76 Offshore export cables installed within the Connecticut OECC will transition onshore at one of the three landfall sites shown on Figure 5.4-1. The economic exposure of the Connecticut OECC connecting to each of the three potential landfall sites (Eastern Point Beach Landfall Site, Ocean Beach Landfall Site, and Niantic Beach Landfall Site) have been analyzed for the commercial fisheries economic exposure analysis. The precise location of the landfall site will be determined through consultations and coordination with state and local officials.

The percentage of average annual fishing revenues in the Massachusetts OECC by state are shown in Table 5.4-9. Massachusetts, Rhode Island, New York, and North Carolina account for approximately 95.9% of the average annual value from the Massachusetts OECC.

Table 5.4-9 Percentage of Revenues from the Massachusetts OECC by State, 2008-2021

State	Percentage of Average Annual Massachusetts OECC Fishing Revenues
Massachusetts	52.9%
Rhode Island	36.7%
New York	3.9%
North Carolina	2.4%
Connecticut	1.5%
All Others	3.9%

Note:
1. NOAA Fisheries (2023b)

The percentage of average annual fishing revenues in the Connecticut OECC by state are shown in Table 5.4-10. Massachusetts, Rhode Island, New York, and Connecticut account for approximately 96.2% of the average annual value from the Connecticut OECC.

Table 5.4-10 Percentage of Revenues from the Connecticut OECC by State, 2008-2021

State	Percentage of Average Annual Connecticut OECC Fishing Revenues		
	Connecticut OECC Using Eastern Point Beach Approach	Connecticut OECC Using Ocean Beach Approach	Connecticut OECC Using Niantic Beach Approach
Massachusetts	32.0%	32.1%	32.1%
Rhode Island	30.4%	30.5%	30.3%
New York	22.3%	22.4%	22.5%
Connecticut	11.4%	11.1%	11.3%
New Jersey	1.8%	1.8%	1.9%
All Others	2%	2%	25

Note:
1. NOAA Fisheries (2023b)

5.4.1.3 *For-Hire Recreational Fishing*

The for-hire recreational fishing fleets contribute to the overall economy in the Northeast through direct employment, income, and gross revenues of the for-hire businesses, as well as through spending on good and services, contributing indirect multiplier effects that are dependent upon the initial demands of the for-hire fleet (Steinback & Brinson 2013).

The economic contribution of for-hire charter/headboat operators was assessed in July to November of 2013 along the Atlantic coast from Maine to Texas (Hutt and Silva 2015). In the Northeast, which includes the Atlantic coast from Maine to Virginia, it is estimated that there were 4,936 charter trips from July to November 2013 that targeted Atlantic highly migratory species (HMS). Hutt and Silva (2015) estimated a total of $12.1 million in gross revenue in the Northeast from July to November 2013, of which $7.3 million was used for trip expenses (fuel, crew, bait, supplies, etc.) and $4.8 million was for owner net return and operation costs. The average fee in the Northeast per charter boat trip was $2,450; after accounting for expenditures, the average net return was estimated at $969 per charter boat trip. The average fee in the Northeast per headboat trip was $6,973; after accounting for expenditures, the average net return was estimated at $2,305 per headboat trip (Hutt and Silva 2015).

NOAA Fisheries report of socioeconomic impacts of Atlantic offshore wind development describe selected fishery landings and estimates of recreational party and charter vessel revenue for offshore wind lease areas from 2008 to 2021 (NOAA Fisheries 2023c). These reports make use of recreational fisheries landings data from VTRs for vessels issued a party/charter permit and data from NOAA Fisheries' Marine Recreational Fishing Expenditure Surveys. NOAA Fisheries (2023c) estimated the 14-year total party/charter revenue in the Lease Area to be $0. Of this 14-year dataset, NOAA Fisheries reports "no trips" by party/charter vessels for 11 years and three years of confidential data (i.e., less than three permits impacted). NOAA Fisheries provided the Proponent with similar recreational fishing data for the portions of the OECCs for which data are available (NOAA Fisheries 2023b). According to NOAA Fisheries (2023b), within these portions of the Connecticut OECC, scup, black sea bass, bluefish, and striped bass are the most common species landed by recreational anglers. NOAA Fisheries was unable to produce species data for the Massachusetts OECC, as all of the species data were confidential data (i.e., less than three permits impacted), suggesting that this type of activity occurs relatively infrequently within the Massachusetts OECC.

Kneebone and Capizzano (2020) estimates the level of recreational fishing effort within the Massachusetts Wind Energy Area (MA WEA), in which the Lease Area is located, and the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA). Kneebone and Capizzano (2020) provides data for a combination of private recreational fishing (as discussed in Section 5.3) and for-hire recreational fishing activities. As described in the study, baseline information on recreational fishing effort was collected by: (1) surveying recreational fishermen from the private (angling category) and charter/headboat sectors on their recreational fishing efforts over the past five years, and (2) analyzing available data on recreational fishing effort over recent decades. Kneebone and Capizzano (2020) report that a total of 171 respondents took the survey; of those respondents, 136 were private anglers, 34 were charter/headboat captains, and one was an unknown category.

Kneebone and Capizzano (2020) describe that numerous HMS are present in the offshore waters in southern New England. Popular and commonly-caught HMS include bluefin tuna, yellowfin tuna, albacore, mahi mahi, white marlin, wahoo, and "sharks," which include shortfin mako, blue shark, common thresher shark, porbeagle, tiger shark, and smooth hammerhead.

Private and for-hire recreational fishing vessels target many of these HMS at popular fishing areas throughout southern New England. Kneebone and Capizzano (2020) determined that recreational effort for HMS is widespread throughout southern New England and that the greatest recreational fishing effort occurs west of the MA WEA and RI/MA WEA (i.e., west of the Lease Area) in the waters south and east of Montauk Point and Block Island (Kneebone and Capizzano 2020).

5.4.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect commercial fisheries and for-hire recreational fishing during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 5.4-11.

Table 5.4-11 Impact Producing Factors for Commercial Fisheries and For-Hire Recreational Fishing

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Vessel Activity	•	•	•
Presence of Structures		•	•

Potential effects to commercial fishing and for-hire recreational fishing were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

5.4.2.1 Vessel Activity

Construction and support vessels will be present within the Lease Area and along the OECCs during pre-installation, installation, maintenance, and decommissioning activities. All Vineyard Northeast vessels and equipment involved in construction and operation will display the required navigation lighting and day shapes. Vessel traffic associated with Vineyard Northeast is not anticipated to represent a significant increase over the current levels of vessel traffic within the Offshore Development Area. Navigation and vessel traffic are further discussed in Section 5.6 and Appendix II-G.

To minimize potential impacts to commercial and for-hire recreational fishing from increased vessel traffic, the Proponent will work to inform commercial and for-hire recreational fishermen of planned vessel activities during construction, maintenance, and decommissioning. During construction, a Marine Coordinator will manage construction vessel logistics and implement communication protocols with external vessels at ports and offshore. The Marine Coordinator will be the primary point of contact and will use tools such as radio communications and safety vessels to address vessels entering active work sites. Additionally, the Proponent will provide Offshore Wind Mariner Updates and coordinate with the US Coast Guard (USCG) to issue Notices to Mariners (NTMs) advising other vessel operators of planned offshore activities. The Vineyard Northeast website will be regularly updated to provide information about activities occurring in the Offshore Development Area.

Depending on the activity, the Proponent may request that mariners give a wide berth to active work sites or construction and maintenance vessel(s) through the issuance of Offshore Wind Mariner Updates. Additionally, the Proponent may request that the USCG establish temporary safety zones, per 33 CFR Part 147, that extend 500 m (1,640 ft) around each wind turbine generator (WTG), electrical service platform (ESP), and booster station (if used) during construction and certain maintenance activities (see Section 8.4 of COP Volume I for additional details). The presence of these safety zones would temporarily preclude commercial and for-hire recreational fishing activities in the immediate vicinity of the structures and may cause fishermen to slightly alter their navigation routes to avoid the active work sites. However, the safety zones would be limited in size and duration and would not affect the entire Lease Area at any given time.

The Proponent has developed a Fisheries Communication Plan (see Appendix I-I) that defines outreach and engagement with commercial and for-hire recreational fishermen during construction, operations, and decommissioning. The Proponent's fisheries communication efforts are led by a Fisheries Manager. The fisheries team also includes a Fisheries Liaison (FL), Fisheries Representatives (FRs), Onboard Fisheries Liaisons (OFLs), and scout vessels.

- FLs are employed by offshore wind developers to implement fisheries communication plans (FCPs) and serve as a communication conduit between offshore wind developers and the fishing industry. At Vineyard Offshore, the FL serves as a readily accessible and knowledgeable point of contact within the company that fishermen and FRs can efficiently and effectively communicate with.

- FRs do not work on behalf of offshore wind developers but represent a particular fishing community, organization, gear type, port, region, state, or sector(s). FRs are responsible for communicating fisheries concerns, issues, and other input to offshore wind developers. Typically, an FR is an active fisherman or group representing active fishermen within the region, fishery, state, or sector they represent.

- OFLs are experienced fishermen employed to assist geophysical and geotechnical survey vessel captains with communication and to document fishing gear in the area to help avoid interactions. OFLs continue the role of the FL offshore so that there is effective communication on-site and in real-time.

- The Proponent also employs local fishing vessels to serve as scout vessels. The scout vessels work ahead of geophysical and geotechnical survey vessels and report fixed gear locations back to the OFL to avoid any gear interaction. The scout vessel identifies fishermen actively working in the area so the FL can reach out to them with detailed survey vessel information throughout the remainder of the survey activity.

As described further in Appendix I-I, Vineyard Offshore is conducting fisheries outreach and will continue to employ a variety of outreach methods and tools to communicate and maintain relationships with commercial and recreational fishermen and fisheries stakeholders. Additionally, Vineyard Offshore has developed a fishing gear loss and compensation protocol that provides a standard approach to fishing gear loss and compensation.

5.4.2.2 Presence of Structures

During operations and maintenance of Vineyard Northeast, the Lease Area and OECCs will be open to commercial and for-hire recreational fishing vessels, and no permanent vessel restrictions are proposed. As described in Section 2.3 of COP Volume I, WTGs and ESPs within the Lease Area will be oriented in fixed east-to-west rows and north-to-south columns with one nautical mile (NM) spacing between WTG/ESP positions. The 1 x 1 NM WTG/ESP layout is consistent with the USCG's recommendations contained in the Massachusetts and Rhode Island Port Access Route Study (MARIPARS) published in the Federal Register on May 27, 2020 (USCG-2019-0131). Based on the findings of the USCG, the proposed spacing will facilitate safe navigation through the Lease Area and the proposed layout is expected to accommodate traditional fishing patterns and activities.

If maintenance activities are required, the Proponent may request that mariners give a wide berth to active work sites or maintenance vessel(s) through the issuance of Offshore Wind Mariner Updates and may request that the USCG establish temporary safety zones that extend 500 m (1,640 ft) around the WTGs, ESP(s), and booster station (if used). However, it is expected that many maintenance activities in the Lease Area will not require in-water work but will instead be based from the structures themselves. A detailed NSRA for Vineyard Northeast is included as Appendix II-G and additional discussion of navigational impacts and the presence of structures in the Offshore Development Area is provided in Section 5.6.

While the layout is expected to accommodate fishing vessels, some fishermen may opt to reroute transits around the Lease Area. As described in Section 6.1.9 of the NSRA (see Appendix II-G), the expected increase in transit time around the Lease Area (between major fishing ports and important fishing areas) ranges from 5 minutes to 30 minutes.

As described in Section 5.6, to aid marine navigation, the WTGs, ESP(s), booster station (if used), and their foundations will be equipped with marine navigation lighting, marking, and signaling in accordance with USCG and BOEM guidance. Each WTG, ESP, and booster station will be maintained as a Private Aid to Navigation (PATON). The Proponent will work with the USCG, BOEM, and Bureau of Safety and Environmental Enforcement (BSEE) to determine the appropriate marine lighting, marking, and signaling scheme for the proposed offshore facilities, including the number, location, and type of AIS transponders and Mariner Radio Activated Sound Signals (MRASS). The Proponent expects to provide a detailed lighting, marking, and signaling plan to BOEM, BSEE, and USCG prior to construction of the offshore facilities. Further information on marine navigation lighting and marking can be found in the NSRA (see Appendix II-G). The WTGs, ESP(s), booster station (if used) will also be identified on NOAA nautical charts.

Appendix II-F provides a detailed description of potential economic exposure, fishing congestion impacts, and notes that a number of factors suggest that the presence of structures will have only a small economic impact on commercial fishing. Commercial fishing vessels will continue to have access to the Lease Area and OECCs as currently permitted by regulation and the proposed grid layout, set in response to input from commercial fishermen and recommendations from the USCG, is intended to accommodate traditional fishing patterns and activities. Additionally, alternative fishing grounds with a demonstrated higher fishery revenue density are available nearby and may be fished at little to no additional cost.

As described in Section 4.6, the addition of foundations and cable protection (if used) may attract fish species to new structured habitat, resulting in increases in biodiversity and abundance of fish (Riefolo et al. 2016; Raoux et al. 2017). It is anticipated that foundations may function as fish aggregating devices by providing additional structure for species that prefer hard/complex bottom, thereby improving the recreational fishing experience within the Lease Area (BOEM 2012). There is also evidence that WTG reef habitats and the resources they provide increase the growth and condition of juvenile Atlantic cod and whiting-pout (*Trisopterus luscus*) (Reubens et al. 2013), which is consistent with observations near deep-water offshore wind farms (Løkkeborg et al. 2002; Hille Ris Lambers and ter Hofstede 2009). In the event WTGs aggregate recreationally targeted species, based on the intensity of recreational fishing within the Lease Area and its geographic scale, neither congestion effects nor gear conflicts are expected. Additional information about seafloor disturbance and habitat modification associated with foundations for the WTGs, ESP(s), and booster station (if used), scour protection, export cables, inter-array and inter-link cables, and cable protection (if required) is provided in Section 4.5.2.1.

The offshore export, inter-array, and inter-link cables will be buried beneath the stable seafloor at a target depth of 1.5 to 2.5 m (5 to 8 ft).[77] The Proponent's engineers have determined that this target burial depth is more than twice the burial depth required to protect the cables from fishing activities.

While every effort will be made to achieve sufficient burial, a limited portion of the inter-array cables (up to 2%), inter-link cables (up to 2%), and offshore export cables (up to 9% for the cables to Massachusetts and up to 6% for the cables to Connecticut) may require remedial cable protection (rocks, rock bags, concrete mattresses, half-shell pipes, or similar) if a sufficient burial depth cannot be achieved. Cable protection may also be used where the cables need to cross other infrastructure (e.g., existing cables, pipelines, etc.), to secure the cable entry protection system in place, or where a cable splice requires protection. Potential cable protection methods are described in Section 3.5.5 of COP Volume I. The Proponent will evaluate the feasibility of using nature-inclusive cable protection designs, which refers to options that can be integrated in or added to the design of cable protection to create suitable habitat for native species (Hermans et al. 2020). Nature-inclusive designs can include adding an additional layer of larger rock to provide larger crevices, using methods that can be easily relocated with minimal disturbance during cable repairs (e.g., rock bags with lifting points), using mattresses with specially-designed concrete blocks that create additional nooks and crannies, and using mattresses with polyethylene fronds. Cable protection will be designed and installed to minimize interfering with bottom fishing gear to the maximum extent practicable and fishermen will be informed of exactly where cable protection exists. However, there will remain a possibility that bottom fishing gear may snag on cable protection resulting in gear damage, lost fishing time, and associated economic losses. Vineyard Northeast has established a program that will compensate commercial fishermen for economic losses associated with damaged gear.

Potential effects to and mitigation measures for fisheries research and survey vessels are described in Section 5.8.

5.4.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to commercial and for-hire recreational fishing during Vineyard Northeast are summarized below:

- The proposed layout is expected to accommodate traditional fishing patterns and activities.

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[77] Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

- The Proponent will work to inform commercial and for-hire recreational fishermen of planned vessel activities during construction, maintenance, and decommissioning. During construction, a Marine Coordinator will manage construction vessel logistics and implement communication protocols with external vessels at ports and offshore. Additionally, the Proponent will provide Offshore Wind Mariner Updates and coordinate with the USCG to issue NTMs advising other vessel operators of planned offshore activities. The Vineyard Northeast website will be regularly updated to provide information about activities occurring in the Offshore Development Area.

- The Proponent has developed a Fisheries Communication Plan (see Appendix I-I) that defines outreach and engagement with commercial and for-hire recreational fishermen during construction, operations, and decommissioning.

- To aid marine navigation, the WTGs, ESP(s), booster station (if used), and their foundations will be equipped with marine navigation lighting, marking, and signaling in accordance with USCG and BOEM guidance.

- Each WTG, ESP, and booster station (if used) will be maintained as a PATON.

- The Proponent has developed a fishing gear loss and compensation protocol that provides a standard approach to fishing gear loss and compensation.

- The offshore export, inter-array, and inter-link cables will be buried at a target depth of 1.5 to 2.5 m (5 to 8 ft) beneath the stable seafloor[78] to avoid interaction with fishing gear.

- The amount of cable protection will be limited. Cable protection will be designed and installed to minimize interfering with bottom fishing gear to the maximum extent practicable and fishermen will be informed of areas where cable protection exists.

5.5 Land Use and Coastal Infrastructure

This section addresses the potential impacts of Vineyard Northeast on land use and coastal infrastructure in the Onshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to land use and coastal infrastructure during the construction, operation, and decommissioning of Vineyard Northeast.

Potential impacts to recreation and tourism are discussed in Section 5.3.

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78 Unless the final CBRA indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

5.5.1 Description of Affected Environment

The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut, as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities. With respect to land use and coastal infrastructure, the Onshore Development Area includes communities surrounding Vineyard Northeast's onshore facilities, operations and maintenance (O&M) facilities, and/or onshore construction staging areas, in addition to communities where port facilities may be utilized. Vineyard Northeast will use more than one port. Ports under consideration are discussed in Section 5.5.1.4.

A 0.4 kilometer (km) (0.25 mile [mi]) buffer was applied to the centerline of each onshore cable route to characterize the land use and land cover immediately adjacent to planned Vineyard Northeast facilities. Figure 5.5-1 provides an overview of planned Vineyard Northeast onshore facilities in Massachusetts and Figure 5.5-3 provides an overview of planned Vineyard Northeast facilities in Connecticut.

5.5.1.1 Massachusetts

Landfall Site

All offshore export cables installed within the Massachusetts Offshore Export Cable Corridor (OECC) would transition onshore at the Horseneck Beach Landfall Site (see Figure 5.5-1). The Horseneck Beach Landfall Site is located within a portion of a paved parking area within Horseneck Beach State Reservation in Westport, Bristol County, Massachusetts. The landfall site is near the entrance to Buzzards Bay, east of the Westport River. Nearby land uses include the public beach, campground, and open space within the State Reservation (see Figure 5.5-2).

Points of Interconnection

In Massachusetts, power will be delivered to one of the following potential POIs:

- **Pottersville POI:** The 115 kV Pottersville Substation in Somerset, Massachusetts is operated by National Grid.
- **Brayton Point POI:** National Grid has proposed to construct and operate a new 345 kV substation near Brayton Point in Somerset, Massachusetts.
- **Bell Rock POI:** The 115 kV Bell Rock Substation in Fall River, Massachusetts is operated by National Grid.

[redacted]

[redacted]

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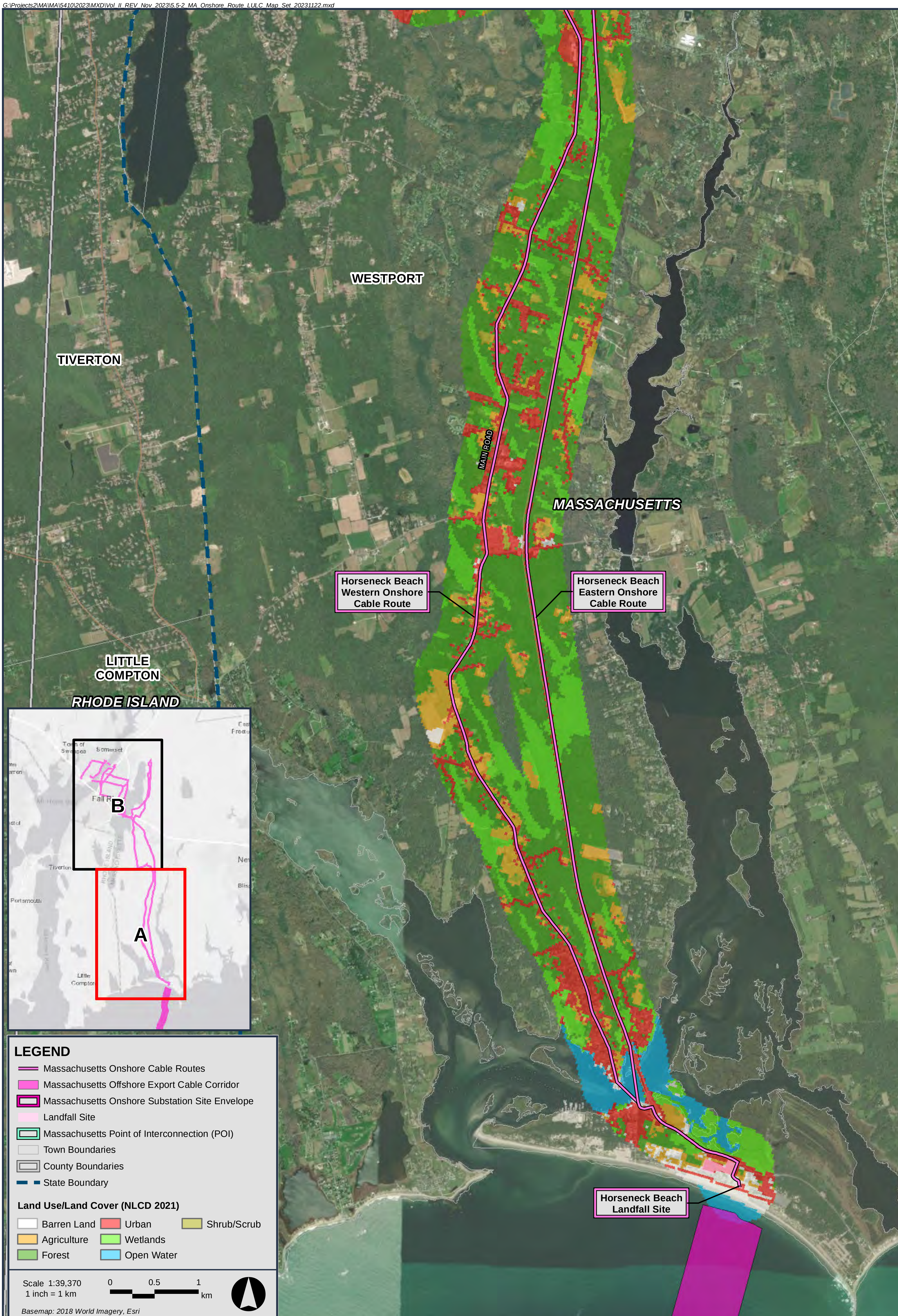

Figure 5.5-2A

Massachusetts Onshore Development Area
Land Use/Land Cover

VINEYARD NORTHEAST
VINEYARD OFFSHORE

[redacted]

Onshore export cables will connect the landfall site to a new onshore substation site and grid interconnection cables will connect the onshore substation site to the POI. Modifications may be required at the selected POI to accommodate Vineyard Northeast's interconnection. The design and schedule of this work will be determined by the results of interconnection studies. Any required system upgrades at the POI would be constructed by the existing substation's owner/operator. Based on negotiations with the substation's owner/operator, the Proponent may install onshore cables[79] (i.e., perform ground disturbing activities) within the property line of the existing substation.

Onshore Cable Routes

From the Horseneck Beach Landfall Site, the onshore cables will follow one of the onshore cable routes shown on Figure 5.5-1 to reach the Pottersville POI, the Brayton Point POI, or the Bell Rock POI. Likely onshore cable routes are described below (see Section 3.8 of COP Volume I for more detail);[80] however, Vineyard Northeast may ultimately use any combination of route segments shown on Figure 5.5-1 to reach any of the three potential POIs.[81] Figure 5.5-2 illustrates the onshore cable routes and the surrounding land use and land cover within 0.4 km (0.25 mi).

- **Horseneck Beach Eastern Onshore Cable Route:** The approximately 30 km (19 mi) long route begins at the landfall site, crosses the Westport River, and proceeds generally north through the Town of Westport and City of Fall River to reach the Bell Rock POI. The route primarily follows town roads and portions of state highways, including Route 88, Route 6, and Blossom Road. Land use along the route is predominantly forested/parkland and agricultural land, although low density residential areas are located along a limited part of the route and there is a commercial area proximate to the I-195/Route 6 crossing.

- **Horseneck Beach Western Onshore Cable Route:** This route is located west of and largely parallels the Horseneck Beach Eastern Onshore Cable Route. The Horseneck Beach Western Onshore Cable Route is approximately 35 km (22 mi) long and travels north from the landfall site, across the Westport River, and through the Town of Westport and City of Fall River to reach the Bell Rock POI. The route primarily follows

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79 At the Brayton Point POI and the Bell Rock POI, the Proponent's grid interconnection cables are expected to be installed within an underground duct bank. Onshore cables at the Pottersville POI may be installed within an underground duct bank or as overhead transmission lines (see Section 3.8.3.3 of COP Volume I).

80 The lengths of the Massachusetts onshore cable routes include conservatism to account for the uncertainty regarding the location of the onshore substation site within the [redacted] Onshore Substation Site Envelopes (see Section 3.9.1 of COP Volume I).

81 For example, any of the variants to the Horseneck Beach Western Onshore Cable Route could be used in conjunction with the southern portion of the Horseneck Beach Eastern Onshore Cable Route.

town roads (such as Main Road and Sandford Road) and utility rights-of-way (ROWs) through a mix of low to moderate-density residential areas and commercial areas. This route also includes five variants, which begin near the intersection of Route 6 and Old Bedford Road and cross the Taunton River to reach the Pottersville or Brayton Point POIs. The maximum length of any one variant is approximately 39 km (24 mi). The five variants follow bike paths, city/town roads, and state roads, primarily through industrial, commercial, and moderate to high density residential areas.

While there are multiple onshore route options under consideration, analysis of land use/land cover indicates that approximately 49-76% of each potential onshore cable route is located in a developed, urban area and approximately 13-31% is located adjacent to forested areas. However, 99-100% of the potential onshore cable routes are co-located within existing roadway or utility ROWs (see Appendix II-C for more detail). Overall, the onshore cables in Massachusetts are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs via open trenching.[82] In most instances, underground trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) (see Figure 5.5-2). However, the northern crossing of the Taunton River [redacted] may require a segment of overhead transmission lines.[83]

Onshore Substation Site

The onshore substation site will be located within one of the following areas shown on Figure 5.1-1:

- [redacted]

[redacted]

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[82] In limited areas, the onshore cable routes may depart from public roadway layouts or utility ROWs, particularly at complex crossings (e.g., crossings of busy roadways, railroads, wetlands, and waterbodies).

[83] As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

- [redacted]

Although the Proponent may select an onshore substation site parcel that contains state-mapped wetlands, the footprint of the onshore substation site would be sited to avoid wetlands.

5.5.1.2 Connecticut

Landfall Sites

Offshore export cables installed within the Connecticut OECC would transition onshore at one of the following landfall sites, as shown on Figure 5.5-3:

- **Ocean Beach Landfall Site:** The Ocean Beach Landfall Site is located in a portion of a paved parking area within Ocean Beach Park in New London, Connecticut. Ocean Beach Park is a public recreation facility owned by the City of New London that includes a beach among other recreational amenities (Ocean Beach Park 2017). The landfall site is located near the mouth of the Thames River. Nearby land uses primarily include private residences.

- **Eastern Point Beach Landfall Site:** The Eastern Point Beach Landfall Site is located in a portion of a paved parking area on Eastern Point in Groton, Connecticut. The beach, which is located near the mouth of the Thames River, is managed by the City of Groton's Parks and Recreation Department (City of Groton 2022). Nearby land uses include the public beach and associated recreational facilities and open space, as well as private residences to the north and east.

- **Niantic Beach Landfall Site:** The Niantic Beach Landfall Site is located in a paved parking area at Niantic Beach in East Lyme, Connecticut. The landfall site is near the mouth of the Niantic River. The town-managed beach includes a boardwalk and bathhouse (Town of East Lyme Connecticut 2022). The beach is abutted by Route 156 and train tracks.

Point of Interconnection

In Connecticut, power from Vineyard Northeast will be delivered to the electric grid at the following POI:

[redacted]

- **Montville POI:** The 345 kV Montville Substation in Montville, Connecticut is operated by Eversource Energy.

Any required system upgrades at the POI would be constructed by the existing substation's owner/operator. Based on negotiations with the substation's owner/operator, the Proponent may install onshore cables[84] (i.e., perform ground disturbing activities) within the property line of the existing substation.

Onshore Cable Routes

Between the potential Connecticut landfall sites and the Montville POI, onshore cables will be installed within one of the following potential onshore cable routes identified on Figure 5.5-4, which are shown in context to the surrounding land use and land cover within 0.4 km (0.25 mi) of the routes:

- **Ocean Beach Onshore Cable Route:** This route begins at the Ocean Beach Landfall Site and travels generally north approximately 21 km (13 mi) through New London, Waterford, and Montville, Connecticut to reach the POI. The route mostly follows town and state roads, including Ocean Avenue, Route 213, Clark Lane, Jefferson Avenue, Vauxhall Street, Williams Street, Old Norwich Road, and Route 32. The route passes through a mix of low to high density residential areas, commercial areas, and forests/parkland.

- **Eastern Point Beach Onshore Cable Route:** This approximately 23 km (14 mi) route begins at the Eastern Point Beach Landfall Site and travels generally north through the towns of Groton and Ledyard, Connecticut before crossing the Thames River into Montville, Connecticut to reach the POI. The route primarily follows utility ROWs, but also follows town and state roads such as Route 349 and Benham Road. Land use along the route is mostly forested/parkland, although moderate density residential areas and commercial areas are located along portions of the route.

- **Niantic Beach Onshore Cable Route:** This approximately 20 km (13 mi) route begins at the Niantic Beach Landfall Site in East Lyme, Connecticut and travels northeast along Route 156 before joining the Ocean Beach Onshore Cable Route near the intersection of United States (US) Highway 1 and Clark Lane. From Clark Lane northward to the POI, the Niantic Beach and Ocean Beach Onshore Cable Routes are identical. Land use along the Niantic Beach Onshore Cable Route is a mix of low to moderate density residential areas, commercial areas, and forests/parkland.

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84 At the Montville POI, the Proponent's grid interconnection cables are expected to be installed within an underground duct bank.

[redacted]

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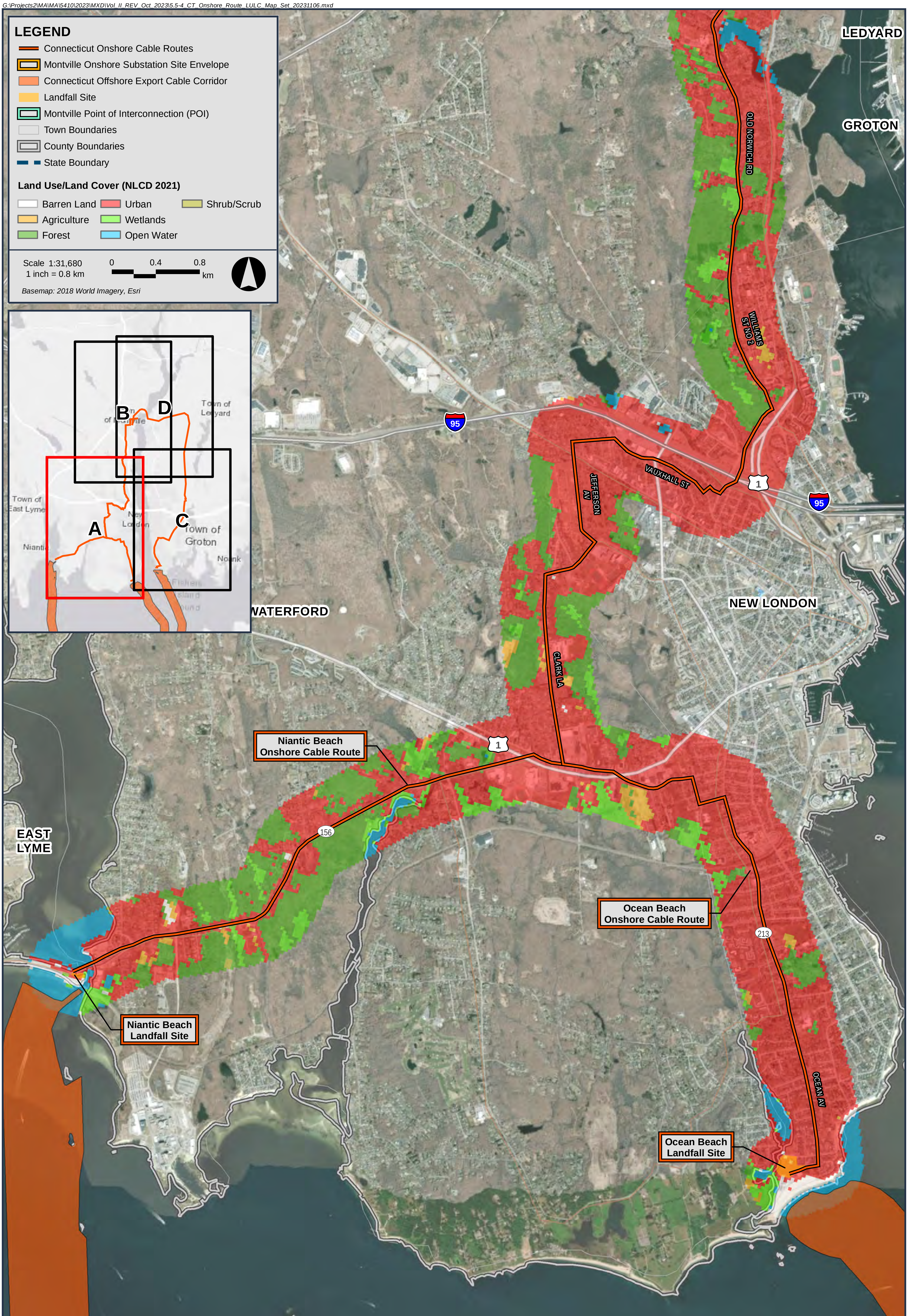

Figure 5.5-4A
Connecticut Onshore Development Area
Land Use/Land Cover

VINEYARD NORTHEAST
VINEYARD OFFSHORE

[redacted]

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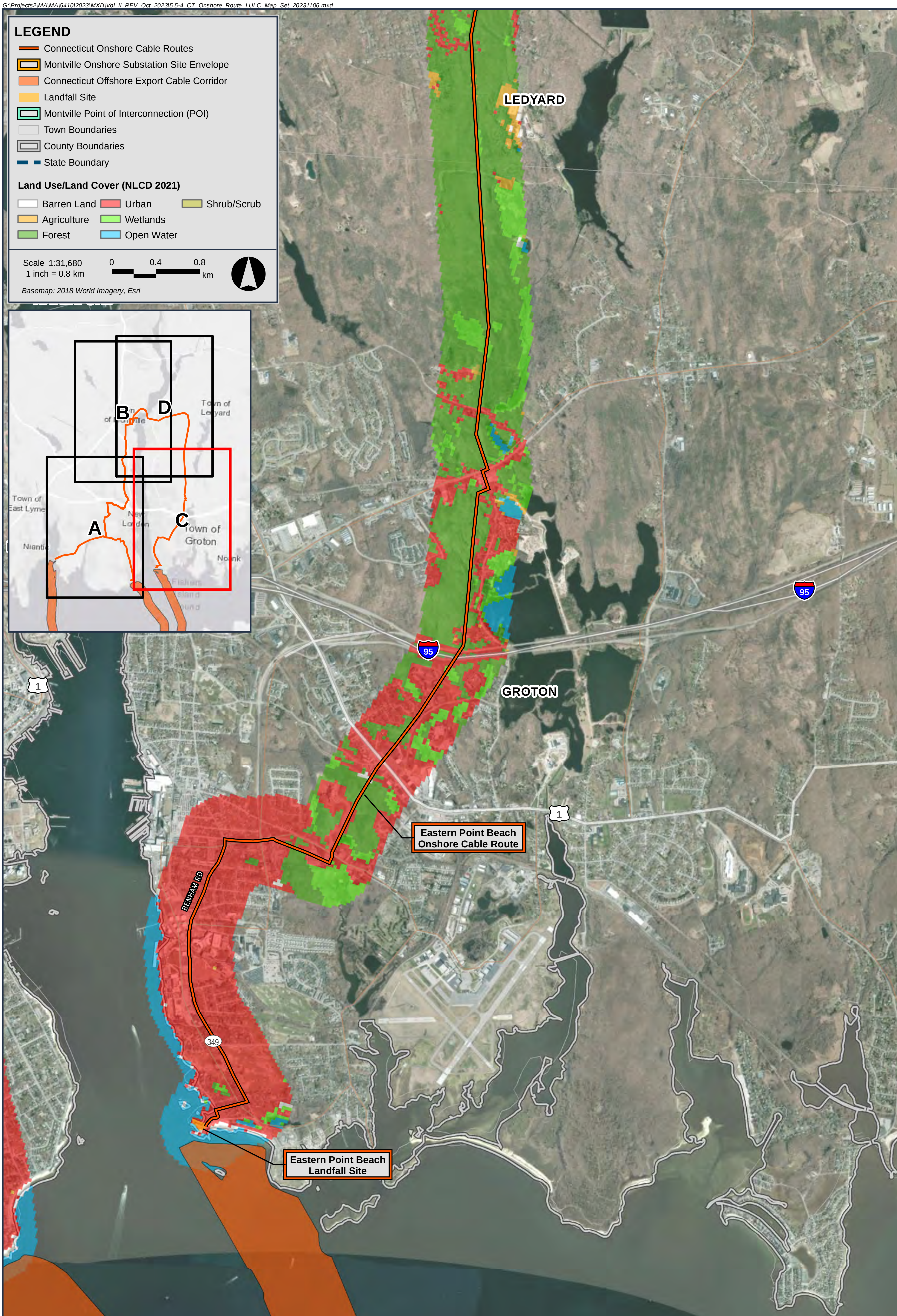

Figure 5.5-4C
Connecticut Onshore Development Area
Land Use/Land Cover

VINEYARD NORTHEAST
VINEYARD OFFSHORE

[redacted]

While there are multiple onshore route options under consideration, analysis of land use/land cover indicates that approximately 37-91% of each potential onshore cable route is located adjacent to an area characterized as urban. Furthermore, 100% of the potential onshore cable routes are co-located within existing roadways and/or utility ROWs (see Appendix II-C for more detail). Overall, the onshore cables in Connecticut are expected to be installed underground within public roadway layouts or within existing utility ROWs via open trenching. Underground trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) (see Figure 5.5-4).

Onshore Substation Site

[redacted]

5.5.1.3 Port Utilization

The Proponent has identified several port facilities in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Canada that may be used to stage Vineyard Northeast components. All ports that have been identified for potential use are either existing facilities or planned facilities that are expected to be developed by others to support the offshore wind industry. The Proponent is not proposing to develop any ports as part of Vineyard Northeast. Several construction ports have been identified to maintain flexibility due to the uncertainty in Vineyard Northeast's construction schedule and the expected demand for ports by other offshore wind developers in the coming years. It is likely that only some of the ports identified in Table 5.5-1 will be utilized for construction. Activities such as refueling, restocking supplies, sourcing parts for repairs, vessel mobilization/demobilization, and potentially some crew transfer, may occur out of ports other than those identified.

Areas surrounding the ports identified for potential use are commercial or industrial and the ports have been chosen due to their ability to support Vineyard Northeast related activities. As such, existing land uses are appropriate for Vineyard Northeast.

Table 5.5-1 Ports

Port	Location (County, State)
Massachusetts Ports	
Ports of New Bedford: • New Bedford Marine Commerce Terminal • Other areas in New Bedford	Bristol County, MA
Brayton Point Commerce Center	Bristol County, MA
Vineyard Haven Harbor	Dukes County, MA
Salem Harbor	Essex County, MA
Fall River Ports	Bristol County, MA
Rhode Island Ports	
Ports of Providence: Port of Providence (Provport) and South Quay Terminal	Providence County, RI
Port of Davisville (Quonset)	Washington County, RI
Connecticut Ports	
New London State Pier	New London County, CT
Port of Bridgeport	Fairfield County, CT
Port of New Haven	New Haven, CT
New York Ports	
Port of Albany-Rensselaer	Albany County, NY; Rensselaer County, NY
Port of Coeymans Marine Terminal	Albany County, NY
New York State Offshore Wind Port	Rensselaer County, NY
Arthur Kill Terminal	Richmond County, NY
Homeport Pier	Richmond County, NY
GMD Shipyard	Kings County, NY
South Brooklyn Marine Terminal	Kings County, NY
New York Harbor: Other	Kings County, NY
Red Hook Container Terminal	Kings County, NY
Shoreham	Suffolk County, NY
Port Jefferson Harbor	Suffolk County, NY
Greenport Harbor	Suffolk County, NY
New Jersey Ports	
New Jersey Wind Port (NJWP)	Salem County, NJ
Paulsboro Marine Terminal	Gloucester County, NJ
Canadian Ports	
Port of Halifax	
Sheet Harbor	
Port Saint John	

5.5.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect land use and coastal infrastructure during the construction, O&M, and/or decommissioning of Vineyard Northeast are presented in Table 5.5-2.

Table 5.5-2 Impact Producing Factors for Land Use and Coastal Infrastructure

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Onshore Construction and Maintenance Activities	•	•	•
Ground Disturbance	•	•	•
Port Utilization	•	•	•

Potential effects to land use and coastal infrastructure were assessed using the maximum design scenario for Vineyard Northeast's onshore facilities as described in Section 1.5.

5.5.2.1 Onshore Construction and Maintenance Activities

Onshore construction and maintenance activities may temporarily result in impacts to land use and coastal infrastructure due to ground disturbance (see Section 5.5.2.2), traffic, emissions, and outdoor lighting.

To avoid and minimize traffic impacts during onshore construction activities, the Proponent will develop a Traffic Management Plan (TMP) prior to construction. In doing so, the Proponent will work with the municipalities where onshore facilities are proposed. Specifically, the timing of onshore construction activities will be coordinated with state and local agencies to avoid seasons or times of peak usage and to align with planned public works projects, where feasible, to minimize traffic disruption. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.

Further, the Proponent will engage with the public prior to and during construction, in an effort to keep the local population informed of Vineyard Northeast activities such as construction schedules, vehicular access impacts, lane closures, detours, parking limitations, equipment delivery, nighttime or weekend construction, repaving activities, and/or emergency vehicle access. Additionally, temporary emissions may occur from support vehicles and equipment during construction and maintenance. Such emissions are expected to be similar to other onshore construction projects.

Outdoor lighting will be used at the onshore substation sites during construction and commissioning. During operations (see Section 4.3 of the COP Volume I), the majority of lights will only be used on an as-needed basis (e.g., if equipment inspection is needed at night). For security reasons, a few lights will typically be illuminated on dusk–to-dawn sensors and a few lights will likely be controlled by motion-sensors. Outdoor lighting at the onshore substation sites will typically be equipped with light shields to prevent light from encroaching into adjacent areas. The Proponent will ensure that the lighting scheme complies with local requirements. A stormwater management system at the onshore substation sites will include low-impact development (LID) strategies (e.g., grass water quality swales to capture and convey site runoff, deep sump catch basin(s) to pretreat surface runoff, etc.), which are designed to capture, treat, and recharge stormwater runoff.

5.5.2.2 Ground Disturbance

Vineyard Northeast will include onshore transmission systems in Massachusetts and Connecticut. Each onshore transmission system will ultimately include one landfall site, one onshore export cable route, one onshore substation site, and one grid interconnection cable route. Localized ground disturbance will occur from construction, O&M, and decommissioning of the landfall sites, onshore cable routes, and new substations. To minimize disturbance, the Proponent has located the onshore cable routes primarily along existing roadway layouts and utility ROWs and intends to prioritize onshore substation sites in industrial/commercial areas that have been previously disturbed. Ground disturbance associated with Vineyard Northeast will be temporary and disturbed areas will be restored to their existing conditions. Construction will be conducted in accordance with soil erosion and sedimentation control plans.

Landfall Sites and Onshore Cable Routes

As further detailed in Section 3.7.3 of COP Volume I, at each landfall site, the offshore export cables are expected to transition onshore using horizontal directional drilling (HDD). HDD avoids or minimizes impacts to boardwalks and any jetties located near the landfall sites. HDD at the landfall sites will require a staging area to be located in a parking lot or previously disturbed area. Further details regarding dimensions and anticipated temporary disturbances associated with the approach pit, exit pit, and staging areas are located in Section 3.7.3 of COP Volume I. Although not anticipated, if detailed engineering for the Connecticut landfall sites determines that HDD is technically infeasible, offshore open trenching may be used to bring the offshore export cables onshore.[85] While not anticipated, if open trenching is utilized, a temporary, three-sided cofferdam will be installed and a trench for the cable conduits will be excavated within the cofferdam.

The Proponent will work with municipalities to develop the construction schedule and hours in accordance with local ordinances and in coordination with other planned public works projects, where feasible. Certain activities cannot stop once they are initiated, such as conduit pull-in for the HDD work, which may extend work in some circumstances. Disturbed ground and/or infrastructure will be restored to existing conditions following completion.

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[85] Open trenching at the Horseneck Beach Landfall Site in Massachusetts is unforeseen. In the event that consultations with state and local agencies result in the identification of an alternative Massachusetts landfall site, open trenching could be required.

Underground high voltage direct current (HVDC) or high voltage alternating current (HVAC) onshore export cables will transmit power from the landfall sites to the onshore substation sites. Underground HVAC grid interconnection cables will transmit power from the onshore substation sites to the POIs. The potential onshore cable routes are described in Sections 3.8.1 and 3.8.2 of COP Volume I. The onshore cables are expected to be installed primarily underground within public roadway layouts or within existing utility ROWs. The underground onshore cables may be installed within a duct bank or within directly buried conduit(s). Both HVDC and HVAC onshore cables typically require splices approximately every 150-610 meters (m) (500–2,000 feet [ft]) or more. At each splice location, one or more splice vaults will be installed. The duct bank and splice vaults are expected to be installed in open trenches using conventional construction equipment (e.g., hydraulic excavator, loader, dump trucks, flatbed trucks, crew vehicles, cement delivery trucks, and paving equipment). The trench dimensions will vary along the onshore cable route (depending on the duct bank layout) but are expected to measure up to approximately 3.4 m (11 ft) in depth, 6.7 m (22 ft) in width at the bottom, and 8.5 m (28 ft) in width at the top. In locations where splice vaults are necessary, the excavated area will be larger (up to approximately 13 m [43 ft] wide, 15 m [50 ft] long, and 6 m [20 ft] deep). Since the splice vaults may be installed anywhere along the onshore cable routes, the maximum extent of disturbance along the entire route is based on the dimensions of the area excavated for splice vaults.

Open trenching is expected to occur primarily within existing roadway layouts (within paved areas or within 3 m [10 ft] of pavement). Any pavement will be removed before excavating and shoring the trenches. Minimal tree trimming and/or tree clearing may be needed where the routes follow existing roadway layouts, depending on the final duct bank alignment.[86] Tree trimming, tree clearing, and/or grading may be required to facilitate onshore cable installation where the onshore cable routes follow existing utility ROWs, in limited areas where the routes depart from the public roadway layout (particularly near complex crossings), at trenchless crossing staging areas (see Section 3.8.3.3 of COP Volume I), and at the POIs. The work, however, will be confined to as narrow a corridor as possible. Excavated material will be hauled away in trucks daily and recycled or disposed of in accordance with state regulations. All work will be performed in accordance with local, state, and federal safety standards, as well as any company-specific requirements.

In most instances, underground trenchless crossing methods are expected to be used where the onshore cables traverse unique features (e.g., busy roadways, railroads, wetlands, and waterbodies) to avoid impacts to these features. However, the northern crossing of the Taunton River [redacted] may

86 Subject to further engineering and consultations with local and state agencies (e.g., Massachusetts Department of Transportation [MassDOT]).

require a segment of overhead transmission lines.[87] At this time, it is envisioned that up to two lattice-type towers would be located [redacted] and up to two lattice-type towers would be located [redacted] to support the overhead transmission lines. Further detail is available regarding proposed construction techniques and specialty cable crossing methods in Section 3.8.3 of COP Volume I.

The contractor will identify construction staging areas (i.e., equipment laydown and storage areas) necessary to complete construction. With the exception of staging areas for trenchless crossings as described above (see Section 3.8.3.3 of COP Volume I), the Proponent anticipates that construction staging areas will either be paved areas or locations already utilized for similar activities and are therefore not expected to cause new ground disturbance.

Mitigation measures such as erosion and sedimentation controls will be utilized during construction. Upon completion of landfall site construction and onshore cable installation, temporarily disturbed areas will be restored.

During O&M, periodic maintenance may be required. If onshore cable repairs are required, the cables would typically be accessed through manholes installed at the splice vaults and transition vaults thereby avoiding and minimizing land disturbance.

Onshore Substations

Vineyard Northeast will include two onshore substations (one onshore substation in Massachusetts and one in Connecticut). Since the Proponent has not yet secured site control for the onshore substation sites, the Proponent has identified several "onshore substation site envelopes." The onshore substation sites will be located within the onshore substation site envelopes described in further detail in Sections 3.9.1 through 3.9.3 of COP Volume I.

Construction of each onshore substation will include site preparation (e.g., land clearing and grading), installation of the substation equipment and cables, commissioning, and site clean-up and restoration. Temporary fencing and a security gate will be installed around the perimeter of the construction area and temporary erosion control measures will be installed. Land clearing and grading may be needed. Up to approximately 0.06 km^2 (15 acres) is anticipated for each onshore substation site.

[87] As described in Section 3.8.3.3 of COP Volume I, the need for overhead transmission lines at this Taunton River crossing depends on the final location of the onshore substation site and the transmission technology employed (HVAC or HVDC) and will be confirmed through further field data collection and detailed engineering.

Upon completion of onshore substation construction, a permanent fence will be installed and the disturbed area immediately adjacent and outside of the fence will be restored and revegetated (if required). Visual screening and sound attenuation walls may be installed, if needed. Native species will be utilized for restoration and vegetative buffers. The Proponent will coordinate with local municipalities regarding local ordinances.

Periodic maintenance will likely occur within the fenced perimeter of the onshore substation site. During decommissioning, potential impacts are expected to be similar to construction and appropriate environmental protection measures, such as installing erosion and sedimentation controls, will be implemented.

5.5.2.3 Port Utilization

Vineyard Northeast construction, O&M, and decommissioning will require the use of ports. Vineyard Northeast has identified several existing and planned ports to be utilized for construction and O&M (see Tables 3.10-1 and 4.4-1, respectively, of COP Volume I). Each port under consideration for Vineyard Northeast is either located in an industrial waterfront area with sufficient existing infrastructure or where another entity may develop such infrastructure by the time construction proceeds. The Proponent has identified a wide range of potential staging ports due to the uncertainty in Vineyard Northeast's construction schedule and to minimize any potential conflicts due to the expected demand for ports by other offshore wind developers in the coming years.

Section 5.6 and the Navigation Safety Risk Assessment (NSRA) included as Appendix II-G provide further detail; however, vessel operations and frequency may increase near the selected port facilities during construction, O&M, and decommissioning. The O&M facilities, which could be located at or near any of the ports identified in Table 4.4-1 of COP Volume I, are expected to include dock space for service operation vessels (SOVs), service accommodation and transfer vessels (SATVs), crew transfer vessels (CTVs), and/or other support vessels (see Section 4.4.3 of COP Volume I). The O&M facility would likely be used for dispatching technicians and crew exchange, bunkering, and loading supplies and spare parts onto vessels. Vessel use during O&M is not anticipated to interfere with normal port operations. Furthermore, the potential ports and surrounding waterways are expected to have the necessary capacity for the potential vessel traffic. Vessel movements will be managed by a Marine Coordinator. Additional mitigation measures are detailed in Section 5.6.

5.5.2.4 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to land use and coastal infrastructure during Vineyard Northeast are summarized below:

- HDD is expected to be used at the landfall sites to avoid or minimize disturbance.
- The onshore cables are expected to be installed primarily underground to minimize disturbance.

- The onshore cable routes have been sited to primarily follow existing roadway layouts or utility ROWs and the Proponent intends to prioritize onshore substation sites in industrial/commercial areas that have been previously disturbed with land uses consistent with the proposed Vineyard Northeast facilities.

- In most instances, underground trenchless crossing methods (e.g., HDD) are expected to be used where the onshore cable routes traverse unique features (e.g., busy roadways, railroads) to avoid impacts to those features.

- Ground disturbance will be temporary, and all disturbed areas will be restored.

- Elements such as natural barriers and landscaping will be incorporated to minimize any effects to surrounding land uses and communities.

- Best management practices for erosion and sedimentation control measures will be utilized during construction.

- The timing of onshore construction activities will be coordinated with state and local agencies to avoid seasons or times of peak usage. Onshore construction at the landfall sites is planned to occur outside of the period from Memorial Day to Labor Day.

- Security measures will be implemented to prevent public access to Vineyard Northeast facilities.

- Vessel movements during construction, O&M, and decommissioning activities will be managed by a Marine Coordinator.

- A range of potential ports have been identified to add flexibility to Vineyard Northeast activities and to minimize any potential conflicts due to the expected demand for ports by other offshore wind developers in the coming years.

5.6 Navigation and Vessel Traffic

This section addresses the potential impacts of Vineyard Northeast on navigation and vessel traffic in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to navigation and vessel traffic during the construction, operation, and decommissioning of Vineyard Northeast.

A Navigation Safety Risk Assessment (NSRA) is presented in Appendix II-G.

5.6.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. For the purposes of assessing effects to navigation and vessel traffic, the Offshore Development Area also includes the waters and ports in which Vineyard Northeast-related vessels and equipment may operate.

The following analysis relies upon the methodology and findings of an NSRA conducted for Vineyard Northeast as required by the United States Coast Guard (USCG). Information on the affected environment is summarized here and presented in greater detail in the NSRA (see Appendix II-G).

5.6.1.1 Navigation Overview

Aids to navigation including Private Aids to Navigation (PATONs), Federal Aids to Navigation (ATONs), and radar transponders are located throughout the Offshore Development Area (see Figure 5.6-1). These aids to navigation serve as visual and audible references to support safe maritime navigation and consist of buoys, lights, sound horns, and onshore lighthouses. Federal ATONs are developed, operated, and maintained or regulated by the USCG to assist mariners in determining their position, identify safe courses, and warn of dangers and obstructions. ATONs are marked on the National Oceanic and Atmospheric Administration (NOAA) nautical charts.

PATONs and Federal ATONs in the Offshore Development Area are located in the vicinity of the Lease Area and OECCs. With the exception of Vineyard Northeast's temporary meteorological oceanographic ("metocean") buoy, which is marked as a PATON, there are no other PATONs or Federal ATONs in the Lease Area. The closest Federal ATON to the Lease Area is the Muskeget Channel Lighted Whistle Buoy MC located approximately 51 kilometers (km) (27 nautical miles [NM]) northwest of the Lease Area.[88] As shown on Figure 5.6-1, there is only one ATON within 500 meters (m) (1,640 feet [ft]) of the Massachusetts OECC. As the Connecticut OECC approaches shore, it splits into three variations: the Eastern Point Beach Approach, the Ocean Beach Approach, and the Niantic Beach Approach. Depending on the approach used, up to nine ATONs and PATONs are located within 500 m (1,640 ft) of the Connecticut OECC (see Figure 5.6-1). Additional information about PATONs, Federal ATONs, and radar transponders in the Offshore Development Area is provided in the NSRA (see Appendix II-G).

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[88] The Muskeget Channel Lighted Whistle Buoy MC is beyond the mapped extent of Figure 5.6-1. As shown on Figure 5.6-1, there are PATONs located closer to the Lease Area; many of these PATONs are research or metocean buoys that are temporarily deployed by other offshore wind developers.

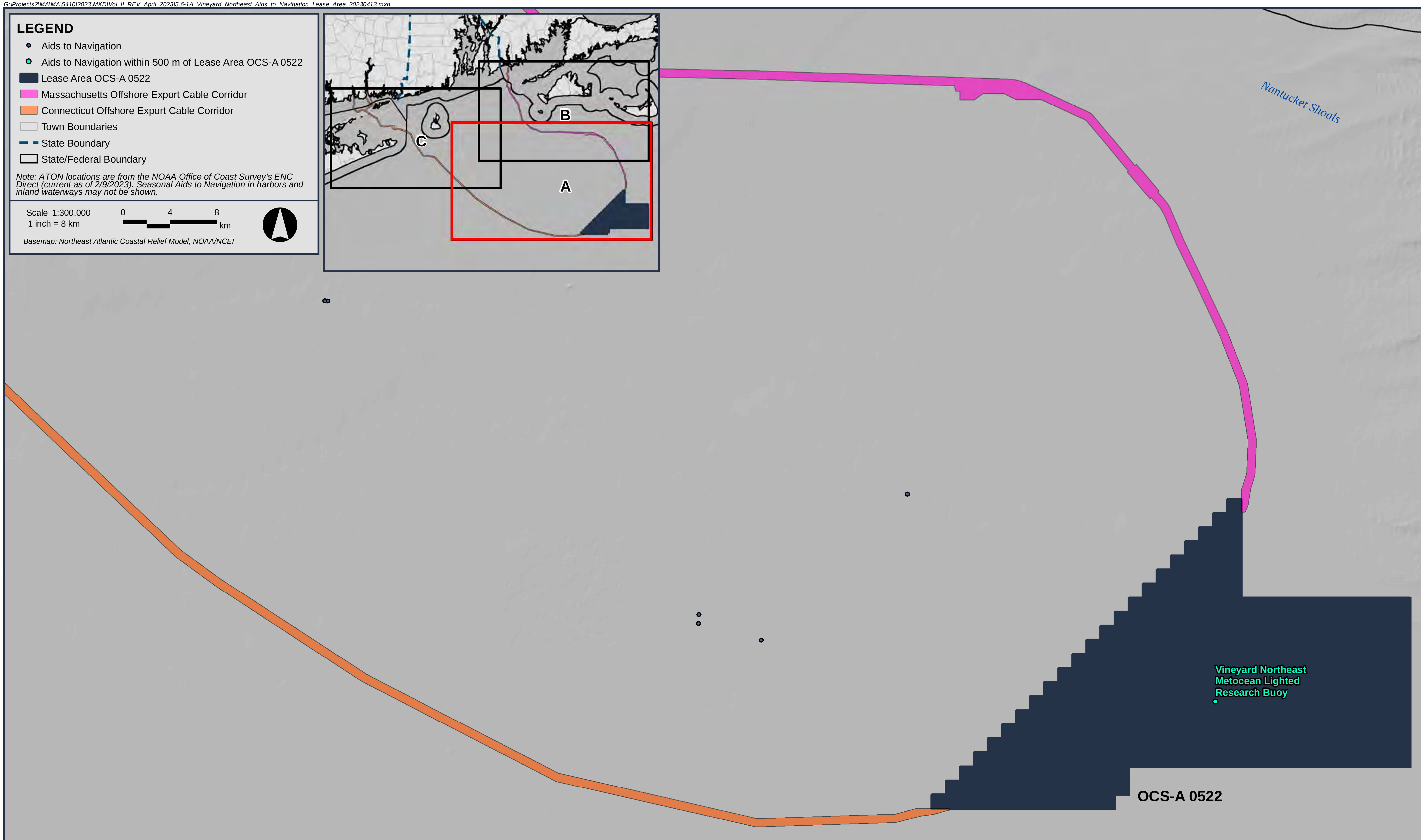

Figure 5.6-1A
Aids to Navigation

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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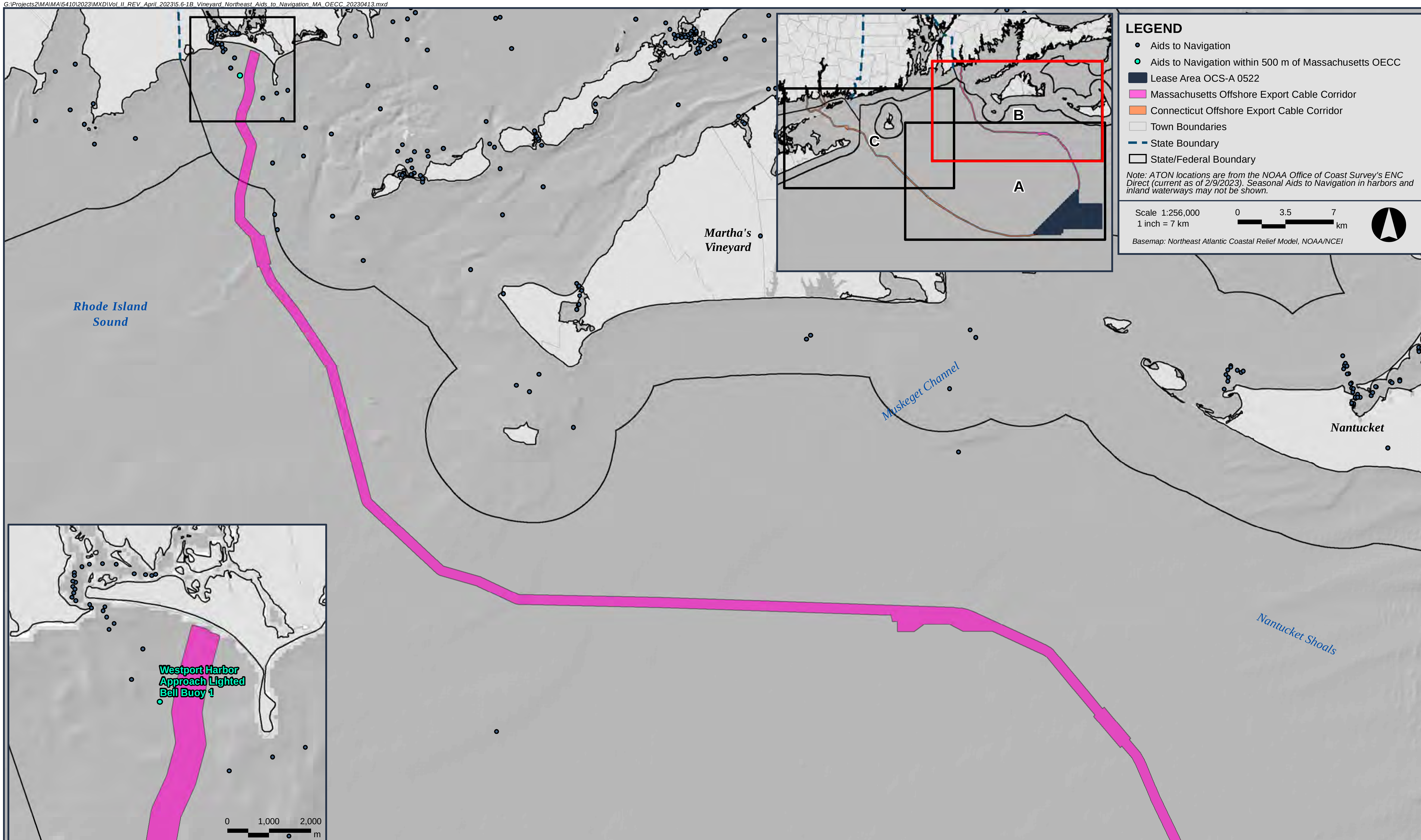

Figure 5.6-1B
Aids to Navigation

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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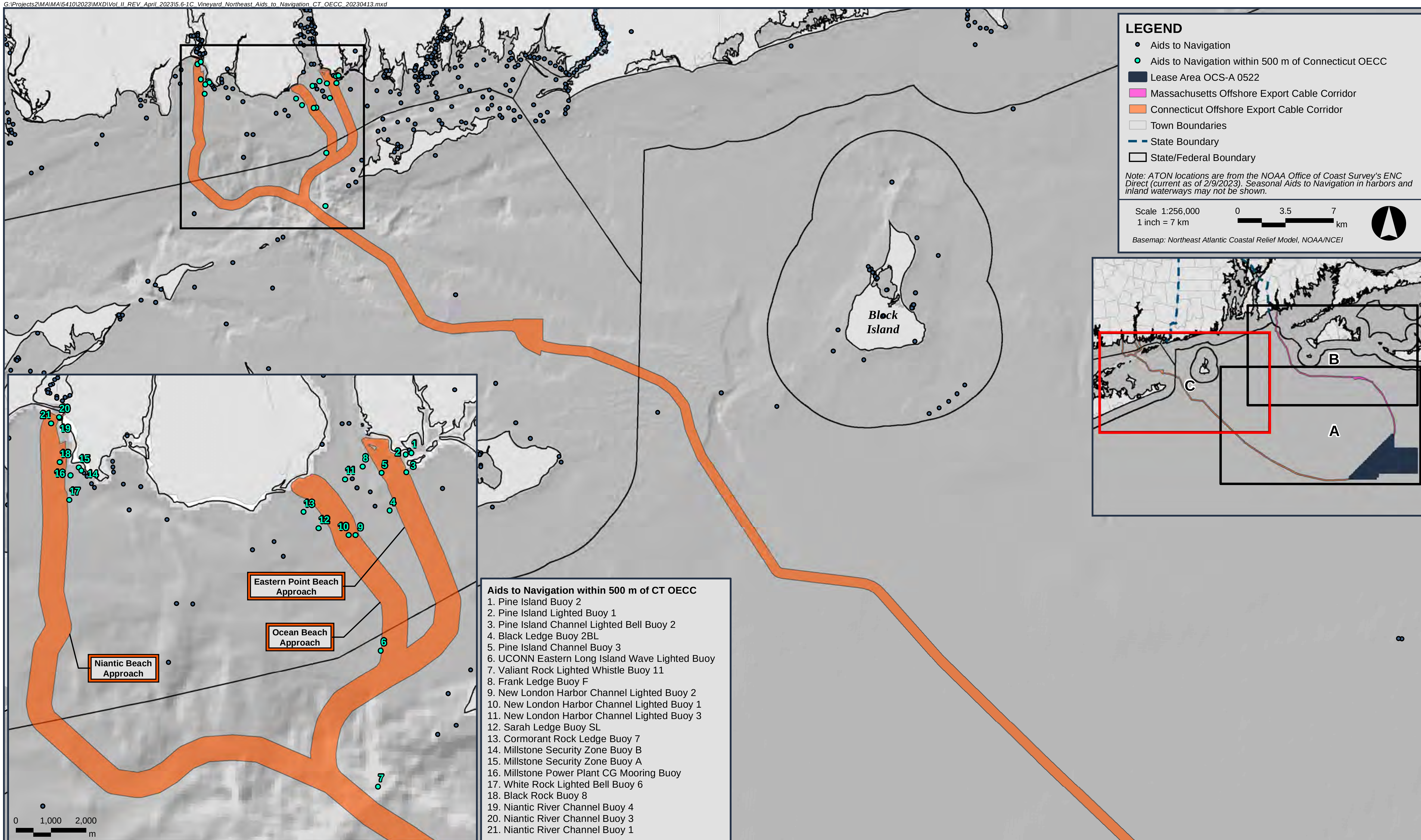

Figure 5.6-1C
Aids to Navigation

VINEYARD NORTHEAST
VINEYARD OFFSHORE

The Lease Area is in relatively deep water ranging from approximately 32 to 64 m (105 to 210 ft); therefore, navigation is not limited by water depth. There are several vessel routing measures in the vicinity of the Lease Area, including a traffic separation scheme (TSS), fairways, and areas to be avoided (see Figure 5.6-2). Most vessels that transit in the Offshore Development Area but not through the Lease Area move along the marked fairways and TSSs, including the Ambrose to Nantucket Traffic Lanes (e.g., TSS) and Safety Fairway. The Nantucket to Ambrose Fairway (westbound) is located approximately 2.8 km (1.5 NM) south of the Lease Area and the Ambrose to Nantucket Safety Fairway (eastbound) is located just farther south. Fairways are the corridors in which no artificial islands or fixed structures are permitted. The Nantucket to Ambrose Traffic Lane (westbound) lies approximately 2.3 km (1.25 NM) south of the Lease Area and the Ambrose to Nantucket Traffic Lane (eastbound) is farther south. A TSS separates opposing streams of vessel traffic by creating separated, unidirectional traffic lanes and is typically designed to safely guide commercial vessels transiting to and from major ports. Information on navigation is presented in greater detail in the NSRA (see Appendix II-G).

5.6.1.2 Vessel Traffic

Vessel traffic in the Offshore Development Area includes a variety of types of vessels including commercial fishing vessels, recreational vessels, passenger vessels, cargo vessels, tankers, and tug-barge tows. Each of these vessel types operate differently and may have unique operational and navigational requirements.

Vessel traffic in the Offshore Development Area is typically quantified using Automatic Identification System (AIS) and Vessel Monitoring System (VMS) data. AIS is a shipborne mobile equipment system that allows vessels to monitor marine traffic in their area and broadcast their location to other vessels with AIS equipment onboard. VMS data are collected by NOAA Fisheries through a satellite monitoring system that is primarily used for monitoring the location and movement of certain commercial fishing vessels fishing for certain species (i.e., not all fishing vessels are included) in United States (US) federal waters.

The NSRA presents an assessment of vessel traffic within the Offshore Development Area based on AIS data from 2016 through and including 2021. AIS equipment is not required for vessels less than 65 ft (20 m) in length, so not all vessels, particularly smaller fishing and recreational vessels, are equipped with AIS equipment. To address the fact that not all fishing and recreational vessels may have AIS, estimates were made of the percentage of AIS and non-AIS equipped fishing and recreational vessels expected to transit the Lease Area. As explained further in Appendix II-G, the AIS traffic volumes assumed in the risk modeling (see Section 6.1.7 of Appendix II-G) were adjusted to account for non-AIS equipped fishing and recreational vessels. In addition, the Bureau of Ocean Energy Management (BOEM) provided polar histograms (i.e., plots of the frequency of vessel tracks by track heading) developed from six years of VMS fishing vessel data (2014 to 2019, inclusive) that were considered.

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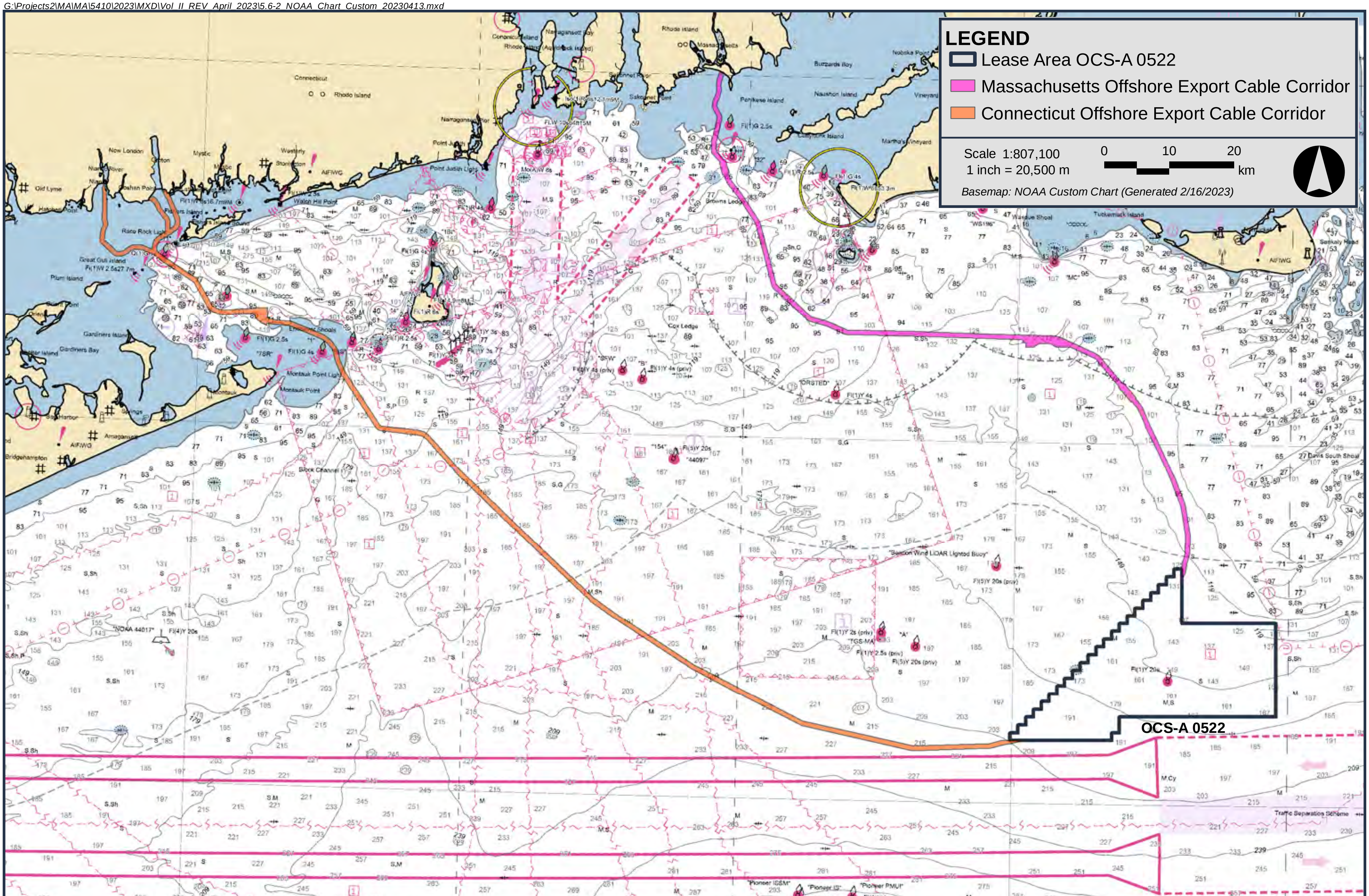

Figure 5.6-2

Vineyard Northeast Overlaid on NOAA Chart

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Based on AIS data from 2016–2021, a total of 1,687 unique vessels passed through the Lease Area. Fishing vessels were responsible for over half of the vessel tracks passing through the Lease Area. Unique vessel types identified using AIS data in the Lease Area (from most common to least common) include fishing vessels, recreational vessels, cargo vessels, unspecified AIS type, tankers, other vessels, passenger vessels, and tug-barge vessels (see Table 5.6-1). The AIS data indicated that, of the known vessel types, recreational vessels are responsible for the next greatest number of unique tracks through the Lease Area (9%). For the OECCs, the Connecticut OECC has a slightly greater average crossing rate of 35 to 44 vessels per day compared to the Massachusetts OECC, with an average crossing rate of 33 to 42 vessels per day based on AIS data from 2016 to 2021. Figures 5.6-3 through 5.6-7 present colored contour maps of the annual average vessel traffic density for different vessel types. Additional information on vessel traffic is provided in the NSRA (see Appendix II-G).

Table 5.6-1 Numbers of Vessels Entering the Lease Area (2016-2021)

Vessel Type	Unique Vessels		Unique Tracks	
	Number	Percentage	Number	Percentage
Cargo Vessels	288	17%	501	6%
Tankers	232	14%	439	5%
Passenger Vessels	39	2%	139	2%
Tug-barge Vessels	31	2%	64	1%
Recreational Vessels	340	20%	773	9%
Fishing Vessels	506	30%	5,692	64%
Other Vessels	68	4%	267	3%
Unspecified AIS Type	183	11%	966	11%
Total (2016–2021)	1,687	100%	8,841	100%
Annual Average	**293**	-	**1,583**	-

Note:

1. Data source is Appendix II-G.

5.6.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect navigation and vessel traffic during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 5.6-2.

Table 5.6-2 Impact Producing Factors for Navigation and Vessel Traffic

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Vessel Activity	•	•	•
Presence of Structures		•	

Potential effects to navigation and vessel traffic were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

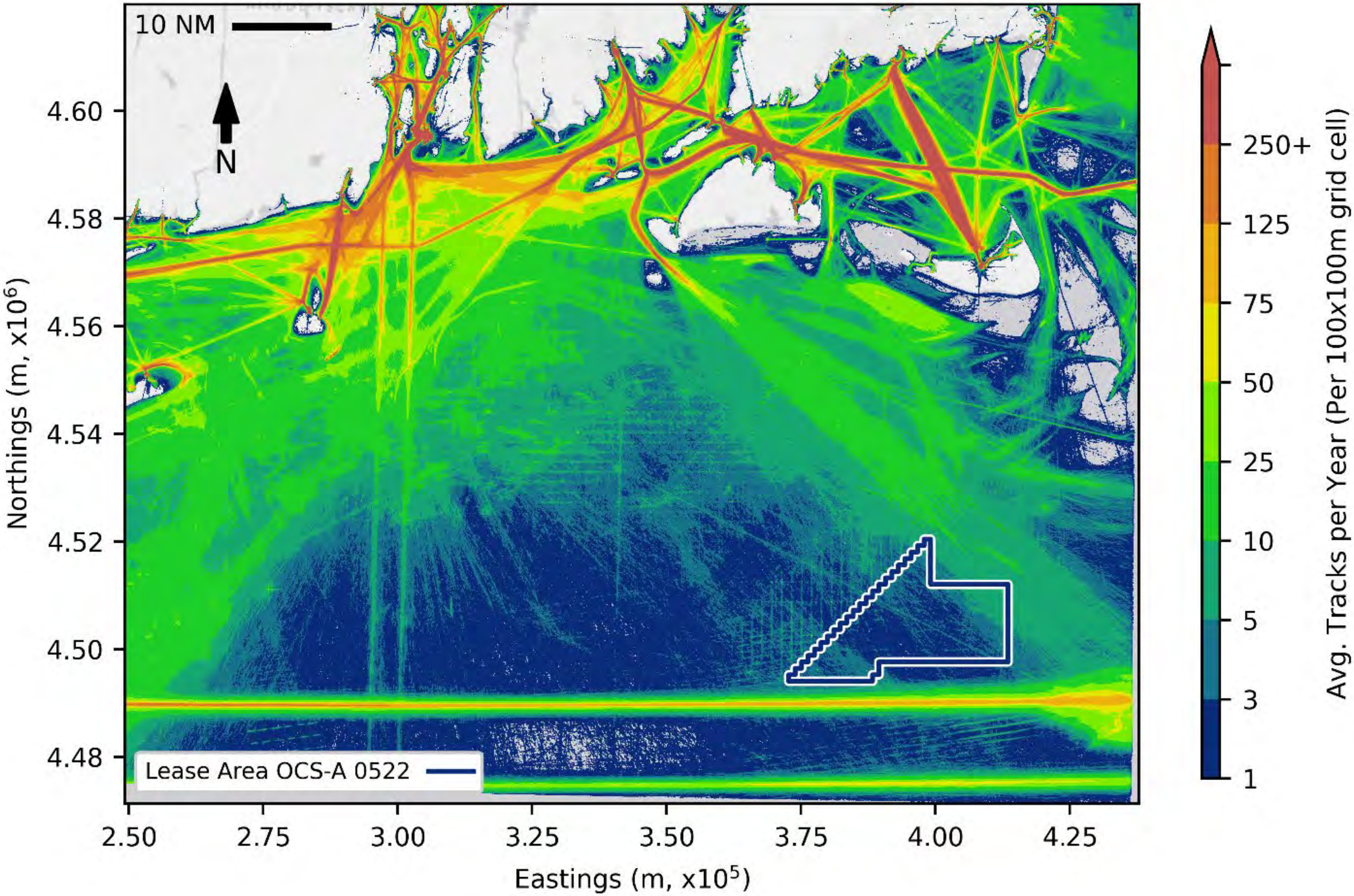

Figure 5.6-3
Annual Average Vessel Traffic Density for AIS-Equipped Vessels

VINEYARD NORTHEAST
VINEYARD OFFSHORE

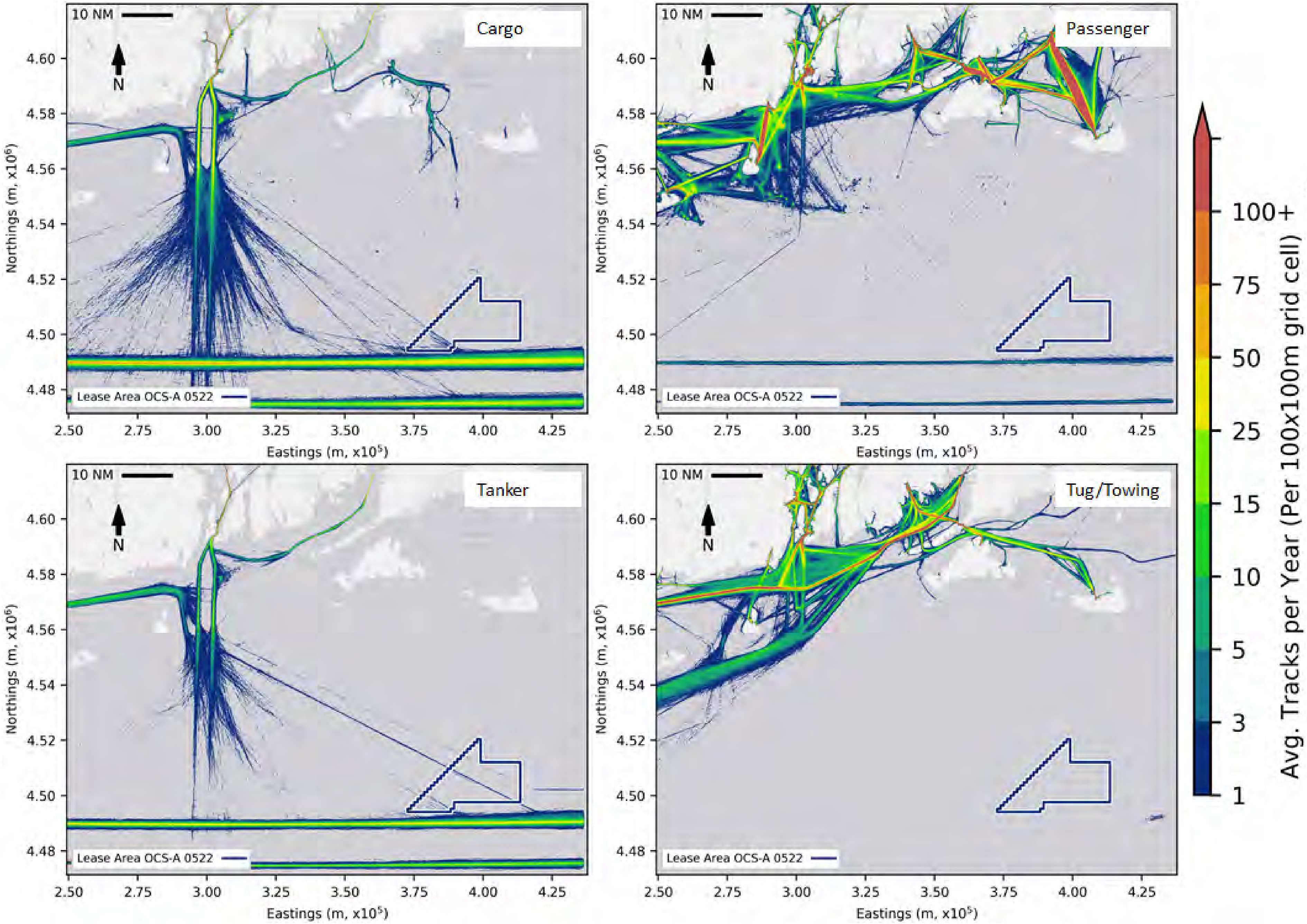

Figure 5.6-4

Commercial (Non-Fishing) Vessel Average Annual Traffic Densities

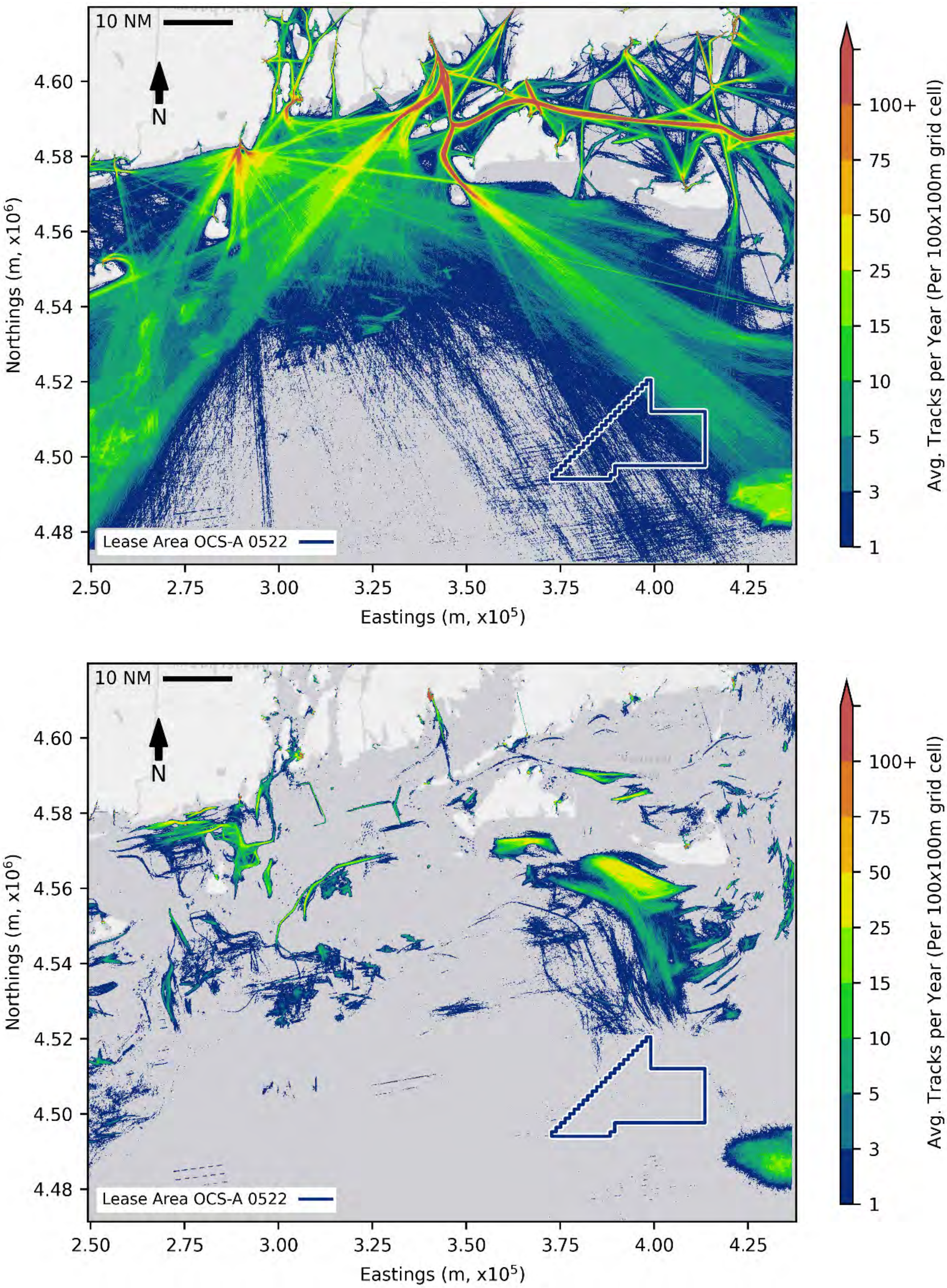

Figure 5.6-5

Transiting (top) and Actively Fishing (bottom) AIS Vessel Average Annual Traffic Densities

VINEYARD NORTHEAST

VINEYARD OFFSHORE

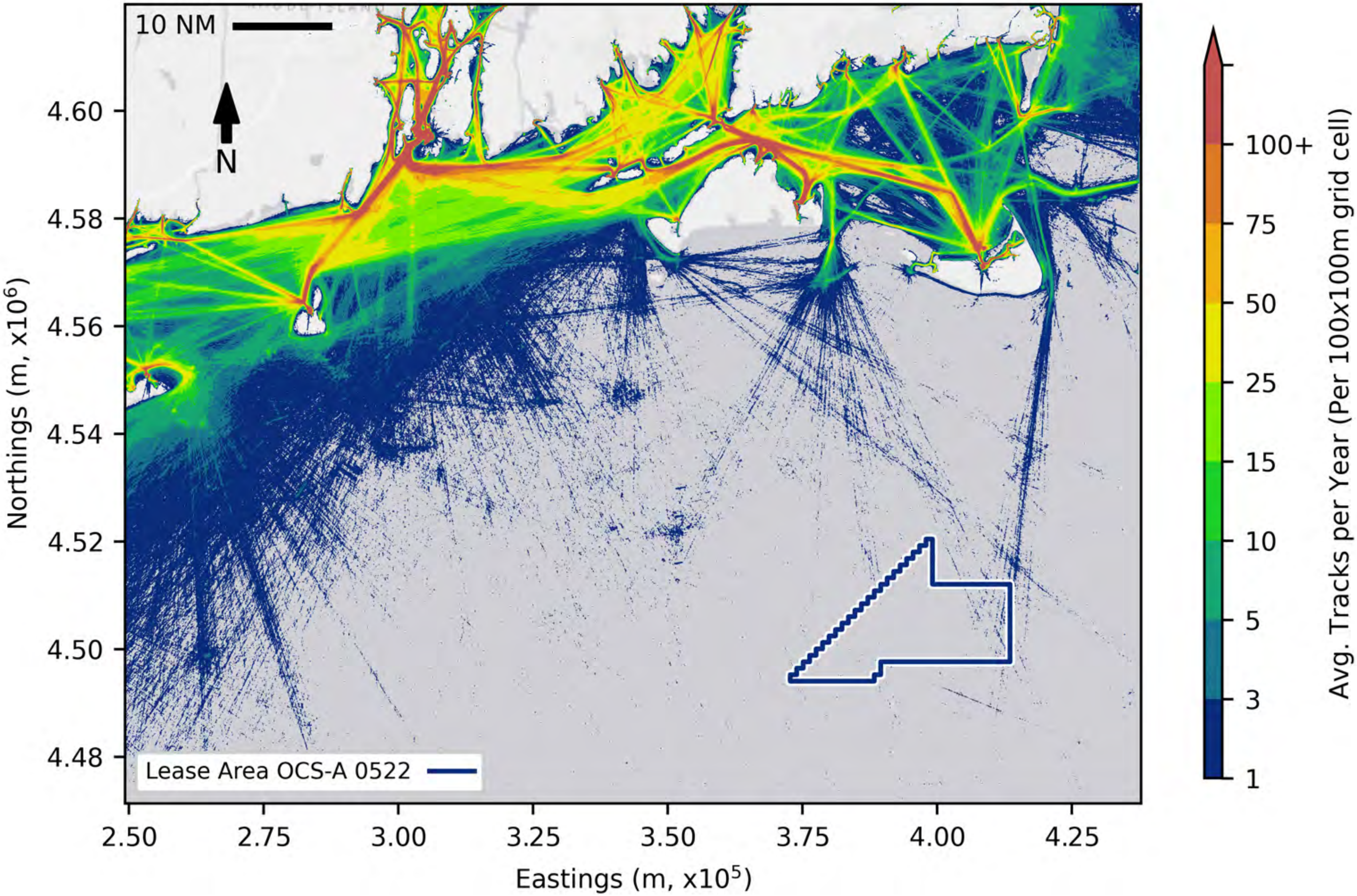

Figure 5.6-6
Recreational Vessel Average Annual Traffic Densities

VINEYARD NORTHEAST
VINEYARD OFFSHORE

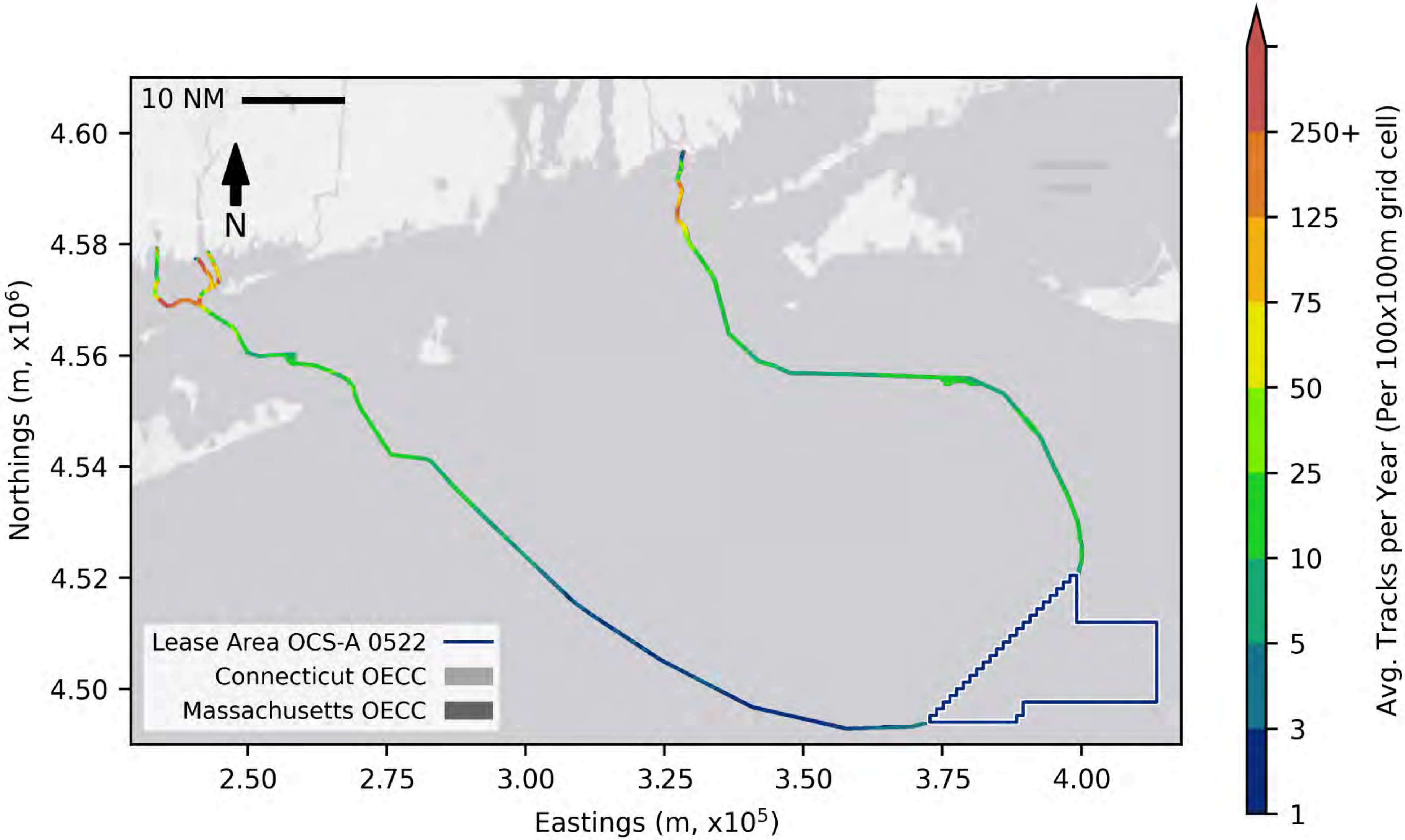

Figure 5.6-7

Annual Average Track Densities for Vessels Crossing the Offshore Export Cable Corridors

VINEYARD NORTHEAST
VINEYARD OFFSHORE

5.6.2.1 Vessel Activity

Construction, O&M, and decommissioning activities will cause increased vessel activity within the Offshore Development Area. Vineyard Northeast vessels operating in the Offshore Development Area may temporarily affect other vessels' activities within the immediate vicinity or cause other vessels to slightly alter their routes to avoid Vineyard Northeast activities. However, vessel traffic associated with Vineyard Northeast is not anticipated to represent a significant increase over the current levels of vessel traffic within the Offshore Development Area (see Appendix II-G).

Offshore construction and O&M will require several types of vessels, many of which will be specifically designed for offshore wind construction and cable installation. The types of vessels that are expected to be used during offshore construction of Vineyard Northeast are provided in Table 3.10-2 of COP Volume I and include jack-up vessels, heavy lift vessels, tugboats, barges, cable laying vessels, dredging vessels, crew transfer vessels (CTVs), service operation vessels (SOVs), and others. All construction and installation vessels and equipment will display the required navigation lighting and day shapes and make use of AIS as required by the USCG. As described further in Section 4.4.2 of COP Volume I, the Proponent expects to use one or a combination of the following logistical approaches during the routine O&M of Vineyard Northeast: SOVs during multi-week service trips to the Lease Area, service accommodation and transfer vessels (SATVs) for multi-day or week-long service trips, and CTVs and helicopters for frequent trips (e.g., daily) to transfer crew and supplies between the offshore facilities and shore. The Proponent may periodically use larger vessels (e.g., jack-up vessels, cable laying vessels) to perform certain maintenance and repair activities, if needed. These vessels would be similar to the vessels used during construction.

It is challenging to precisely quantify the number of vessels and vessel trips from each port at the early planning stages of Vineyard Northeast because they depend on: (1) the specific vessels and ports used; (2) the final construction schedule; and (3) the installation and transportation methods employed, which continue to evolve rapidly and will vary based on the final project design. The estimated number of vessels and vessel trips presented below, which are based on current understanding of a potential construction schedule, are likely conservative and subject to change.

Assuming the maximum design scenario (see Section 1.5), it is estimated that an average of ~25 vessels would operate at the Lease Area or along the OECCs at any given time during offshore construction. During the most active period of construction, it is conservatively estimated that a maximum of approximately 61 vessels could operate in the Offshore Development Area at one time.[89] Up to approximately 3,800 total vessel round trips are

89 This includes vessels at the Lease Area, at the OECCs, and in transit to, from, or within a port.

expected to occur during the busiest year of offshore construction. During the most active month of construction, it is anticipated that an average of approximately 19 daily vessel round trips could occur. Vessel activity for decommissioning activities is anticipated to be similar to construction needs.

During the busiest year of O&M, an average of approximately nine vessels are anticipated to operate in the Offshore Development Area at any given time, although additional vessels may be required during certain maintenance or repair activities. Based on the maximum design scenario, approximately 575 vessel round trips are estimated to take place annually during O&M. However, these estimates are highly dependent on the logistics approach used during O&M, the location of the O&M facilities, the timing and frequency of activities, and the final design of the offshore facilities. All vessels used during the operation of Vineyard Northeast will be equipped with AIS to track vessel activity and monitor compliance with permit requirements.

The Proponent has identified several ports in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Canada that may be used to stage offshore components (see Table 3.10-1 and Figure 3.10-1 of COP Volume I). These staging ports could be used for frequent crew transfer and to offload, store, pre-assemble, inspect, pre-commission, and/or load components onto vessels for delivery to the Lease Area and OECCs.[90] During the operational period, the Proponent expects most vessel activity to be based out of one or more of the ports listed in Table 4.4-1 of COP Volume I. See Sections 3.10.1 and 4.4.1 of COP Volume I for a complete list of ports that may be used for construction and O&M activities. Vessel operations and frequency may increase near these port facilities during construction, O&M, and decommissioning. Vessel and port utilization will be highest during construction and decommissioning. Also, use of larger vessels will be more prevalent during the installation phase. The potential ports and surrounding waterways are expected to have the capacity for the potential increase in vessel traffic during all Vineyard Northeast-related activities. Further, the Proponent has defined a wide range of port facilities, which will allow use of the most appropriate port facilities for a given activity, including consideration of the capacity of a port to accommodate the planned vessel traffic.

To minimize effects to existing maritime activities, the Proponent employs a Marine Liaison Officer who is responsible for safe marine operations and ensuring that the Proponent is a good neighbor while on the water. The Marine Liaison Officer currently serves as the Proponent's point of contact for all external maritime agencies, partners, and stakeholders, including USCG, US Navy, port authorities, state and local law enforcement, and commercial operators (e.g., ferry, tourist vessels, and other offshore wind developers). During construction, the Proponent expects to employ a dedicated Marine Coordinator to manage construction

[90] Some components (e.g., monopiles) may instead be pulled by tugs while floating in the water rather than loaded onto vessels.

vessel logistics and implement communication protocols with external vessels at ports and offshore. During construction, the Marine Coordinator will be the primary point of contact with external maritime agencies, partners, and stakeholders for day-to-day offshore operations. The Marine Coordinator will use tools such as radio communications and safety vessels to address vessels entering active work sites. The safety vessels would provide guidance to mariners and fishing vessels, explain the ongoing activities, and request that they give a wide berth to the work site or construction vessel(s), if necessary.

As described below, the Proponent will inform mariners of construction and certain maintenance activities, including the anticipated locations of those activities, allowing vessels to alter their navigation routes if needed to avoid affected areas. Some of the measures to minimize effects to mariners include:

- The Marine Liaison Officer will issue Offshore Wind Mariner Updates to notify maritime stakeholders of the Proponent's offshore activities. The Offshore Wind Mariner Updates will include a description of the planned activity, pictures of the vessel(s) and equipment to be deployed, a chart showing the location of the activity, vessel contact information, and the Proponent's Onboard Fisheries Liaisons' contact information (if applicable). Depending on the activity, the Offshore Wind Mariner Update may request that mariners give a wide berth to the work site or construction and maintenance vessel(s). These updates are published on the Proponent's website, social media channels, and sent via email and SMS text alert to those who have opted-in to receive notifications from the Proponent.

- The Proponent distributes a weekly email to consolidate and recirculate active Offshore Wind Mariner Updates in order to help mariners and fishermen keep track of the various notifications that they receive.

- The Proponent will also coordinate with the USCG to issue Notices to Mariners (NTMs) to notify recreational and commercial vessels of their planned offshore activities.

- To help ensure safety within the vicinity of active work areas, the Proponent may request that the USCG establish temporary safety zones, per 33 CFR Part 147, that extend 500 m (1,640 ft) around each wind turbine generator (WTG), electrical service platform (ESP), and booster station (if used) during construction and certain maintenance activities (see Section 8.4 of COP Volume I for additional details). The safety zones would be limited in size and duration and would not affect the entire Lease Area at any given time.

5.6.2.2 Presence of Structures

The presence of structures, including the WTGs, ESP(s), booster station (if used), and offshore cable system may affect vessel traffic, search and rescue (SAR) activities, marine radar and communications, and other activities.

General Navigation Effects

During O&M, the Lease Area and OECCs will be open to marine traffic, other than any temporary safety zones established by USCG during limited maintenance activities in the Lease Area. As described in the NSRA (see Appendix II-G), the Lease Area is not generally subject to dense traffic, which limits the scale of potential navigational effects.

As proposed, the WTGs and ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with 1 NM (1.9 km) spacing between positions (see Figure 5.6-8).[91] This 1 x 1 NM WTG/ESP layout is consistent with the layout adopted by other developers throughout the Massachusetts Wind Energy Area (MA WEA) and Rhode Island/Massachusetts (RI/MA WEA). The 1 NM (1.9 km) corridors would accommodate all of the existing AIS-equipped fishing fleet and 98% or more of the AIS-equipped recreational vessels, depending on the assumed buffer (0 m, 50 m, or 250 m) around the WTGs. For the minimum 0.6 NM corridor, depending on the assumed buffer (0 m, 50 m, or 250 m), between 87% and 96% of recreational vessels and between 95% and 100% of the fishing vessels could transit through the corridors based on the Massachusetts and Rhode Island Port Access Route Study (MARIPARS) navigation corridor width methodology (see Appendix II-G).

It is anticipated that larger commercial vessels (e.g., cargo, tanker, passenger, and tug tow vessels) may navigate to the south of the Lease Area toward and along shipping routes, including the Nantucket to Ambrose Safety Fairway (westbound) and Ambrose to Nantucket Safety Fairway (eastbound), rather than through the Lease Area. While rerouting around the Lease Area may add to transit time for these vessels, the increase in duration is estimated to be less than 15 minutes to the overall journey time based on the average vessel speed.

Sailboat excursions will need to consider the presence of offshore facilities in the Lease Area. Large sailing craft transiting in this region with mast heights that exceed the maximum allowable air draft (i.e., the maximum distance from the water line to the highest point on the vessel) should take this into account and may elect to travel around the Lease Area rather than through it. The minimum blade tip clearance is 27 m (89 ft) relative to Mean Lower Low Water (MLLW). Highest Astronomical Tide (HAT) is 0.97 m (3.18 ft) above MLLW. Therefore, the maximum allowable vessel air draft, when allowing for a 1.5 m (5 ft) safety margin, is approximately 24.4 m (80 ft). This air draft assumes calm conditions; the presence of waves will reduce the air draft further. The Proponent will provide information on the air draft restrictions in the Lease Area to the USCG and NOAA so that these restrictions can be identified by means of NTMs, in the Coast Pilots, and on navigational charts. Note that sailing vessels are at little risk of interacting with the WTGs under normal conditions.

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[91] Where necessary, WTGs and ESP(s) may be micro-sited by a maximum of 152 m (500 ft) to avoid unfavorable seabed conditions, maintain facilities within the Lease Area boundaries, and/or for other unexpected circumstances.

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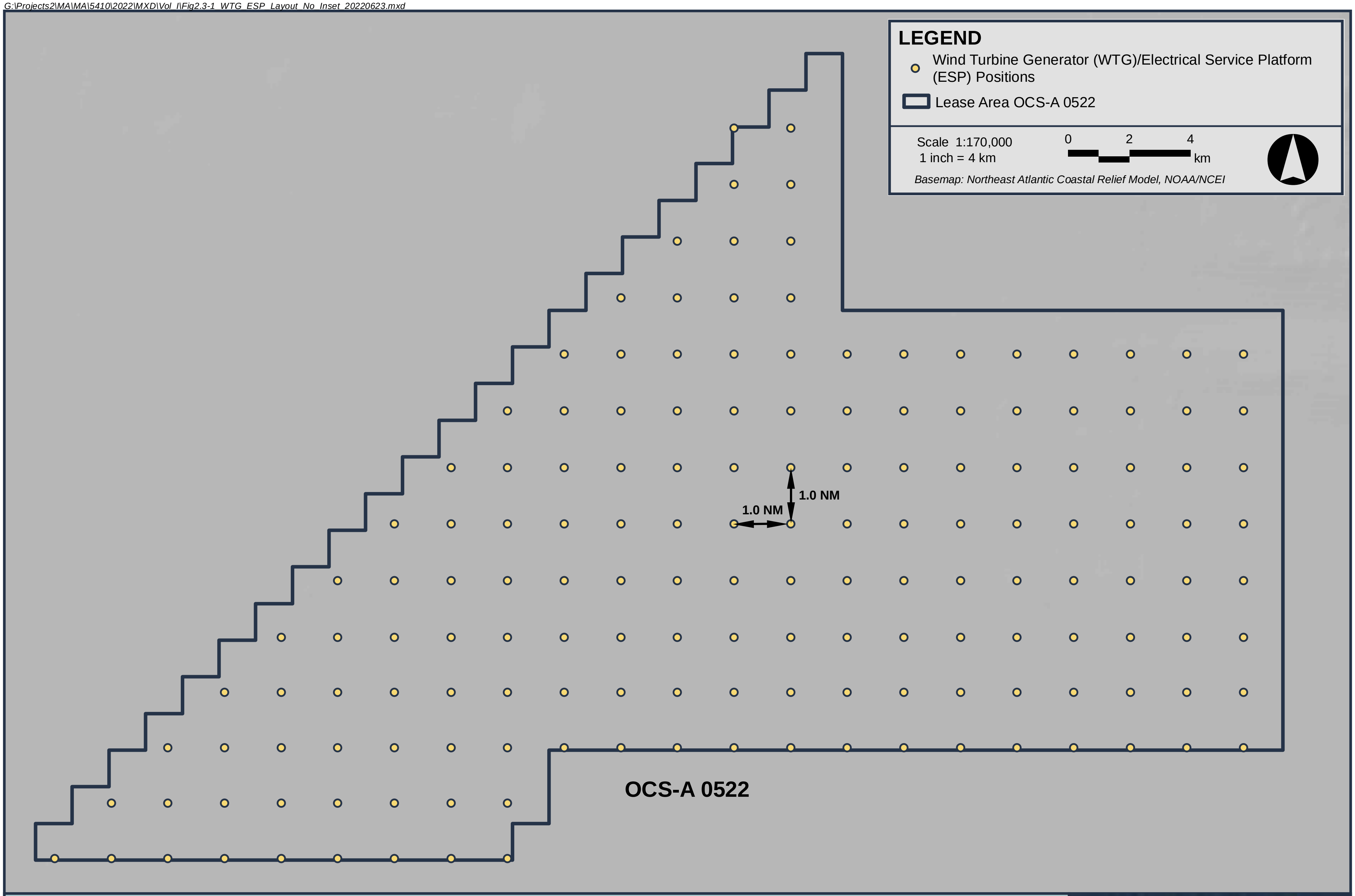

Figure 5.6-8
WTG/ESP Layout

VINEYARD NORTHEAST
VINEYARD OFFSHORE

To aid marine navigation, the WTGs, ESP(s), booster station (if used), and their foundations will be equipped with marine navigation lighting, marking, and signaling in accordance with USCG and BOEM guidance. Each WTG, ESP, and booster station will be maintained as a PATON. Based on USCG's current *ME, NH, MA, RI, CT, NY, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance*,[92] the Proponent expects the lighting, marking, and signaling scheme of the offshore facilities to include the following:

- Unique alphanumeric identifiers will be displayed on the WTGs, ESP(s), booster station and/or their foundations following the *Rhode Island and Massachusetts Structure Labeling Plot* (see Appendix I-A1 of COP Volume I). For the WTGs, the alphanumeric identifiers will be on the tower, nacelle, and potentially the foundation. The alphanumeric identifiers on the WTG tower will be as close to 3 m (10 ft) high as possible and will be visible from all directions. The alphanumeric identifiers on the ESP(s) and booster station will be as close to 1 m (3 ft) high as possible and will be visible from all directions.

- The WTG's air draft restriction will be indicated directly on the WTG foundation and/or tower and will be visible in all directions.

- Each foundation will be coated with high-visibility yellow paint above sea level.

- Each structure will include yellow flashing lights that are visible in all directions at a distance of 2 to 5 NM (3.7 to 9.5 km). The intensity of the lights will depend on the location of the structure within the Lease Area.

- Mariner Radio Activated Sound Signals (MRASS) will be located on select foundations.

- AIS will be used to mark the WTGs, ESP(s), and booster station (virtually or using physical transponders).

The Proponent will work with the USCG, BOEM, and the Bureau of Safety and Environmental Enforcement (BSEE) to determine the appropriate marine lighting, marking, and signaling scheme for the proposed offshore facilities, including the number, location, and type of AIS transponders and MRASS. The Proponent expects to provide a detailed lighting, marking, and signaling plan to BOEM, BSEE, and USCG prior to construction of the offshore facilities. Additional information on marine navigation lighting, marking, and signaling can be found in the NSRA (see Appendix II-G).

[92] USCG's PATON guidance for offshore wind energy structures in First District-area waters is periodically updated in District 1 Local Notice to Mariners (LNMs).

Collisions and Allisions

The frequency of collisions and allisions of marine vessels may be influenced by increased vessel traffic associated with Vineyard Northeast and the presence of new offshore structures (e.g., WTGs, ESPs, etc.). The Proponent conducted a quantitative risk assessment for existing conditions and post-construction within the Lease Area using Baird's proprietary Navigational and Operational Risk Model (NORM). The model utilizes raw AIS data, wind, current, and visibility data as inputs along with the geometric layout and Vineyard Northeast-specific dimensions of the WTGs and ESPs. The results of the model show that the overall risk for potential marine accidents is relatively low for both pre-construction and post-construction conditions, and that the bulk of the risk is for fishing and cargo vessels. The risk of a potential accident changes from an average of one in every 48 years (pre-construction) to one in every 45 years (post-construction) and is primarily attributed to O&M traffic and allisions with WTGs, which translates to one additional accident every 720 years. See the NSRA in Appendix II-G for a detailed assessment of the risk of collision and allision due to Vineyard Northeast.

The Proponent will minimize the risk of collisions and allisions by following mitigation measures to aid mariners navigating within and near the Lease Area, including marking and lighting all structures in accordance with BOEM and USCG guidelines, maintaining each WTG and ESP position as well as the booster station (if used) as a PATON, using AIS to mark the WTGs, ESP(s), and booster station, including unique alphanumeric identification on each foundation, providing lights on each foundation that are visible in all directions, and including sound signals on select foundations. The Proponent will continue to coordinate with BOEM, USCG, and BSEE on measures to maintain safe navigation.

Marine Radar and Communications Effects

Marine radar is an electromagnetic system used for the detection of ships and obstacles at sea, which provides the operator with an estimate of the distance and bearing to any object. Studies have been conducted to evaluate concerns that the WTGs may affect some shipborne radar systems, potentially creating false targets on the radar display or causing vessels navigating within the Lease Area to become "hidden" on radar systems due to shadowing created by the WTGs. WTGs can also mask or shadow weaker signal returns from smaller objects within a turbine field (Angulo et al. 2014). The effectiveness of radar systems and any effects from WTGs will vary from vessel to vessel based on several factors, including radar equipment type, settings, and installation (including location of placement on the vessel). As identified in previous studies of this issue in Europe (BWEA 2007), the potential effects of WTGs may be reduced through adjustment of the gain setting on the radar.

The USCG's (2020) MARIPARS reviewed several studies on the relationship between offshore renewable energy installations and marine radar interference. After reviewing these studies, the USCG concluded that, "To date, the USCG is not aware of an authoritative scientific study that confirms or refutes the concern that WTGs will degrade marine radar." According to the

MARIPARS, United Kingdom studies show that, "additional mitigation measures, such as properly trained radar operators, properly installed and adjusted equipment, marked wind turbines and the use of AIS, enable safe navigation with minimal loss of radar detection."

In recognition of the concerns associated with potential radar system impacts from offshore wind development, the Wind Turbine Radar Interference (WTRIM) Working Group has been established with the support of a number of agency and partners including BOEM, the Department of Energy, the Department of Defense (DoD), the Federal Aviation Administration (FAA), NOAA, and the Department of Homeland Security. The purpose of this working group is to mitigate the technical and operational impacts of offshore wind projects on critical radar missions. The goal is to develop near- (5-year), mid- (10-year), and long-term (20-year) mitigation solution recommendations, recognizing that these will be primarily technology driven. In 2022, the National Academy of Sciences, Engineering, and Medicine published the *Wind Turbine Generator Impacts to Marine Vessel Radar* (NASEM 2022), which provides a comprehensive overview of marine radar impacts and lays out potential mitigation measures as well as providing recommendations for future work.

Vineyard Northeast, as with many other similar facilities around the world, may have an impact on certain marine radar systems. The principal issue appears to be the shadow effect and the detection of vessels that are located within the wind turbine field. The issue of radar clutter and false targets when navigating outside the wind turbine field, as will occur south and east of the Lease Area, is common to wind farms in Europe, some of which are located adjacent to heavily used shipping channels. Vessels do safely navigate outside these wind farms despite the radar impacts. The lighting and marking of the WTGs, ESP(s), and booster station, as well as the use of AIS and MRASS as per USCG guidance will help mitigate potential allision risk due to the presence of Vineyard Northeast's offshore facilities. Mitigation for radar impacts (if needed) as well as communications consistency measures are expected to be based on regional efforts, which would be implemented in conjunction with other MA WEA and RI/MA WEA developers. It is expected that regional mitigation measures will be refined and updated pending ongoing consultations with BOEM, USCG, and other MA WEA and RI/MA WEA developers.

Based on a review of various studies, the Vineyard Northeast WTGs are expected to have little impact on very high frequency (VHF) communications or AIS reception. Additional information on marine radar and communications effects can be found in the NSRA (see Appendix II-G.)

<u>Search and Rescue Effects</u>

Using vessel and helicopter assets, the USCG conducts SAR missions for incidents including vessels capsizing, disabled vessels, vessels taking on water, and persons in water. A review of approximately 10 fiscal years (2011 to 2020) of historical USCG SAR data for an area within a 20 NM (37 km) buffer around the Lease Area documented that there were four incidents within or immediately adjacent to the Lease Area. Of the 91 reported SAR incidents within the 20 NM

(37 km) buffer around the Lease Area, approximately half of the incidents occurred in the summer months of June through August, with an average of 9.1 incidents per year. There were no reported collisions in the Lease Area vicinity.

The WTG spacing and minimum tip clearance of the blades is not expected to affect the operation of USCG marine assets (or commercial salvors' vessels) that are in use in the area. It is expected that these marine assets will be able to safely navigate and maneuver adequately within the Lease Area. Given the WTG spacing and relative size, the Proponent anticipates that Vineyard Northeast will not affect travel times to and within the Lease Area by vessels responding to SAR distress calls.

The 1 x 1 NM WTG/ESP layout of Vineyard Northeast is consistent with the USCG's WTG spacing recommendations to accommodate SAR operations contained in the MARIPARS. The MARIPARS found that, "One NM spacing between WTGs allows aircrews to safely execute turns to the adjacent lane using normal flight procedures in visual conditions" and "may allow sufficient navigational room for aircrews to execute USCG missions in diverse and challenging weather conditions or deal with an aircraft emergency and/or navigational malfunction." According to the MARIPARS, a standard and uniform WTG/ESP layout will assist SAR in favorable weather conditions.

Vineyard Northeast may facilitate SAR operations as the WTGs and ESP(s) will be marked and lighted and Vineyard Northeast vessels will operate frequently within the Lease Area. Alphanumeric markings on the WTGs may also aid mariners in reporting their position during distress calls. The Proponent will work with the USCG and DoD to develop an operational protocol that outlines the procedures for the braking system on requested Vineyard Northeast WTGs to be engaged within a specified time upon request from the USCG or DoD during SAR operations and other emergency response situations. The formal shutdown procedure will be described in the Proponent's Emergency Response Plan (see Section 6.1 of COP Volume I) and will be tested on a regular basis.

If the ESP(s) include a helipad, the helipad will be designed to accommodate USCG rescue helicopters. Enabling USCG helicopters to land on the ESP(s) could allow for more efficient responses to potential emergency situations within and outside the Lease Area. The Proponent is also evaluating the use of cameras on WTGs and/or ESP(s), which may aid in the detection of distressed mariners and enhance the USCG's ability to respond in emergency situations. Additional information on SAR operations and mitigations are discussed in the NSRA (see Appendix II-G).

Other Marine Transportation Effects

Other potential effects on marine transportation associated with the WTGs, ESP(s), booster station, offshore cable system, and other components include anchoring risk, potential impacts to existing aids to navigation, attraction of more fishing activity to the Lease Area, and potential increased tour vessel traffic.

The presence of offshore cables within the Lease Area and the OECCs is not anticipated to interfere with any typical anchoring practices, as there are no designated anchoring areas in proximity to the Lease Area and OECCs. All offshore cables will have a target burial depth of 1.5 to 2.5 m (5 to 8 ft)[93] below the stable seafloor. The Proponent's engineers have determined that this target burial depth is more than twice the burial depth required to protect the cables from fishing activities and also generally provides a maximum of 1 in 100,000 year probability of anchor strike,[94] which is considered a negligible risk.

As described in Section 5.6.1.1, there are no Federal ATONs or PATONs in the Lease Area besides Vineyard Northeast's own metocean buoy. The Proponent will engage with the USCG early in the permitting process and coordinate closely to address ATONs in proximity to or within the OECCs. These ATONs will be avoided through micro-siting the offshore export cables (within the OECC) around the ATONs in accordance with USCG's Minimum Safe Distance requirements.[95] ATONs within approximately 1,500 m (4,920 ft) from the landfall sites may be avoided through the use of horizontal directional drilling (HDD), subject to further detailed engineering. If deemed necessary, the Proponent would coordinate with the owners of PATONs located in proximity to the Connecticut OECC.

The presence of structures in the Lease Area may become an attraction for fishing. The foundations may create an artificial reef effect which could cause fish aggregation (see Sections 5.3 and 5.4). This in turn could result in an increase in certain types of commercial and recreational fishing in the Lease Area.

5.6.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to navigation and vessel traffic during Vineyard Northeast are summarized below:

- Utilize a Marine Coordinator to manage construction vessel logistics and implement marine communication protocols with external vessels at ports and offshore.
- Employ a Marine Liaison Officer who will act as the strategic maritime liaison between Vineyard Northeast's internal parties and all external maritime partners and stakeholders.

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93 Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

94 Based on a preliminary CBRA (see Appendix II-T), in portions of the Ocean Beach Approach and Niantic Beach Approach of the Connecticut OECC, a greater target burial depth of approximately 3 m (10 ft) is needed to achieve a 1 in 100,000 year probability of anchor strike.

95 USCG defines the Minimum Safe Distance (MSD) as greater than or equal to the Position Tolerance (PT) + Chain Length (CL) + Length of Servicing Vessel (LSV) (+ shoaling consideration). The specific inputs for each ATON would be obtained from USCG.

- Provide Offshore Wind Mariner Updates and coordinate with the USCG regarding the issuance of NTMs advising other vessel operators of Vineyard Northeast's activities. Depending on the activity, the Offshore Wind Mariner Update may request that mariners give a wide berth to the work site or construction and maintenance vessel(s).

- Regularly update the Vineyard Northeast website to provide information about vessel activities occurring in the Offshore Development Area.

- Regularly provide updates as to the locations of installed WTGs, ESP(s), and the booster station (if used) to the USCG and NOAA for use in navigational charts.

- Light and mark the WTGs, ESP(s), booster station (if used), and their foundations in accordance with USCG and BOEM guidance. Each structure will be marked with a unique alphanumeric identifier to aid in visual confirmation of vessel location. Each WTG, ESP, and booster station will be maintained as a PATON.

- Use of a 1 x 1 NM WTG/ESP layout-oriented north-south and east-west will allow fixed fishing gear to be placed along the east-west turbine alignment so that it is visually apparent where this gear is located. This is consistent with the current practice of placing such gear along east-west LORAN lines.

- Provide temporary lighting and marking on foundation structures as they are built, depending on the sequence and timing of construction.

- Include an aviation obstruction lighting system on the WTGs, ESP(s), and booster station (if they exceed a height of 60.96 m [200 ft] above Mean Sea Level or any obstruction standard contained in 14 CFR Part 77) in compliance with FAA and BOEM requirements.

- Require all Vineyard Northeast construction vessels and equipment to display required navigation lighting and day shapes.

- Work with the USCG and DoD to develop an operational protocol that outlines the procedures for the braking system on requested Vineyard Northeast WTGs to be engaged within a specified time upon request from the USCG or DoD during SAR operations and other emergency response situations.

- Coordinate with the USCG to identify ways for Vineyard Northeast to support SAR efforts, which may include the use of cameras on WTGs and/or ESP(s) to aid in the detection of distressed mariners.

- Design the helipads on the ESP(s), if present, to accommodate USCG rescue helicopters.

- Engage with the USCG early in the permitting process and coordinate closely to address ATONs in proximity to or within the OECCs. These ATONs will be avoided through micro-siting the offshore export cables (within the OECC) around the ATONs in accordance with USCG's Minimum Safe Distance requirements. If deemed necessary, the Proponent would coordinate with the owners of PATONs located in proximity to the Connecticut OECC.

- Request that the USCG establish temporary safety zones, per 33 CFR Part 147, that extend 500 m (1,640 ft) around each WTG, ESP, and booster station (if used) during construction and certain maintenance activities to help ensure safety within the vicinity of active work areas.

- When feasible, deploy one or more safety vessels to provide guidance to mariners and fishing vessels, explain the ongoing activities, and request that they give a wide berth to the work site or construction vessel(s), if necessary.

- Include MRASS and AIS transponders in the design of the offshore facilities to enhance safety; the number, location, and type of these items will be determined in coordination with the USCG, BOEM, and BSEE.

5.7 Aviation, Military, and Radar Uses

This section addresses the potential impacts of Vineyard Northeast on aviation, military, and radar uses in the Onshore Development Area and Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to aviation, military, and radar uses during the construction, operation, and decommissioning of Vineyard Northeast.

Appendix II-H includes the aviation and radar studies conducted for Vineyard Northeast.

5.7.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut, as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities.

The description of the affected environment is informed by the following studies included in Appendix II-H:

- Obstruction Evaluation and Airspace Analysis

- Air Traffic Flow Analysis
- Radar and Navigational Aid Screening Study

5.7.1.1 Aviation and Military Uses

Aviation and Military Airspace

Territorial airspace is airspace over the United States (US), its territories and possessions, and over US territorial waters out to 22 kilometers (km) (12 nautical miles [NM]) from the coast. The Lease Area is located approximately 46 km (25 NM) from Nantucket, which is outside territorial airspace. 14 CFR Part 77 applies to all structures within US territorial airspace. 14 CFR Part 77.9 requires that all structures exceeding 200 feet [ft] above ground level (AGL) (61.0 meters [m]) be submitted to the Federal Aviation Administration (FAA) so that an aeronautical study can be conducted. For the portions of a project that lie outside of US territorial airspace and in Bureau of Ocean Energy Management (BOEM) jurisdiction, BOEM will consult with the FAA for airspace impacts.

An Obstruction Evaluation and Airspace Analysis (OE/AA) was completed for the proposed Vineyard Northeast wind turbine generators (WTGs) (see Appendix II-H). The OE/AA determined proximity to airports, published instrument procedures, enroute airways, FAA minimum vectoring altitude and minimum instrument flight rules (IFR) altitude charts, as well as military airspace and training routes. The OE/AA also evaluated all 14 CFR Part 77 imaginary surfaces, published instrument approach and departure procedures, visual flight rules operations, FAA minimum vectoring altitudes, minimum IFR altitudes, and enroute operations.

The closest public airports in proximity to Vineyard Northeast include:

- Nantucket Memorial Airport (ACK)
- Katama Airpark (1B2)
- Martha's Vineyard (MVY)
- Newport State (UUU)

Additional private-use airports are also present on Nantucket, Martha's Vineyard, and the south coast of Rhode Island, as shown on Figure 1 of the OE/AA in Appendix II-H.

The OE/AA demonstrated that the lowest obstacle clearance surfaces overlying Vineyard Northeast range from 319.7 to 1,386.5 m (1,049 to 4,549 ft) above mean sea level (AMSL) and are associated with multiple minimum vectoring altitude (MVA) sectors. An increase to Boston Consolidated (A90) Terminal Radar Approach Control (TRACON) MVAs from 609.6 to 701.0 m (2,000 to 2,300 ft) AMSL could be required in the northwest corner of the Lease Area; however, no proposed WTGs are located in the area with the lowest clearance (see Figures 13 and 14 of the OE/AA in Appendix II-H). Additionally, review of flight track data, as described in the Air Traffic Flow Analysis included in Appendix II-H, indicates that no flights operate in the affected airspace.

The US Navy and/or other US Department of Defense (DoD) organizations use the airspace over and adjacent to the Lease Area. The DoD uses domestic and international airspace for readiness training and exercises. To make "nonparticipating pilots" aware of military operations, the FAA designates sectors of airspace as Warning Areas and charts these areas on aeronautical charts with an identifying number. Within Warning Area airspace, limitations may be imposed on aircraft not participating in military operations. The Lease Area, along with much of the Massachusetts Wind Energy Area (MA WEA), is located within W-105A, which is a block of airspace ranging from 0–15,240 m (0–50,000 ft) AMSL.

It is noted that, although the Lease Area is outside territorial airspace, portions of the Massachusetts OECC and Connecticut OECC, portions of the vessel routes between port facilities and the Lease Area, and the port facilities themselves are within territorial airspace.

Additionally, depending on the final location of the onshore substation site in Massachusetts and the transmission technology employed (high voltage alternating current [HVAC] or high voltage direct current [HVDC]), the northern crossing of the Taunton River [redacted] (see Figure 3.8-1 of COP Volume I) may require overhead transmission lines. The overhead transmission towers are anticipated to have a maximum height of approximately 115 m (377 ft) above ground. The total length of overhead transmission is estimated to be approximately 940 m (3,084 ft). The overhead transmission towers and lines would be marked and lit in accordance with FAA guidance.

United States Navy

The US Navy has a significant presence along the US northeastern seaboard. Several naval facilities located in the broader region may conduct training or operations within the Offshore Development Area. These include Naval Station Newport in Newport, Rhode Island, which is home to 50 US Navy, US Marine Corps, US Coast Guard (USCG), and US Army Reserve commands and activities. Naval Station Newport is also home to the US Navy Supply Corps School, the Center for Service Support, the US Marine Corps Aviation Logistics School, and the Naval War College. Naval Station Newport also hosts the Naval Undersea Warfare Center, which is one of the corporate laboratories of the Naval Sea Systems Command. Additionally, New London and Groton, Connecticut host equipment and personnel at US Naval Submarine Base New London and the USCG Academy.

The US Navy maintains three range complexes located along the mid-Atlantic and northeastern seaboard of the US. A range complex is a designated set of specifically bounded geographic areas where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. They include established Operating Areas (OPAREAs) and special use airspace, which may be further divided to provide better control of an area and events being conducted for safety reasons.

The three range complexes—the Boston Range Complex, the Narragansett Bay Range Complex, and the Atlantic City Range Complex—are collectively referred to as the Northeast Range Complex and span the coast from Maine to New Jersey. Combined, these areas are the principal locations for some of the US Navy's major training and testing events and infrastructure in the Northeast. The Northeast Range Complex includes special use airspace with associated Warning Areas and surface and subsurface sea space of three OPAREAs: the Boston OPAREA, the Narragansett Bay OPAREA, and the Atlantic City OPAREA. The boundaries of the three OPAREAs largely correspond with the boundaries of the Boston, the Narragansett Bay, and the Atlantic City Range Complexes (see Figure 5.7-1). The Lease Area is located within the Narragansett Bay Range Complex and Narragansett Bay OPAREA (see Figure 5.7-1). This OPAREA is a surface and subsurface exercise/operating area, extending approximately 185 km (100 NM) south and 407 km (220 NM) east of the coasts of Massachusetts, Rhode Island, and New York. Submarine Transit Lanes, which are transit corridors where submarines may navigate underwater, are also located within the broader region but are outside of the Lease Area.

United States Coast Guard

The USCG 1st District is headquartered in Boston, Massachusetts and is responsible for USCG activities in Northern New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine (USCG 2022a). The USCG 5th District, headquartered in Portsmouth, Virginia, maintains maritime safety and security of 404,038 square kilometers (km^2) (156,000 square miles [mi^2]) of navigable waterways in the Mid-Atlantic Region, from South Carolina to New Jersey (USCG 2022b). Each district is further divided into sectors.

The Lease Area and Massachusetts OECC are located within Sector Southeastern New England (see Figure 5.7-2). The Connecticut OECC passes through both Sector Southeastern New England and Sector Long Island Sound (see Figure 5.7-2). Sector Southeastern New England's area of responsibility extends offshore between Watch Hill Point, Rhode Island and Manomet Point, Massachusetts and includes the waters surrounding Cape Cod and the Islands. Sector Long Island Sound is responsible for an area that covers Long Island Sound from the New York-Connecticut border to the Connecticut-Rhode Island border and extends 200 NM out to sea. Sector Long Island Sound includes the entire Connecticut coastline as well as the northern and southern coastlines of Long Island.

Air Station Cape Cod, the only USCG Aviation Facility in the Northeast, is located at Joint Base Cape Cod. Air Station Cape Cod provides search and rescue (SAR) operations, maritime law enforcement, international ice patrol, aids to navigation support, and marine environmental protection. USCG Base Cape Cod, also located at Joint Base Cape Cod, serves as the Deputy Commandant for Mission Support in support of USCG operations within the USCG 1st District.

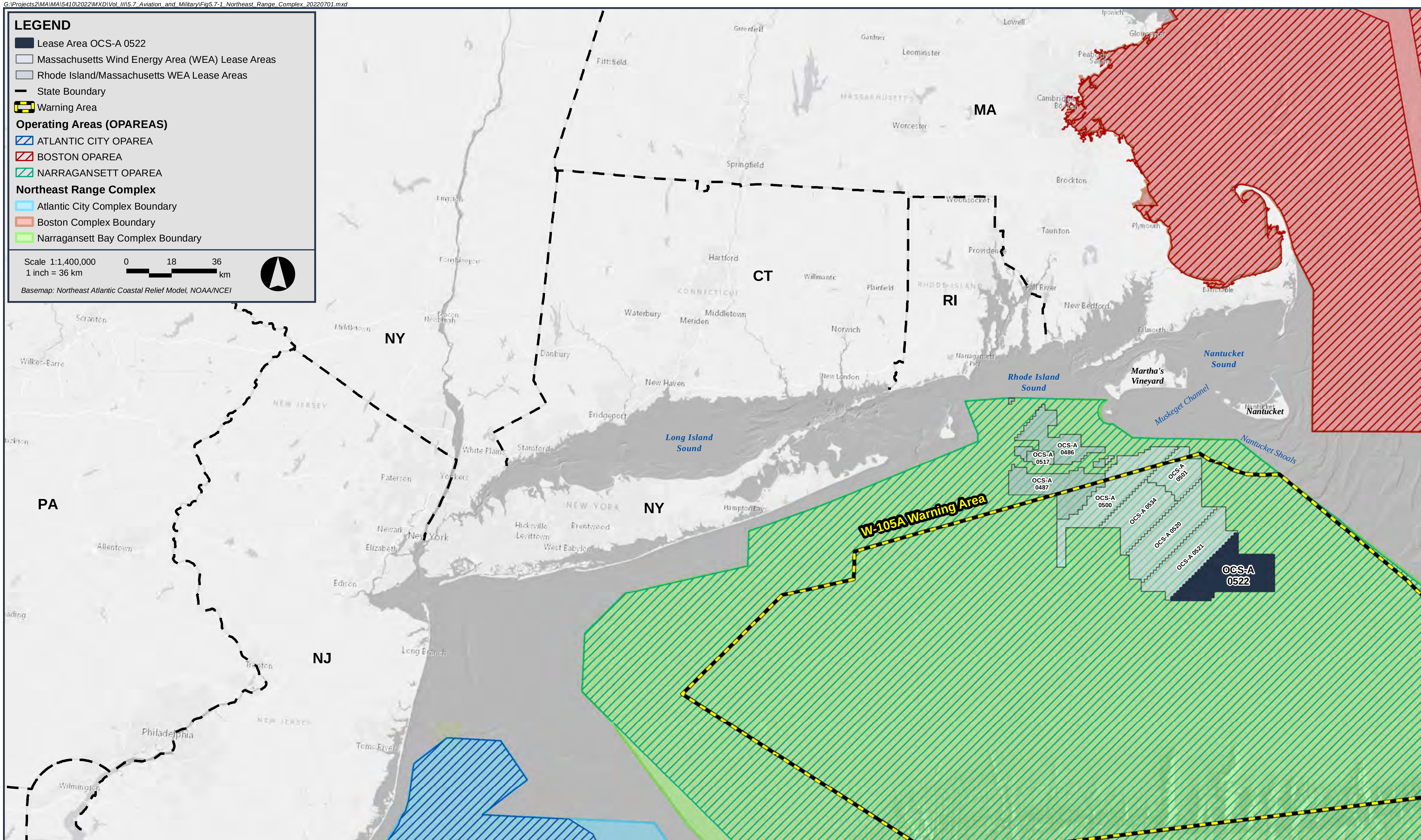

Figure 5.7-1
Military and Airspace Uses

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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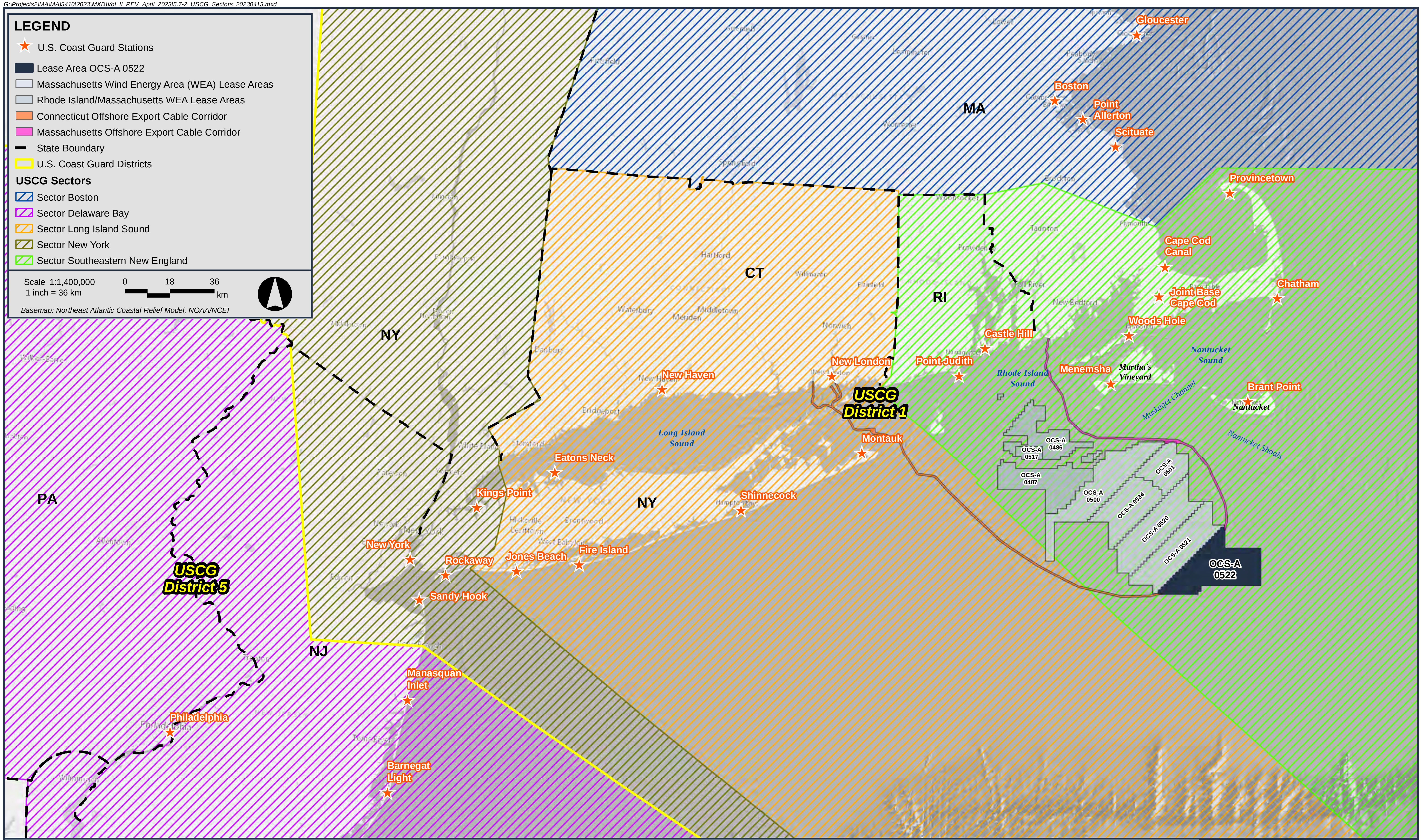

Figure 5.7-2
USCG Sectors

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Additionally, vessels transiting to and from potential ports in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey may pass through Sector Boston, Sector Southeastern New England, Sector Long Island Sound, Sector New York, and Sector Delaware Bay (see Figure 5.7-2).

5.7.1.2 Radar Uses

Different types of radar sites are present within the Onshore Development Area and Offshore Development Area (see Figure 5.7-3).

<u>Air Route Surveillance Radar and Airport Surveillance Radar</u>

The following six air route surveillance radar (ARSR) and airport surveillance radar (ASR) sites are located in the vicinity of Vineyard Northeast:

- Boston Airport Surveillance Radar-9 (ASR-9)
- Falmouth Airport Surveillance Radar-8 (ASR-8)
- Nantucket ASR-9
- North Truro Air Route Surveillance Radar-4 (ARSR-4)
- Providence ASR-9
- Riverhead ARSR-4

The DoD and Department of Homeland Security (DHS) use these radar sites for air defense and homeland security and the FAA uses these radar sites for air traffic control at multiple facilities, including the Boston Consolidated TRACON, Nantucket Air Traffic Control Tower, Boston Air Route Traffic Control Center (ARTCC), Providence TRACON, and the New York ARTCC.

<u>Co-Located Secondary Surveillance Radar</u>

The following secondary surveillance radar systems co-located with the ARSR and ASR systems are located in the vicinity of Vineyard Northeast:

- An Air Traffic Control Beacon Interrogator-5 is co-located with the Falmouth ASR-8.
- An Air Traffic Control Beacon Interrogator-6 is co-located with the North Truro ARSR-4 and the Riverhead ARSR-4.
- A Mode S is co-located with the Boston ASR-9, Nantucket ASR-9, and the Providence ASR-9.

In general, secondary surveillance radar systems are less susceptible to interference from WTGs than primary surveillance radar systems, such as the ARSR and ASR systems.

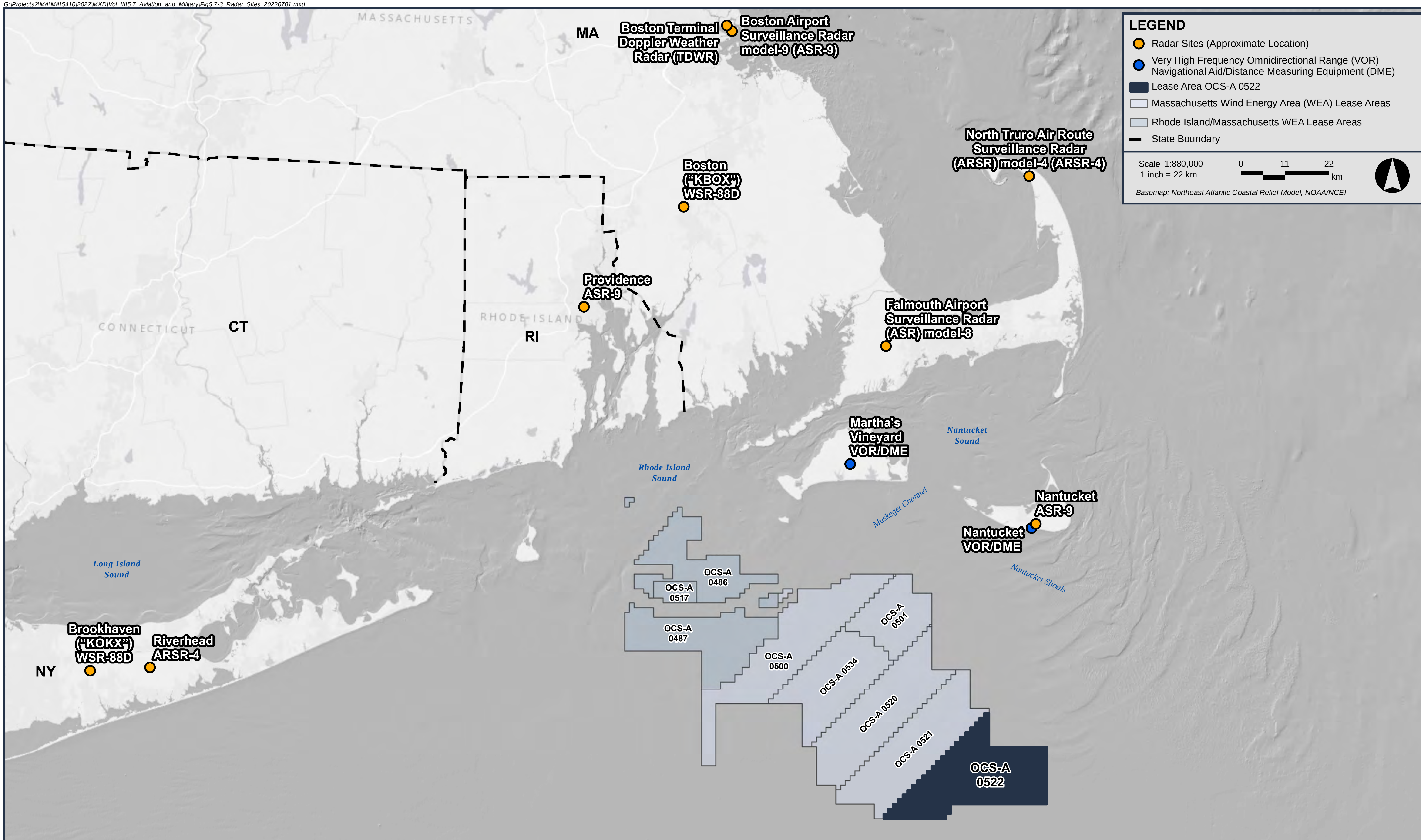

Figure 5.7-3
Radar Sites

VINEYARD NORTHEAST
VINEYARD OFFSHORE

Early Warning Radar (EWR)

The Cape Cod Space Force Station (SFS) EWR is located in the vicinity of Vineyard Northeast. The DoD uses this radar site for ballistic missile defense and space surveillance.

Terminal Doppler Weather Radar (TDWR)

The Boston TDWR is located in the vicinity of Vineyard Northeast. The FAA uses this radar site for air traffic control at the Boston TRACON. In addition, the National Weather Service (NWS) uses this radar site for weather operations at the Boston/Norton Weather Forecast Office (WFO).

Very High Frequency Omnidirectional Range (VOR) Navigational Aid

The following two navigational aid sites are located in the vicinity of Vineyard Northeast:

- Martha's Vineyard VOR and co-located Distance Measuring Equipment (VOR/DME)
- Nantucket VOR/DME

Next Generation Radar (NEXRAD) Weather Radar

The following two NEXRAD weather radar sites are located in the vicinity of Vineyard Northeast:

- Boston Weather Surveillance Radar-1988 Doppler (WSR-88D)
- Brookhaven WSR-88D

The NWS uses these radar sites for weather operations at multiple facilities, including the Boston/Norton WFO and the New York WFO.

Coastal High Frequency (HF) Radar

The following eight HF radar sites are located in the vicinity of Vineyard Northeast:

- Amagansett HF radar
- Block Island Long Range HF radar
- Long Point Wildlife Refuge HF radar
- Martha's Vineyard HF radar
- Moriches HF radar
- Nantucket HF radar
- Nantucket Island HF radar
- Nauset HF radar

The Amagansett HF radar, Block Island Long Range HF radar, Martha's Vineyard HF radar, Moriches HF radar, and the Nantucket Island HF radar are operated by Rutgers University. The Long Point Wildlife Refuge HF radar and the Nantucket HF radar are operated by the Woods Hole Oceanographic Institution. The Nauset HF radar is operated by the University of Massachusetts Dartmouth. In partnership with the National Oceanic and Atmospheric Administration (NOAA) Integrated Ocean Observing System (IOOS), various federal agencies use the ocean surface current and wave data provided by these HF radar sites. In particular, the USCG has integrated HF radar data into its SAR planning systems.

5.7.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect aviation, military, and radar uses during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 5.7-1.

Table 5.7-1 Impact Producing Factors for Aviation, Military, and Radar Uses

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Presence of Structures		•	
Vessel Activity	•	•	•

Potential effects to aviation, military, and radar uses were assessed using the maximum design scenario for Vineyard Northeast's offshore and onshore facilities as described in Section 1.5.

5.7.2.1 Presence of Structures

The presence of structures, such as WTGs, may cause radar effects or clutter including a partial loss of primary target detection and false targets within the vicinity of offshore wind projects. A radar line-of-sight study was conducted to evaluate effects to the various radar systems (see Appendix II-H). Additionally, the presence of structures within W-105A may influence military activities.

Air Route Surveillance Radar (ARSR) and Airport Surveillance Radar (ASR)

For the six identified ARSR and ASR radar sites:

- Vineyard Northeast WTGs are beyond the instrumented range of the Boston ASR-9 and the Providence ASR-9.
- Vineyard Northeast WTGs are beyond the radar line-of-sight for the North Truro ARSR-4 and the Riverhead ARSR-4.
- Vineyard Northeast WTGs are within the radar line-of-sight for the Falmouth ASR-8 and the Nantucket ASR-9.

For the Nantucket ASR-9, the radar site uses adaptive processing techniques to self-optimize the radar settings such that separate mitigation may not be required. Mitigation may be required for the Falmouth ASR-8. Mitigation options include optimization (referred to as Radar Adverse-impact Mitigation) to minimize false primary targets and maximize primary target detection. The Proponent is consulting with the DoD through the Military Aviation and Installation Assurance Siting Clearinghouse (DoD Siting Clearinghouse) process to understand potential impacts to radar systems and develop appropriate mitigation measures, as needed.

Co-Located Secondary Surveillance Radar

In general, secondary surveillance radar systems are less susceptible to interference from WTGs than primary surveillance radar systems, such as the ARSR and ASR systems. It is not expected that WTGs will affect the secondary surveillance radar systems co-located with the Falmouth ASR-8 or the Nantucket ASR-9.

Early Warning Radar (EWR)

Fifty-eight of the proposed WTGs are within the line-of-sight of the Cape Cod SFS EWR. The Proponent will consult with the DoD Siting Clearinghouse for the Cape Cod SFS EWR to discuss potential effects and mitigation measures.

Terminal Doppler Weather Radar (TDWR)

Vineyard Northeast WTGs are beyond the instrumented range of Boston TDWR, so no effects are expected.

Very High Frequency Omnidirectional Range (VOR) Navigational Aid

Vineyard Northeast WTGs are greater than 15 km (8 NM) from the VOR sites, so it is not expected that the FAA will have concerns with WTGs at the proposed locations.

Next Generation Radar (NEXRAD) Weather Radar

The NEXRAD weather radar screening analysis for the Boston WSR-88D and the Brookhaven WSR-88D shows that the Vineyard Northeast WTGs will not be within line-of-sight of and will not interfere with these radar sites. The results in Appendix II-H also show that the Vineyard Northeast WTGs fall within a NOAA green No Impact Zone for these radar sites.

Coastal High Frequency (HF) Radar

Of the eight identified HF radar sites, some or all of Vineyard Northeast's WTGs are within line-of-sight of five of these HF radars. Where the WTGs are within line-of-sight, potential effects may include clutter in the vicinity of the WTGs (Trockel et. al 2021). While less likely, clutter in the vicinity of WTGs beyond line-of-sight may also occur due to the propagation of HF electromagnetic waves over the ocean surface. As noted above, the USCG has integrated HF radar data into its SAR planning systems. Thus, any potential impact on these identified HF radar sites may impact the USCG's ability to conduct SAR operations (see the Navigation Safety Risk Assessment provided as Appendix II-G for additional details).

Potential mitigation options include implementation of a software package to address interference and/or installation of other current or wave sensors in the Lease Area (Trockel et. al 2021). The Proponent will consult with the DoD Siting Clearinghouse for an informal review, with the USCG, with the National Telecommunications and Information Administration (NTIA) (the NTIA is essentially a clearinghouse for other federal agencies, including NOAA), and with NOAA's IOOS Program Office regarding potential effects to HF radar sites.

Military Airspace and Training Routes

US Air Force (USAF) training activities may occur within the military airspace (W-105A) above Vineyard Northeast and such training activities may result in daily sonic overpressures (sonic booms) and potential falling debris from chaff and flare dispensed by the USAF. The Proponent recognizes that such military training occurs and fully expects that Vineyard Northeast structures can withstand these activities. The Proponent further expects that any future COP Approval would include a "hold and save harmless" provision whereby the Proponent would agree to save harmless the US against all claims for loss, damage, or injury in connection with these military activities.

5.7.2.2 Vessel Activity

While all Vineyard Northeast WTGs are outside territorial airspace, No Hazard Determinations from the FAA may be required for activities at construction staging areas and vessel transits based on proximity to airport runways and whether certain imaginary surface heights are exceeded. As the development of Vineyard Northeast progresses, the Proponent will continue to evaluate potential vessel transit routes and the heights of components being transported and will file with the FAA as necessary.

5.7.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

The Proponent's proposed measures to avoid, minimize, and mitigate potential effects to aviation, military, and radar uses during Vineyard Northeast are summarized below:

- While Vineyard Northeast is outside the radar line-of-sight for many radar systems, the Proponent is consulting with the DoD Siting Clearinghouse to understand potential impacts to radar systems and military uses and develop appropriate mitigation measures as needed.
- Vineyard Northeast structures are not expected to interfere with military training activities in W-105A.
- The Proponent will consult with BOEM, USCG, the NTIA, and with NOAA's IOOS Program Office on potential effects to HF radar sites.

- The Proponent will file for necessary authorizations if required for activities at construction staging areas and vessel transits.
- Overhead transmission towers and lines at the Taunton River crossing (if used) would be marked and lit in accordance with FAA guidance.

5.8 Other Marine Uses

This section addresses the potential impacts of Vineyard Northeast on other marine uses in the Offshore Development Area. An overview of the affected environment is provided first, followed by a discussion of impact producing factors (IPFs) and the Proponent's proposed measures to avoid, minimize, and mitigate potential effects to other marine uses during the construction, operation, and decommissioning of Vineyard Northeast.

The state and federal waters associated with the Offshore Development Area support a myriad of marine-based uses. This section addresses sand and mineral resources, offshore energy, cables and pipelines, and scientific research and surveys occurring within or adjacent to the Offshore Development Area. Marine uses associated with recreation and tourism, commercial fisheries and for-hire recreational fishing, navigation and vessel traffic, and aviation and military uses are addressed in Sections 5.3, 5.4, 5.6, and 5.7, respectively.

5.8.1 Description of Affected Environment

The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. For the purposes of assessing effects to other marine uses, the Offshore Development Area includes existing uses within the Outer Continental Shelf (OCS) waters of the Lease Area to the nearshore and intertidal waters along the Massachusetts OECC and Connecticut OECC to each landfall site.

The following section is based on state and federal publications, online databases, maps, and portals, including the following:

- Bureau of Ocean Energy Management (BOEM) Renewable Energy State Activities (BOEM 2020)
- BOEM's Marine Minerals Information System (MMIS)
- National Oceanic and Atmospheric Administration's (NOAA) Raster Navigational Charts
- NOAA Northeast Fisheries Science Center (NEFSC) information on fisheries surveys (NOAA Fisheries 2022)
- Massachusetts Division of Marine Fisheries (MA DMF) information on fisheries surveys (MA DMF 2022)

- Connecticut Department of Energy and Environmental Protection (CT DEEP) information on fisheries surveys (CT DEEP 2022)

5.8.1.1 Sand and Mineral Resources and Ocean Disposal Sites

Sand and mineral resources can be used for coastal resilience and restoration projects to protect coastal communities from coastal storm damage or other effects associated with climate change-induced sea level rise. BOEM funded offshore surveys between 2015–2017 as part of the Atlantic Sand Assessment Project to identify new sources of sand in federal waters approximately 5.5–15 kilometers (km) (3–8 nautical miles [NM]) offshore.

BOEM's MMIS identifies marine mineral lease areas in the Offshore Development Area, which are categorized as complete, active, proposed, or expired, as well as sand resource areas, which are categorized as proven, potential, unverified, and unusable. A review of BOEM's MMIS indicates that no marine mineral lease areas (complete, active, proposed, or expired) or sand resource areas (proven, potential, unverified, or unusable) are intersected by the Lease Area, Massachusetts OECC, or Connecticut OECC, as shown on Figure 5.8-1. The nearest marine mineral lease area, which is categorized as "proposed," is located offshore New Jersey approximately 282 km (175 miles [mi]) and 198 km (123 mi) from the Massachusetts and Connecticut OECCs, respectively (BOEM 2023).[96] The closest potential sand resource area is approximately 88 km (55 mi) from the Massachusetts OECC and approximately 16 km (10 mi) from the Connecticut OECC (see Figure 5.8-1). The nearest unverified sand resource area is approximately 41 km (25 mi) from the Massachusetts OECC and 16 km (10 mi) from the Connecticut OECC (see Figure 5.8-1). The closest proven and unusable sand resource areas are considerably farther away,[97] located approximately 461 km (286 mi) and 471 km (293 mi) from the Massachusetts OECC, respectively, and approximately 392 km (244 mi) and 402 km (250 mi) from the Connecticut OECC, respectively.

One NOAA mapped discontinued ocean disposal site intersects the Connecticut OECC along the Ocean Beach Approach on the most current nautical charts, as shown on Figure 5.8-2. The Connecticut OECC was routed around the discontinued disposal site to the extent that was possible, and cables will be micro-sited to avoid the inactive disposal site. The Proponent will coordinate with the appropriate agencies on measures to avoid or minimize potential impacts to the discontinued disposal sites.

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[96] All marine mineral lease areas (complete, active, proposed, or expired) are beyond the mapped extent of Figure 5.8-1.

[97] All proven and unusable sand resource areas are beyond the mapped extent of Figure 5.8-1.

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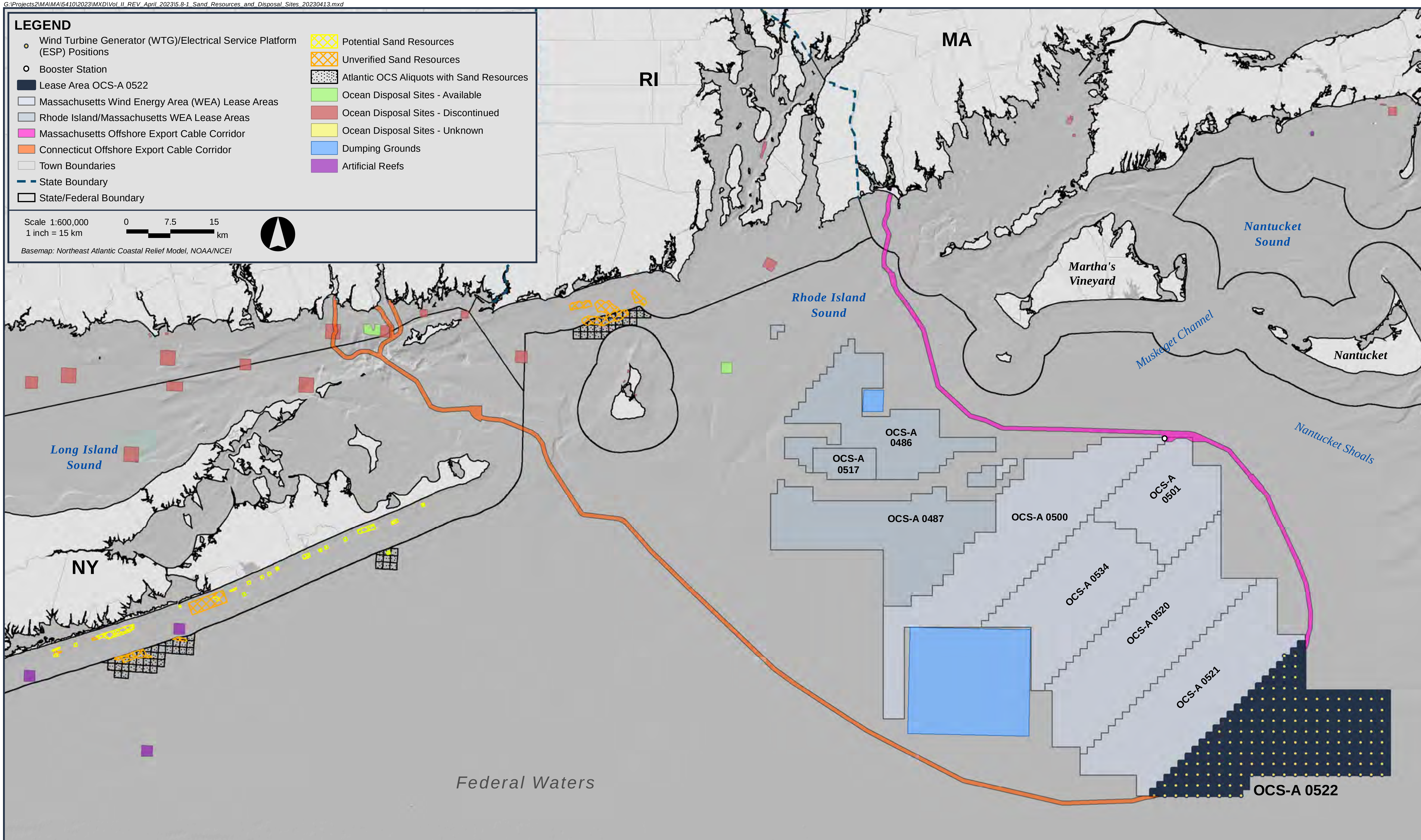

Figure 5.8-1
Mapped Sand Resource Areas

VINEYARD NORTHEAST
VINEYARD OFFSHORE

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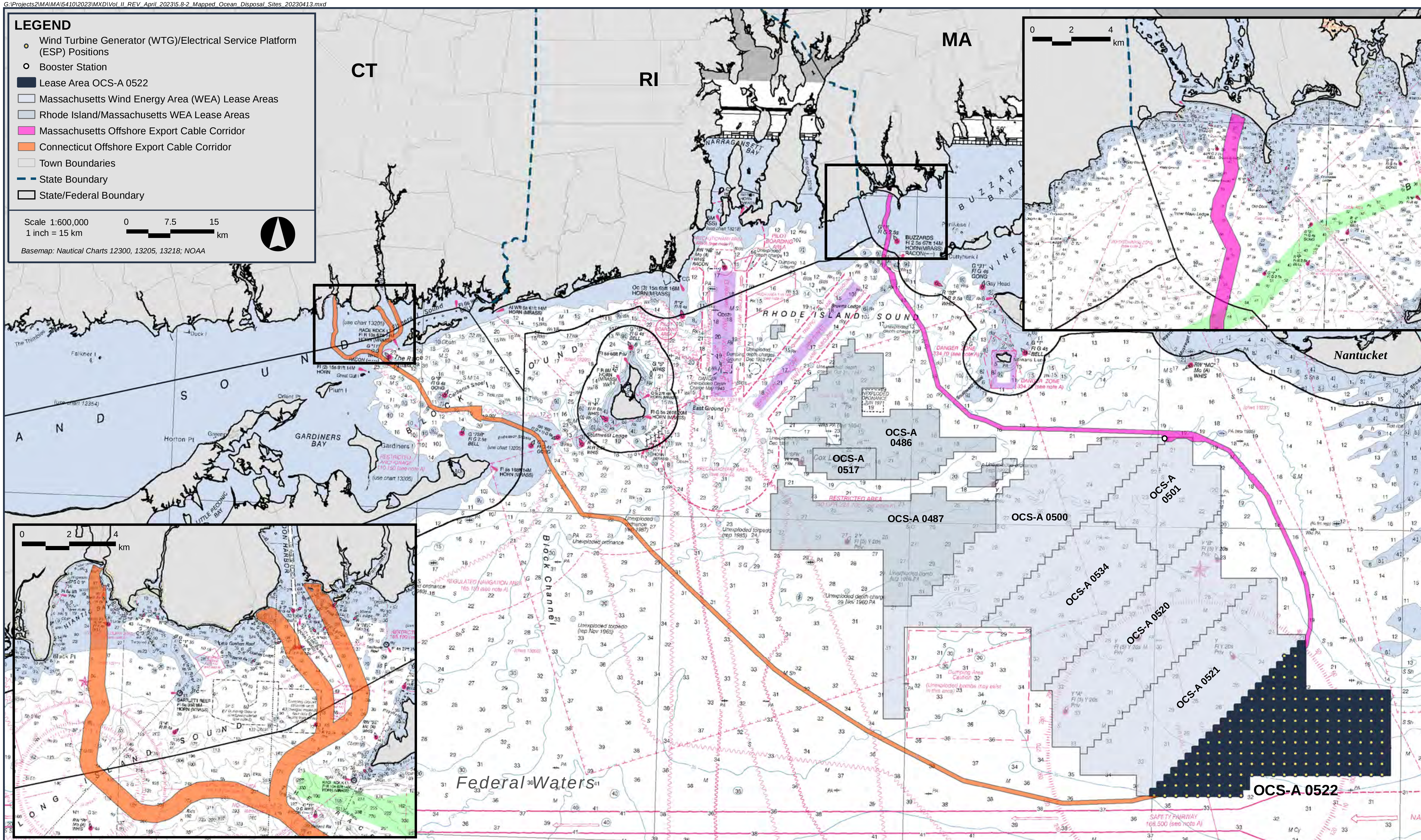

Figure 5.8-2
Mapped Ocean Disposal Sites

VINEYARD NORTHEAST
VINEYARD OFFSHORE

5.8.1.2 Offshore Energy

As mentioned above, Vineyard Northeast is located at the easternmost lease area within the Massachusetts Wind Energy Area (MA WEA), which is contiguous with the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA). The development of additional offshore wind energy projects in lease areas within these geographic areas is ongoing. As of February 2023, the following projects within the MA WEA and the RI/MA WEA are planned:

- Beacon Wind, OCS-A 0520
- Bay State Wind, OCS-A 0500
- Vineyard Wind 1, OCS-A 0501
- SouthCoast Wind, OCS-A 0521
- New England Wind, OCS-A 0534
- South Fork, OCS-A 0517
- Revolution Wind, OCS-A 0486
- Sunrise Wind, OCS-A 0487

Vineyard Northeast is adjacent to the planned SouthCoast Wind project located in Lease Area OCS-A 0521. In addition to the projects listed above within the MA WEA and RI/MA WEA, additional lease areas in the broader region (i.e., New York Bight area) are expected to support offshore wind development in the future. Most developers in the MA WEA and RI/MA WEA have publicly-announced offshore export cable routes or corridors. Nearby lease areas and publicly-available offshore export cable corridors are shown on Figure 5.8-3.

5.8.1.3 Cables and Pipelines

Known cables and pipelines are mapped on NOAA's Raster Navigational Charts and shown on Figure 5.8-4. Additionally, several offshore wind developers have publicly announced plans to install offshore export cables from individual lease areas in the MA WEA and RI/MA WEA to landfall sites in the region.

Vineyard Northeast's offshore export cables are expected to cross existing and proposed submarine cables and mapped pipeline areas. As shown in Figure 5.8-4, Vineyard Northeast's offshore export cables within the Massachusetts OECC may cross the offshore cables proposed for Vineyard Wind 1 (two cables), New England Wind (up to five cables), SouthCoast Wind (up to 11 cables, with six of the cables crossed twice), and one designated cable and

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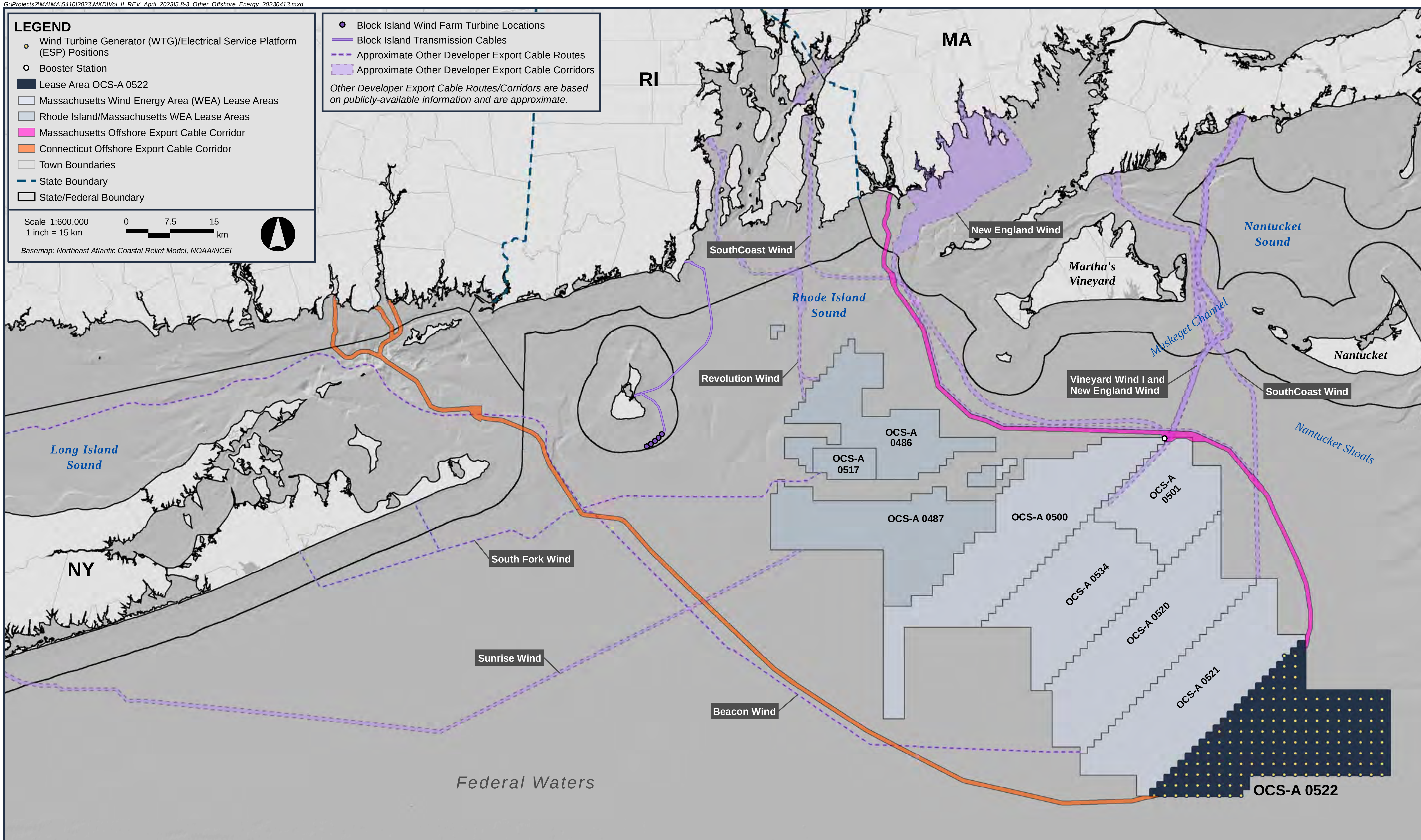

Figure 5.8-3
Other Offshore Wind Energy Projects

VINEYARD NORTHEAST
VINEYARD OFFSHORE

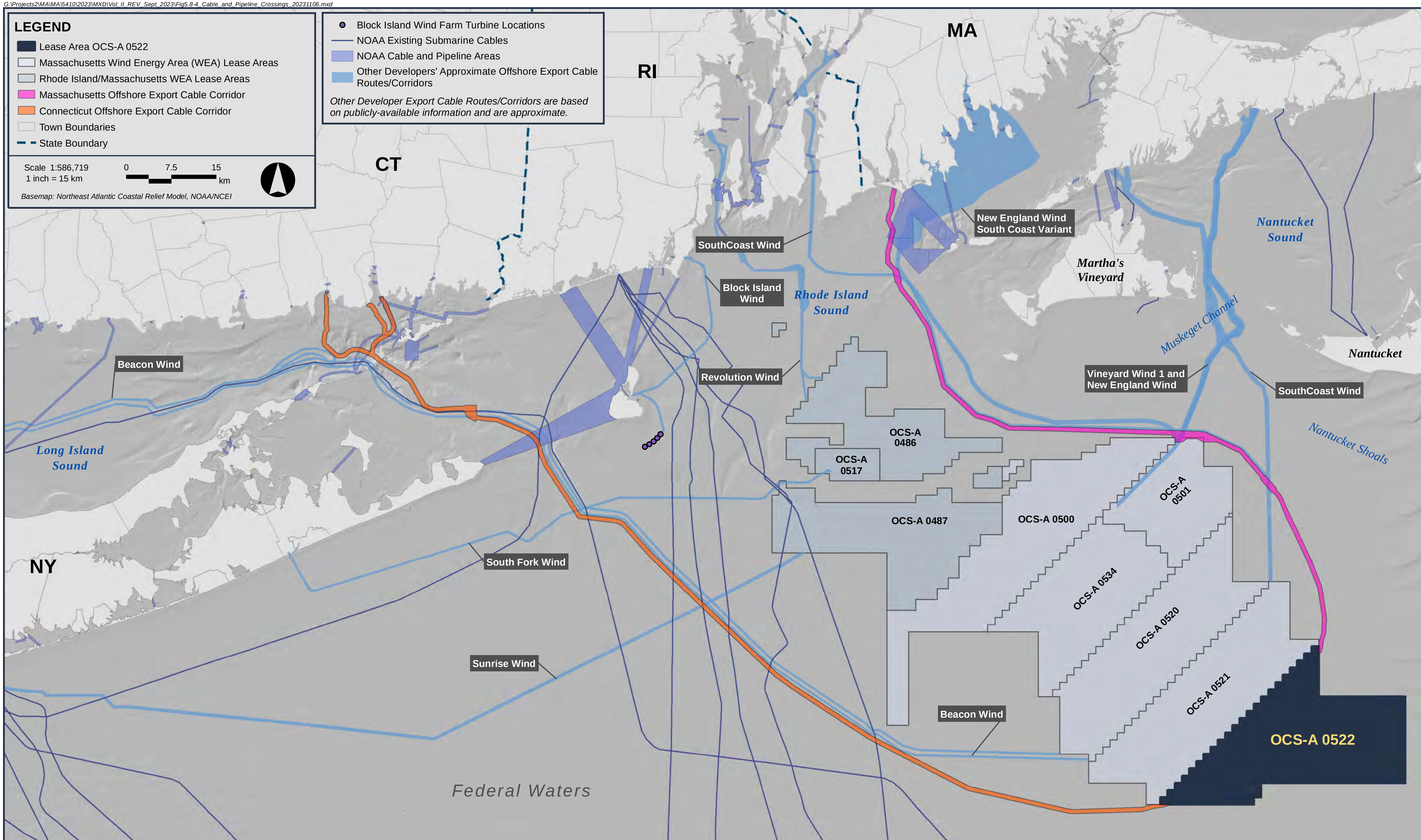

Figure 5.8-4
Expected Cable and Pipeline Crossings within the OECCs

VINEYARD NORTHEAST
VINEYARD OFFSHORE

pipeline area.[98] To account for other offshore wind projects that may be developed within the MA WEA and RI/MA WEA as well as unmapped infrastructure that may be identified during offshore surveys, the Proponent conservatively estimates that there will be up to 42 cable crossings for each high voltage alternating current (HVAC) cable/high voltage direct current (HVDC) cable bundle within the Massachusetts OECC. The offshore export cables within the Connecticut OECC may cross the offshore cables proposed for Beacon Wind (up to four cables), South Fork Wind (one cable), and Sunrise Wind (one cable bundle) as well as eight other submarine cables and up to four designated cable and pipeline areas, depending on which Connecticut landfall site is used. Accounting for future offshore wind projects and unmapped infrastructure, the Proponent has conservatively assumed there will be up to 37 crossings for each cable bundle in the Connecticut OECC. The cable crossings will be designed to minimize the risk of snagging fishing equipment.

For crossings of active, in-service cables and pipelines, the Proponent will make all reasonable efforts to enter into a crossing agreement with the cable's or pipeline's owner. The terms of the crossing agreement will govern the design, coordination process, and execution of the crossing. If an existing cable is inactive/abandoned, it may alternatively be cut and removed prior to installing the Proponent's cables. More information about cable crossings is provided in Section 3.5.6 of COP Volume I.

5.8.1.4 Scientific Research

A number of stakeholders conduct scientific research and studies in the vicinity of the Offshore Development Area. These include, but are not limited to, state and federal agencies, non-governmental environmental organizations, and educational institutions.

NOAA Fisheries uses Fisheries Independent Surveys to provide time-series data on the abundance, distribution, and vital rates of marine animals and marine habitat information. In the Northeast region, these surveys include multi-species bottom trawl surveys, Atlantic scallop surveys, ocean quahog and Atlantic surf clam surveys, ecosystem monitoring surveys, marine mammal and sea turtle ship-based and aerial survey, apex predator surveys, and North Atlantic right whale aerial surveys (Hogan et al. 2003). Specifically, NOAA's NEFSC collects data during regularly-scheduled research vessel trawl surveys. The NEFSC has research facilities in Connecticut, Maine, Massachusetts, New Jersey, and Rhode Island to cover the Northeast Continental Shelf Ecosystem from the Gulf of Maine to Cape Hatteras in North Carolina. The NEFSC conducts over 20 studies regularly and is split into four divisions for research: ecosystems and aquaculture, fishery monitoring and research, population and ecosystems monitoring and analysis, and resource evaluation and assessment.

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[98] A cable and pipeline area is defined as an area of known locations of two or more pipelines/cables in special/protected resource areas (such as harbors).

Further, Massachusetts and Connecticut have state-specific fisheries surveys. In Massachusetts, the DMF conducts spring and fall trawl surveys. In Connecticut, CT DEEP conducts the Long Island Sound trawl survey each spring and fall and estuarine seine survey each September, which aim to monitor the population of finfish and invertebrate species from Groton to Greenwich. The estuarine seine survey occurs at eight sampling sites each year. CT DEEP's trawl surveys are conducted at randomly selected stations in Connecticut and New York State waters each year. These surveys may occur in the same geographical areas as the Massachusetts and Connecticut OECCs.

In addition to these, other surveys that may occur in the Offshore Development Area include, but are not limited to, the following:

- CT DEEP larval lobster survey and Atlantic sturgeon survey
- MA DMF Ventless Trap Survey
- NorthEast Area Monitoring and Assessment Program (NEAMAP) Trawl Survey
- NEFSC Ecological Monitoring (EcoMon) Survey
- Atlantic Marine Assessment Program for Protected Species surveys (Phase II occurred 2015–2019; has been renewed another 5 years)
- New England Aquarium aerial surveys
- NEFSC Surf clam and Ocean Quahog Survey, shellfish surveys, groundfish surveys, and ecosystems surveys
- Surveys associated with and conducted by the Proponent within the Lease Area
- Surveys completed by other offshore wind developers within their respective lease areas

5.8.2 Potential Impacts and Proposed Avoidance, Minimization, and Mitigation Measures

The potential IPFs that may affect other marine uses during the construction, operations and maintenance (O&M), and/or decommissioning of Vineyard Northeast are presented in Table 5.8-1.

Table 5.8-1 Impact Producing Factors for Other Marine Uses

Impact Producing Factors	Construction	Operations & Maintenance	Decommissioning
Vessel Activity	•	•	•
Presence of Cables and Structures		•	

Potential effects to other marine uses were assessed using the maximum design scenario for Vineyard Northeast's offshore facilities as described in Section 1.5.

5.8.2.1 Vessel and Aircraft Activity

Construction, O&M, and decommissioning activities will cause increased vessel activity within the Offshore Development Area. Vessel activity is discussed in further detail in Section 5.6. In addition to marine vessels, helicopters may be used for crew transfer and visual inspections of offshore components. Fixed-wing aircraft or drones (autonomous underwater/surface vessels or aerial drones) may be used to support environmental monitoring and mitigation (see Section 4.4.2 of COP Volume I). The Proponent will manage vessel and aircraft activities to minimize disruptions and impacts to the maximum extent practicable.

A Navigation Safety Risk Assessment (NSRA; see Appendix II-G) was conducted and identified potential hazards to navigation as well as measures to mitigate potential risk. Vessels associated with other marine uses could experience localized disruption due to vessel traffic associated with Vineyard Northeast activities. Depending on the activity, the Proponent may request that mariners give a wide berth to active work sites or construction and maintenance vessel(s) through the issuance of Offshore Wind Mariner Updates. Additionally, to help ensure safety within the vicinity of active work areas, the Proponent may request that the US Coast Guard (USCG) establish temporary safety zones, per 33 CFR Part 147, that extend 500 m (1,640 ft) around each wind turbine generators (WTG), electrical service platform (ESP), and booster station (if used) during construction and certain maintenance activities (see Section 8.4 of COP Volume I for additional details). The presence of these safety zones may cause other vessels to slightly alter their routes to avoid the active work sites. However, the safety zones would be limited in size and duration and would not affect the entire Lease Area at any given time. Vessel traffic associated with Vineyard Northeast is not anticipated to represent a significant increase over the current levels of vessel traffic within the Offshore Development Area (see Appendix II-G).

Lastly, construction, maintenance, and decommissioning activities associated with Vineyard Northeast may impact other offshore wind projects in terms of access to port facilities, vessels, and/or construction equipment. As described in Section 3.10.1 of COP Volume I, the Proponent has identified several ports located across the Northeast to provide flexibility. The Proponent plans to coordinate with port facilities and other developers to avoid conflicts.

The Proponent expects to use one or more onshore O&M facilities, which are anticipated to be located at port(s) that support other developers' offshore wind projects and/or other maritime industries. Port use during O&M would not be exclusive to Vineyard Northeast and would allow for other activities. In addition to the O&M facilities, the Proponent may lease space at an airport hangar in reasonable proximity to the Lease Area for aircraft and helicopters used to support operations (see Section 4.4 of COP Volume I).

5.8.2.2 Presence of Cables and Structures

Within the Offshore Development Area, the presence of installed cables and structures may affect vessel traffic for other marine uses and may influence the siting of future marine infrastructure (navigation impacts are further described in Section 5.6). BOEM considered other marine uses during the siting of the MA WEA and conducted a public process and environmental review prior to designating the MA WEA, which includes Lease Area OCS-A 0522, as suitable for offshore wind energy development. Additionally, recognizing the importance of other marine users in the area, the Proponent has conducted extensive coordination with various agencies and stakeholders to present Vineyard Northeast and the various options considered for siting the Massachusetts OECC and Connecticut OECC. As described further in Section 2 of COP Volume I, throughout the OECC routing process, the Proponent consulted with numerous federal and state agencies, including BOEM, National Marine Fisheries Service (NMFS) (on several occasions), United States Army Corps of Engineers (USACE), USCG, the US Department of Homeland Security (US DHS), and the CT DEEP, as well as stakeholders (including fishermen). Mapped resources from the Massachusetts Ocean Management Plan, the Long Island Sound Blue Plan, the Northeast Ocean Data Portal, and the Mid-Atlantic Ocean Data Portal, among others, were considered in the routing process. Further, characteristics such as cable route length, water depths and geologic conditions, sensitive habitats, cultural resources, and socioeconomic resources were considered. The OECC routing process was designed to minimize any potential conflicts with other marine users and is detailed in Section 2.8 of COP Volume I.

Sand and Mineral Resources

No designated sand and mineral resources are intersected by the Massachusetts or Connecticut OECCs; therefore, the presence of cables and structures associated with Vineyard Northeast are not anticipated to limit sand borrowing.

Offshore Energy and Cables and Pipelines

As noted in Section 5.8.1.2, a number of offshore wind projects are planned for the MA WEA and RI/MA WEA with different construction timelines that will likely overlap with Vineyard Northeast's timeline. Vineyard Northeast's cable routes and points of interconnection may impact the planned or future siting of other offshore wind projects. However, due to coordination with other developers, spatial and/or temporal conflicts are expected to be avoided or minimized. Further, the Proponent has identified a range of port options across the Northeast that would be suitable to support construction thereby providing flexibility in the event another offshore wind project should require a specific port at a given time. Moreover, the Proponent designed Vineyard Northeast in conformance with the Proponent's Commercial Lease of Submerged Lands for Renewable Energy Development, such that no activities are proposed that will unreasonably interfere with or endanger activities or operations carried out under any lease or grant issued or maintained pursuant to the Outer Continental Shelf Lands Act.

As noted in Section 5.8.1.3, Vineyard Northeast cables within the Connecticut OECC may cross cables associated with Beacon Wind, South Fork Wind, and Sunrise Wind. Vineyard Northeast cables within the Massachusetts OECC may cross cables associated with SouthCoast Wind, New England Wind, and Vineyard Wind 1. For crossings of active, in-service cables and pipelines, the Proponent will make all reasonable efforts to enter into a crossing agreement with the cable's or pipeline's owner. The terms of the crossing agreement will govern the design, coordination process, and execution of the crossing. The OECCs are wider near potential cable crossings to allow flexibility in the crossing's future design.

Scientific Research

Construction of Vineyard Northeast may temporarily alter transit routes for research and survey vessels in the Lease Area and along the OECCs to avoid installation activities. Low altitude aerial surveys may also need to alter routes to avoid WTGs. The Proponent will continue to coordinate with appropriate parties throughout construction and will coordinate with the USCG to provide Notices to Mariners (NTMs) that describe relevant Vineyard Northeast-related activities.

As stated above, proposed offshore wind energy development may impact NEFSC surveys. However, this is not unique to Vineyard Northeast, and any of the lease areas within the MA WEA and RI/MA WEA may impact NEFSC surveys given their scope. Within the Lease Area, the WTGs and ESP[s] will be oriented in fixed rows and columns with one nautical mile (NM) (1.9 km) spacing between positions. This 1 x 1 NM WTG/ESP layout is consistent with the layout adopted by other developers throughout the MA WEA and RI/MA WEA. This grid layout provides continuous 1 NM (1.9 km) wide corridors in the east-west and north-south directions as well as at least 0.6 NM (1.1 km) wide corridors in the northwest-southeast and northeast-southwest directions across the entire MA WEA and RI/MA WEA. The use of such a layout allows the use of smaller survey vessels to access the area.

In December 2022, BOEM and NOAA released their joint Federal Survey Mitigation Implementation Strategy for the Northeast U.S. Region (Hare et al. 2022). The Federal Survey Mitigation Implementation Strategy describes the approach NOAA Fisheries and BOEM will use to mitigate the impacts of offshore wind energy development on NOAA Fisheries surveys (from Maine to North Carolina) and is intended to guide the implementation of the NOAA Fisheries Federal Survey Mitigation Program. The Proponent will continue to work with BOEM, NOAA Fisheries, academic institutions, and other fisheries stakeholders as the federal agencies implement the mitigation strategy.

5.8.2.3 Summary of Avoidance, Minimization, and Mitigation Measures

The majority of potential impacts to other marine uses were considered during the planning and design phase and, as such, the Proponent has taken steps to avoid, minimize, and mitigate impacts during construction, O&M, and decommissioning. The Proponent's proposed measures to avoid, minimize, and mitigate potential impacts to other marine uses during Vineyard Northeast are summarized below:

- Offshore structures and cables were sited and designed to avoid or minimize impacts to other marine uses to the maximum extent practicable.
- For crossings of active, in-service cables and pipelines, the Proponent will make all reasonable efforts to enter into a crossing agreement with the cable's or pipeline's owner.
- The Proponent will continue to work with BOEM, NOAA Fisheries, and others as the agencies implement the Federal Survey Mitigation Implementation Strategy.
- During construction, a Marine Coordinator will manage construction vessel logistics and implement communication protocols with external vessels at ports and offshore.
- The Proponent will provide Offshore Wind Mariner Updates and coordinate with the USCG to issue NTMs advising other vessel operators of planned offshore activities. The Vineyard Northeast website will be regularly updated to provide information about activities occurring in the Offshore Development Area.
- The Proponent will continue to collaborate with other offshore wind developers to minimize potential impacts to other offshore wind energy projects.

6 Visual and Cultural Resources

6.1 Visual Resources (Non-Historic)

This section addresses non-historic resources within the offshore and onshore viewsheds of Vineyard Northeast that may be impacted by the development. Visually sensitive cultural resources and historic properties that may be impacted by Vineyard Northeast are discussed in Section 6.2.3.

A detailed Seascape, Landscape, and Visual Impact Assessment (SLVIA) is provided as Appendix II-J.

6.1.1 Affected Environment

For Vineyard Northeast's offshore facilities, the Visual Study Area (VSA) is the outer limit of the visual impact analysis. This limit is established as the maximum distance beyond which any view of an offshore component would be considered negligible. For the Vineyard Northeast SLVIA, the VSA extends to a radius of 83.7 kilometers (km) (52 miles [mi]) from the outermost wind turbine generator (WTG) positions. The extent of the VSA was determined in consultation with the Bureau of Ocean Energy Management (BOEM). The VSA includes the entire landmass of Nantucket, Martha's Vineyard, Nomans Land, Muskeget, Tuckernuck, and Esther Islands. The VSA does not include any portion of the Elizabeth Islands, Cape Cod, mainland Massachusetts, Rhode Island (including Block Island), Connecticut, or New York's Long Island, which are more distant.

The maximum geographic area within which some portion of Vineyard Northeast's offshore facilities could potentially be visible was identified based on Geographic Information System (GIS) generated viewshed analysis. The viewshed analysis is limited to the 83.7 km (52 mi) radius VSA. Beyond this distance, it is assumed that any remaining views of Vineyard Northeast components would be negligible due to sheer distance. At distances greater than 65.5 km (40.7 mi), the top of the nacelle will fall below the visible horizon when viewed from sea level vantage points (assuming an observer with an eye height of 1.8 meters [6 feet] above sea level). From the same viewpoint, the blade tip will fall below the horizon at distances greater than 81.6 km (50.7 mi).

For the purpose of the SLVIA, two viewshed conditions are identified:

- **Zone of Theoretical Visibility (ZTV):** The ZTV defines the theoretical worst-case area of potential visual effect considering only the screening effect of existing topography and earth's curvature (i.e., "bare earth" condition).

- **Zone of Likely Visibility (ZLV):** The ZLV presents the more realistic-case area of potential visual effect including the real-world screening elements of existing intervening vegetation and structures (i.e., "land cover" condition).

Although the possibility of views of Vineyard Northeast exists throughout the oceanfront area, 32 key observation points (KOPs) were selected in consultation with BOEM from which more detailed analyses were conducted. KOPs were selected based on the following criteria:

- Locations identified by federal, state, local, or tribal officials/agencies as important visual resources, either in prior studies or through direct consultation;
- Locations which provide clear, unobstructed views toward the Lease Area (as determined through ZLV analysis and field verification);
- Visually sensitive places representative of a larger group of candidate KOPs of the same type or in the same geographic area;
- Vantage points representative of typical views from different Landscape Character Areas;
- Views of the Lease Area commonly available to representative viewer/user groups; and
- Geographic distribution across the VSA illustrating a range of distances to the Lease Area and booster station.

Section 6.1 of the SLVIA provides information about each of the 32 KOPs analyzed and includes figures illustrating the location of the selected KOPs. A photo log and supplemental information is provided for each KOP in Appendix C of Appendix II-J.

Of the 32 KOPs, 12 have associated photo simulations: four on Martha's Vineyard and eight on Nantucket. The KOPs selected for photo simulations represent a variety of viewing distances, viewer elevations, Seascape and Landscape Character Areas, and viewer types as well as overall geographic distribution and general intensity of use. Simulated KOPs were selected in consultation with BOEM. The photo simulations are provided in Appendices D and E of Appendix II-J.

For Vineyard Northeast's onshore facilities, the ZLV is determined using GIS-generated viewshed analysis of a representative substation design within each onshore substation site envelope. The potential segment of overhead transmission lines at the northern crossing of the Taunton River [redacted] is also assessed. KOPs are identified and photo simulations are provided for those onshore substation sites that are currently more likely to be used. The onshore photo simulations are provided in Appendix II-J.

6.1.2 Potential Effects and Proposed Avoidance, Minimization, and Mitigation Measures

The potential visual impacts of Vineyard Northeast on Character Areas and viewer experience within the VSA are assessed in detail in the SLVIA (see Appendix II-J). The sheer distance of Vineyard Northeast from the nearest coastal vantage point—greater than 49.1 km (30.5 mi) from the closest WTG to Nantucket—serves to minimize visibility of the offshore facilities from sensitive visual resources. For a development of this type, mitigation options are limited due to the size and structural requirements of the WTGs, the number of WTGs necessary to meet energy production requirements, and their location on an unscreened seascape. However, Vineyard Northeast is applying important mitigation techniques to minimize potential visual impacts to the maximum extent practicable, which include:

- Vineyard Northeast is located in an area identified by BOEM as suitable for offshore wind development, sited far from shore to minimize visual impacts.
- The location of the nearest WTG (more than 49.1 km [30.5 mi] offshore) eliminates all foreground, mid-ground, and even near background views from visually sensitive public resources and population centers.
- The WTGs (blades, nacelle, and tower) will be no lighter than pure white (RAL 9010) and no darker than light grey (RAL 7035) in color; the Proponent expects that the WTGs will be off-white/light grey. When viewed from ground level vantage points, the expected off-white/light grey color of the WTGs generally blends well with the sky at the horizon. The electrical service platform (ESP) and booster station topsides are expected to be light grey in color, which would appear muted and indistinct.
- Subject to BOEM approval, the Proponent will use an Aircraft Detection Lighting System (ADLS) or similar system that automatically turns on and off aviation obstruction lights in response to the detection of aircraft. The ADLS is estimated to be activated less than 1.25 hours per year (see Appendix II-I). Thus, the effect of nighttime lighting is substantially minimized through the use of ADLS.
- Based on current United States Coast Guard (USCG) guidance, marine navigation lights mounted on each foundation (or near the bottom of the ESP and booster station topsides) will be visible in all directions at a distance of 3.7 to 9.5 km (2 to 5 nautical miles), depending on the structure's location. Due to sheer distance, marine navigation lights on the WTGs and ESP(s) will not be visible from any coastal vantage point. The low intensity marine navigation lights on the booster station (if used) would be inconspicuous to observers from coastal vantage points.
- At the onshore facilities, adaptive color treatments will be considered to minimize impact. Visual screening may be installed at the onshore substations, if needed.

More detail on these measures is provided in Appendix II-J. An assessment of the activation frequency of an ADLS is included in Appendix II-I.

6.2 Cultural Resources

This section provides information regarding cultural resources that may be affected by Vineyard Northeast to assist the Bureau of Ocean Energy Management (BOEM) in meeting its obligations under Section 106 of the National Historic Preservation Act (NHPA). BOEM is the lead federal agency for Vineyard Northeast and will initiate the Section 106 consultation with the State Historic Preservation Officer(s) (SHPO[s]), Tribal Historic Preservation Officer(s) (THPO[s]), and/or other interested parties. This summary section, along with the Terrestrial Archaeological Resources Assessment (TARA) (see Appendix II-L), the Marine Archaeological Resources Assessment (MARA) (see Appendix II-Q), and the Historic Resources Visual Effects Assessment (HRVEA) (see Appendix II-K), was prepared to support BOEM's National Environmental Policy Act (NEPA) and NHPA review, in accordance with 30 CFR Part 585.627(a)(6). BOEM provides recommended approaches for assessing impacts to historic properties during the offshore wind energy permitting process in "Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585" (BOEM 2020a). The identification of historic properties was based on standard practices within each discipline.

Cultural resources include:

- aboveground buildings, structures, districts, and other properties of historic significance;
- archaeological resources, which are areas where human alterations to the earth, artifacts, or other signs of past human activity are found; and
- traditional cultural properties (TCPs), which are places, landscape features, or locations associated with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community.

Cultural resources with historic significance and integrity under NHPA criteria are called "historic properties" and are eligible for listing or listed in the National Register of Historic Places (NRHP). As defined in the regulations implementing Section 106 of the NHPA, historic property means:

> *…any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. This term includes artifacts, records, and remains that are related to and located within such properties. This term also includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization and that meet the National Register criteria.*

The Area of Potential Effects (APE) is defined in 36 CFR § 800.16 as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

BOEM's "Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585" (dated May 27, 2020) state that "[t]he scope of these geographic areas should include the following:

- The depth and breadth of the seabed potentially impacted by any bottom-disturbing activities;
- The depth and breadth of terrestrial areas potentially impacted by any ground disturbing activities;
- The viewshed from which renewable energy structures, whether located offshore or onshore, would be visible; and
- Any temporary or permanent construction or staging areas, both onshore and offshore" (BOEM 2020a).

The Proponent has identified a Preliminary Area of Potential Effects (PAPE) to assist BOEM with the development of the APE. The PAPE is based on the maximum Project Design Envelope (PDE) for Vineyard Northeast. The PAPE for Vineyard Northeast is subdivided into three geographic elements:

1. PAPE for physical impacts to marine cultural resources;
2. PAPE for physical impacts to terrestrial cultural resources; and
3. PAPE for visual impacts to visually sensitive cultural resources (onshore and offshore).

Each of these elements of the PAPE are described separately below, followed by a discussion of Vineyard Northeast's potential effects to cultural resources within each element of the PAPE and the Proponent's proposed measures to avoid, minimize, and mitigate those effects.

6.2.1 Marine Cultural Resources

This summary section discusses marine cultural resources, including archaeological resources and TCPs located offshore, that may be physically impacted by Vineyard Northeast.[99] Marine cultural resources include shipwrecks, submerged ancient landforms, sunken aircraft, and other maritime infrastructure. This section, along with the MARA (see Appendix II-Q), was prepared in accordance with 30 CFR Part 585.627(a)(6) to support BOEM's NEPA and NHPA review.

The PAPE for marine archaeological resources was analyzed pursuant to 30 CFR § 585 and BOEM guidelines under the supervision of the Qualified Marine Archaeologist (QMA). The high-resolution geophysical (HRG) surveys were conducted primarily in 2022 and 2023 and were performed in accordance with guidelines issued by BOEM (2020a and 2020b), Connecticut State Historic Preservation Office (CTSHPO), and Massachusetts Board of Underwater Archaeological Resources. A detailed MARA is provided as Appendix II-Q.

6.2.1.1 Preliminary Area of Potential Effects

The PAPE for marine archaeological resources is comprised of the depth and breadth of the seabed potentially impacted by any bottom-disturbing activities associated with Vineyard Northeast's offshore facilities. The PAPE (including maps and a description of potential impacts associated with Vineyard Northeast) is fully described in the MARA (see Appendix II-Q).

6.2.1.2 Summary of Potential Avoidance, Minimization, and Mitigation Measures

The MARA identifies recommended minimum avoidance buffers for shipwrecks within and adjacent to the PAPE based on the visible extent of each resource gleaned from geophysical survey data. The Proponent plans to avoid the shipwreck sites by the recommended avoidance buffer. Identified Ancient Submerged Landform Features (ASLFs) with the potential to contain intact cultural resources are considered to be below the vertical PAPE. If needed, the Proponent will develop and adhere to a Historic Properties Treatment Plan, which will define proposed mitigation measures that will be implemented to avoid and minimize potential effects to historic properties and ASLFs within the PAPE. The Proponent also expects to develop an Unanticipated Discoveries Plan to address the possibility of encountering an unidentified and unanticipated submerged cultural resource during offshore activities. These measures will be finalized in consultation with BOEM, the Massachusetts State Historic Preservation Office (MASHPO), the CTSHPO, Tribes/Tribal Nations, and other relevant consulting parties through the Section 106 and NEPA processes.

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[99] Vineyard Northeast (particularly the Massachusetts OECC) has been sited to avoid TCPs (see Section 2.8 of COP Volume I). Therefore, no direct physical effects to TCPs are anticipated.

6.2.2 Terrestrial Cultural Resources

This summary section addresses terrestrial cultural resources, including archaeological resources, historic buildings, and historic districts located onshore, that will be physically impacted by Vineyard Northeast.

BOEM recommends that efforts to identify historic properties "within onshore terrestrial areas" be "conducted and reported following the guidance published by the affected State Historic Preservation Office (SHPO) and provided through consultation with the affected SHPO" (BOEM 2020a). The Proponent's consultant, Public Archaeology Laboratory (PAL), has conducted the Phase IA (i.e., "assessment") survey for Vineyard Northeast in accordance with applicable federal and state guidance. Key personnel involved in the archaeological surveys meet the Secretary of the Interior's Professional Qualification Standards (36 CFR 61, Appendix A). All tasks associated with the surveys were undertaken in accordance with the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (48 FR 44716–44742; National Park Service [NPS] 1983), and survey work in Massachusetts followed Massachusetts Historical Commission's (1979) Public Planning and Environmental Review: Archaeology and Historic Preservation. The TARA (see Appendix II-L) follows the guidelines established by the NPS in Recovery of Scientific, Prehistoric, Historic, and Archaeological Data (36 CFR 66, Appendix A).

This summary section, along with the TARA (see Appendix II-L), was prepared in accordance with 30 CFR Part 585.627(a)(6) to support BOEM's NEPA and NHPA review.

6.2.2.1 Preliminary Area of Potential Effects

The PAPE for terrestrial cultural resources is comprised of the depth and breadth of terrestrial areas potentially impacted by any ground-disturbing activities within the footprint of Vineyard Northeast's onshore facilities and construction staging areas. This includes both below ground archaeological resources and aboveground historic properties that are within or intersect with the footprint of the onshore facilities and construction staging areas. The PAPE (including maps and a description of potential impacts associated with Vineyard Northeast) is fully described in the TARA (see Appendix II-L) and HRVEA (Appendix II-K).

In July 2022, an archaeological due diligence survey was completed for the Onshore Development Area, which includes the landfall sites, onshore cable routes, onshore substation site envelopes, and points of interconnection (POIs) in Bristol County, Massachusetts and New London County, Connecticut.[100] The due diligence survey provides information on the types and distribution of archaeological cultural resources in or near the Onshore Development

[100] The archaeological due diligence survey did not include the variants to the Horseneck Beach Western Onshore Cable Route [redacted]. However, a detailed archaeological sensitivity assessment of these onshore facilities has been included in the Massachusetts Archaeological Reconnaissance Survey report.

Area. The study area encompassed areas within 0.8 kilometers (km) (0.5 miles [mi]) of the Onshore Development Area. The study area is located in sections of Waterford, New London, Montville, Ledyard, and Groton, Connecticut; and Fall River and Westport, Massachusetts. The due diligence review indicated that the Vineyard Northeast Onshore Development Area study area contains numerous recorded pre-contact and post-contact period archaeological sites. The Archaeological Due Diligence report is provided in Appendix II-L.

In fall 2022 and fall 2023, archaeological reconnaissance surveys were completed for the Onshore Development Area to produce a comprehensive archaeological sensitivity assessment of the PAPE. Rankings of low, moderate, and high sensitivity were determined for the PAPE. The Archaeological Reconnaissance Survey reports for Massachusetts and Connecticut are provided in Appendix II-L and contain detailed maps of archaeological sensitivity.

As further described in the HRVEA (see Appendix II-K), no adverse effects to aboveground historic properties are anticipated from the direct physical effects of Vineyard Northeast. Construction impacts will be temporary and the onshore cable routes will be primarily underground. More detail is provided in Appendix II-K.

6.2.2.2 Summary of Potential Avoidance, Minimization, and Mitigation Measures

The Proponent will consult with the CTSHPO and MASHPO regarding the potential for Vineyard Northeast to affect both known and un-recorded cultural resources that may be present within the study area. Potential avoidance, minimization, and mitigation measures include the following:

- The Proponent intends to prioritize avoiding known cultural resources. The onshore routes are sited primarily within public roadway layouts or existing utility rights-of-way (ROWs) (i.e., within previously disturbed areas) to minimize disturbance to cultural resources.

- The Proponent anticipates completing Phase 1B studies (intensive surveys), as appropriate.

- The Proponent anticipates developing an Onshore Archaeological Monitoring Plan as part of the Section 106 consultation process and conducting monitoring of archaeologically sensitive areas during construction.

- The Proponent anticipates developing and implementing an Onshore Post-Review Discovery Plan as part of the Section 106 consultation process.

The Proponent will continue to develop appropriate avoidance, minimization, and mitigation measures (as needed) in consultation with BOEM, MASHPO, CTSHPO, federally recognized Tribes/Tribal Nations, and other relevant consulting parties.

6.2.3 Visually Sensitive Cultural Resources (Aboveground Historic Properties and TCPs)

This summary section addresses visually sensitive cultural resources, including TCPs, located within the viewshed of Vineyard Northeast's onshore and offshore facilities. Visual impacts to non-historic resources are addressed in Section 6.1.

BOEM provides recommended approaches for assessing impacts to historic properties during the offshore wind energy permitting process in "Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585" (BOEM 2020a). These guidelines state that a HRVEA should be conducted in a manner acceptable to the relevant SHPO for the state(s) within the areas that will have a view of Vineyard Northeast's onshore or offshore components (see Appendix II-K). This summary section, along with the HRVEA (see Appendix II-K), was prepared in accordance with 30 CFR Part 585.627(a)(6) to support BOEM's NEPA and NHPA review.

6.2.3.1 Preliminary Area of Potential Effects

The PAPE for direct visual effects includes "the viewshed from which renewable energy structures, whether located offshore or onshore, would be visible" (BOEM 2020a). To delineate the PAPE for direct visual effects, the Proponent identified areas from which Vineyard Northeast would, with some certainty, be visible and recognizable under a reasonable range of meteorological conditions. Then, the Proponent identified historic properties and TCPs included in, or eligible for inclusion in the NRHP, that are within the PAPE and assessed the potential effects of Vineyard Northeast on those properties. Baseline photography and fieldwork that supported the development of the PAPE was conducted in spring 2022 and fall 2023.

Offshore

For Vineyard Northeast's offshore components, the PAPE for direct visual effects includes areas where the wind turbine generators (WTGs), electrical service platforms (ESP[s]), and booster station would be visible. Since the maximum height of the ESP topside(s) (70 m [230 ft]) is much less than the maximum nacelle height of the WTGs (249 m [817 ft]), the PAPE for the WTGs encompasses the PAPE for the ESP(s). The offshore export cables from the ESP(s) to the mainland landfall sites as well as the inter-array and inter-link cables within the Lease Area are underwater and will not have a visual impact. Delineating the offshore PAPE for direct visual effects involved a three-step process:

- The first step in determining the PAPE included identifying the maximum theoretical area of visibility due to the earth's curvature. The maximum theoretical distance that the top of the blades could potentially be visible is 81.6 km (50.7 mi) from the WTGs.

- The second step involved identifying the maximum theoretical area where Vineyard Northeast could potentially be visible taking into account intervening topography, built structures, and vegetation (i.e., the Zone of Likely Visibility [ZLV]). The ZLV was generated using a Geographic Information System (GIS) viewshed calculation utilizing Light Detection and Ranging (LiDAR) data. The ZLV includes areas of theoretical visibility of both the nacelle and blade tips.

- The third step in determining the PAPE included utilizing the photo simulations and, where available, field observations to identify those areas within the ZLV where Vineyard Northeast "would be visible."

The PAPE (including maps and a description of potential impacts associated with Vineyard Northeast) is fully described in the HRVEA (see Appendix II-K). The PAPE for direct visual effects includes portions of Martha's Vineyard (and adjacent Nomans Land), portions of Nantucket (and its adjacent outlying islands), and a limited portion of Nantucket Sound. Accordingly, the PAPE for direct visual effects also encompasses portions of the Chappaquiddick Island TCP, Vineyard Sound and Moshup's Bridge TCP, and the Nantucket Sound TCP.

Onshore

For the onshore portions of Vineyard Northeast, the PAPE for direct visual effects is mostly related to the new onshore [redacted] sites as the onshore cables will be primarily underground. Additionally, in Massachusetts, the northern crossing of the Taunton River [redacted] may require a short segment of overhead transmission lines. Accordingly, the onshore PAPE for direct visual effects includes both the new onshore substation sites and the potential overhead lines across the Taunton River.

The PAPE for Vineyard Northeast's onshore facilities is based on the identification of a ZLV, which is determined using GIS-generated viewshed analysis of a representative substation design within each onshore substation site envelope. A ZLV is also identified for the potential segment of overhead transmission lines at the northern crossing of the Taunton River [redacted] using GIS-generated viewshed analysis. Photo simulations for the onshore substations and, where available, field observations are used to identify those areas within the ZLV where Vineyard Northeast's onshore facilities "would be visible." The PAPE (including maps and a description of potential impacts associated with Vineyard Northeast) is fully described in the HRVEA (see Appendix II-K).

The onshore substation sites will have a perimeter access fence and may include sound attenuation walls, if necessary. Substation construction may require initial clearing and grading of the site, but the periphery of the site (outside the security fencing) will be restored and revegetated (if required). Vegetative buffers for visual screening may be installed, if needed.

More information is included in Appendix II-K.

6.2.3.2 Summary of Potential Avoidance, Minimization, and Mitigation Measures

The Proponent is avoiding and minimizing visual impacts to the maximum extent practicable.

The WTGs will have uniform shape, design, and color and will be aligned and spaced consistently with other offshore wind facilities, thereby reducing potential for visual clutter. Additionally, the WTGs will be no lighter than RAL 9010 Pure White and no darker than RAL 7035 Light Grey in color in accordance with BOEM and Federal Aviation Administration (FAA) guidance; the Proponent anticipates painting the WTGs off-white/light grey to reduce contrast with the sea and sky and thus, minimize daytime visibility of the WTGs. This lack of contrast between the WTGs and the background means that the percentage of the time the structures might be visible is greatly reduced. Additionally, the upper portion of the ESP(s) and booster station (if used) will be a grey color, which would appear muted and indistinct. Color contrast decreases as distance increases. Color contrast will diminish or disappear completely during periods of haze, fog, or precipitation.

Lighting will be kept to the minimum necessary to comply with navigation safety requirements and safe operating conditions. For each WTG, ESP, and booster station (if used), marine navigation lighting will include yellow flashing lights that are visible in all directions at a distance of 3.7 to 9.5 km (2 to 5 nautical miles [NM]), in accordance with current United Stated Coast Guard (USCG) guidance.

Subject to BOEM approval, the Proponent will use an Aircraft Detection Lighting System (ADLS) or similar system that automatically turns on and off aviation obstruction lights in response to the detection of aircraft. The ADLS is estimated to be activated less than 1.25 hours per year (see Appendix II-I). Thus, the effect of nighttime lighting is substantially minimized through the use of ADLS.

The onshore cables are expected to be installed primarily underground within public roadway layouts or within existing ROWs, thus minimizing potential visual effects to adjacent properties. At the onshore facilities, adaptive color treatments will be considered to minimize impact. Lastly, vegetative buffers for visual screening of the onshore substations may be installed, if needed.

7 Low Probability Events

Low probability events that could occur during construction, operation, and/or decommissioning of Vineyard Northeast include: collisions and allisions, severe weather and natural events, corrective maintenance activities or significant infrastructure failure, cable displacement or damage, offshore spills and inadvertent releases, coastal and onshore spills and inadvertent releases, or terrorist attacks.

The following sections discuss these low probability events in the Offshore Development Area and Onshore Development Area. The Offshore Development Area is comprised of Lease Area OCS-A 0522 (the "Lease Area"), two offshore export cable corridors (OECCs), and the broader region surrounding the offshore facilities that could be affected by Vineyard Northeast-related activities. The Onshore Development Area consists of the landfall sites, onshore cable routes, onshore substation sites, and points of interconnections (POIs) in Bristol County, Massachusetts and New London County, Connecticut as well as the broader region surrounding the onshore facilities that could be affected by Vineyard Northeast-related activities.

7.1 Collisions, Allisions, and Grounding

Generally, collisions involve vessels colliding with other vessels or with marine life, while allisions involve vessels colliding with fixed objects, such as wind turbine generators (WTGs) or electrical service platforms (ESPs). Grounding occurs when a vessel runs aground or makes contact with the seafloor in shallow water. As described further in the Navigation Safety Risk Assessment (NSRA) provided as Appendix II-G, collisions and allisions are considered low probability events within the Offshore Development Area. Each event could result in spills (as described below in Sections 7.5 and 7.6); damage to infrastructure or vessels; human injuries or fatalities; or, in the case of a collision with marine life, injury or fatalities of marine life (see Sections 4.7 and 4.8).

However, the risk of vessel collisions is considered low due to the use of a uniform grid pattern for the WTG/ESP layout, the planned marine navigation lighting and marking of the offshore facilities, and mariners' adherence to United States Coast Guard (USCG) and international maritime regulations designed to promote safety. First and foremost, as described in Section 2.3 of Construction and Operations Plan (COP) Volume I, Vineyard Northeast's WTGs and ESP(s) will be oriented in fixed east-to-west rows and north-to-south columns with 1 nautical mile (NM) (1.9 kilometer [km]) spacing between positions.[101] This 1 x 1 NM WTG/ESP layout is consistent with the layout adopted by other developers throughout the Massachusetts Wind Energy Area (MA WEA) and Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA). This grid layout provides continuous 1 NM wide corridors in the east-west and north-south

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[101] Where necessary, WTGs and ESP(s) may be micro-sited by a maximum of 152 meter (500 feet) to avoid unfavorable seabed conditions, maintain facilities within the Lease Area boundaries, and/or for other unexpected circumstances.

directions as well as at least 0.6 NM (1.1 km) wide corridors in the northwest-southeast and northeast-southwest directions across the entire Lease Area. These corridors, which are consistent with the USCG's recommendations contained in the May 27, 2020 final Massachusetts and Rhode Island Port Access Route Study (MARIPARS), help organize vessel traffic and limit vessel interactions when navigating through the Lease Area.

In addition to Vineyard Northeast's uniform grid layout, the Lease Area is within the MA WEA, which was sited by the Bureau of Ocean Energy Management (BOEM) following a public process and environmental review. When siting the MA WEA, BOEM took into consideration avoiding areas with higher traffic densities, shipping lanes, and in-demand fishing areas.

Further, vessels and mariners are expected to follow the International Regulations for Preventing Collisions at Sea. To enhance marine navigation safety, Vineyard Northeast's offshore facilities will be equipped with marine navigation lighting and marking in accordance with USCG and BOEM guidance. The risk of allision is expected to be further reduced due to the inclusion of Mariner Radio Activated Sound Signals (MRASS) and Automatic Identification System (AIS) transponders in the design of Vineyard Northeast's offshore facilities. Additional information on marine navigation lighting, marking, and signaling can be found in the NSRA in Appendix II-G. Furthermore, the specific location of Vineyard Northeast's offshore facilities (e.g., WTGs and ESP[s]) will be provided to USCG and the National Oceanic and Atmospheric Administration (NOAA) for inclusion on nautical charts.

7.2 Severe Weather and Natural Events

Severe weather events such as winter nor'easters, hurricanes (albeit less frequently), and major storms may occur within the Offshore Development Area. Nor'easters typically form between October and April. While their frequency and strength are correlated to the southerly jet stream along the eastern United States (US), over the last 20 years, an average of 1.6 significant nor'easters with wave heights over 2 meters (m) (6.6 feet [ft]) occurred each year in the southern New England continental shelf and New York Bight region. Based on future climate predictions, nor'easters along the US East Coast are expected to decrease in frequency but increase in severity (Colle et al. 2015). Historical data reveal that 16 Category 2 or 3 hurricanes have occurred in the region since 1869, resulting in an average of one every 9.3 years. Only six of these hurricanes have been Category 3 hurricanes, which translates to an average frequency of one Category 3 hurricane every 50 years. No Category 4 or 5 hurricanes have occurred since 1869.

Vineyard Northeast's offshore facilities will be designed to withstand severe weather events and extreme environmental conditions (including wind speed and wave height) based on site-specific conditions and in accordance with applicable US and international standards. As described in Section 3.12.2 of COP Volume I, a Certified Verification Agent (CVA) will conduct an independent assessment of the offshore facilities' proposed design. The WTG design will be reviewed by the third-party CVA to verify that the design is able to withstand the site-specific conditions (e.g., sustained wind speeds and gusts) anticipated at the Lease Area. The WTGs will be designed to automatically stop power production when wind speeds exceed a maximum value, after which the rotor will normally idle. The exact speed at which power production will cease depends on the manufacturer's specifications.

Under certain meteorological conditions, ice may accumulate on WTG blades, presenting a possible falling ice risk if dislodged or ejected. Ice accumulation risk is greatest when air temperatures are less than 0 °Celsius [C] (32 °Fahrenheit [F]), relative humidity is greater than 95%, and when wind speeds are relatively low (<5 meters per second [10 knots]). Based on an analysis of meteorological data from the Martha's Vineyard Airport and two National Data Buoy Center (NDBC) ocean buoys located near the Lease Area, these potential icing conditions occurred for only two to three hours over the 20-year analysis period, which is 0.031% of the observations.[102] Therefore, the risk of ice formation on the WTG blades is very low. See the NSRA provided as Appendix II-G for additional details.

Vineyard Northeast is sited in an area with relatively low seismic activity. As described in Section 3.3.2.1 and the Marine Site Investigation Report (see Appendix II-B), any earthquakes that do occur typically have a magnitude of ~2 to 3. Of the 96 earthquake epicenters reported within approximately 200 km (108 NM) of the Lease Area[103] since 1668 (an average of one earthquake every 3.7 years), 86 earthquakes (90%) have been magnitude 3.0 or smaller (USGS 2023). Few recorded historical events in the region have had magnitudes greater than 4. The largest earthquake recorded within ~200 km (108 NM) of the Lease Area was a 4.8 magnitude earthquake in 1992, located offshore approximately 240 km (130 NM) south of Madaket, Massachusetts. The largest earthquake in Massachusetts history was the Cape Ann earthquake of 1755 (a magnitude of ~6) and the largest earthquake in Connecticut history occurred in Moodus in 1791 (a magnitude of ~4.4 to 5.0) (NESEC 2023a, 2023b). Overall, the potential for catastrophic damage to the onshore and offshore facilities from an earthquake is extremely low. Vineyard Northeast's foundations will be designed for the relevant seismic accelerations for the region. Additional discussion of seismic activity in the region and how the offshore facilities are designed to withstand seismic inertial loads can be found in the Marine Site Investigation Report (see Appendix II-B).

Catastrophic damage to Vineyard Northeast's onshore facilities, such as the transition vaults, splice vaults, or buried concrete duct bank, is not anticipated. Although unlikely, damage could occur as a result of a natural disaster, severe weather, or other event. Any damage to, or breakage of, these underground components would require excavation to uncover and repair the damaged section. Repair work impacts would be localized and temporary and similar to

102 Excluding periods when the NDBC ocean buoys were not operational; with these periods included, the total time for potential icing conditions represents 0.0016% of entire analysis period.

103 The analysis considered earthquakes within 200 km (108 NM) of the center of the Lease Area.

those from initial transition vault, splice vault, and duct bank installation (see Sections 3.7.3 and 3.8.3.2 of COP Volume I). Any required repair work will incorporate mitigation for construction activities as described in Section 5.5.

7.3 Corrective Maintenance Activities or Significant Infrastructure Failure

Although highly improbable, as with any major infrastructure, it is possible that a component of Vineyard Northeast could experience a significant structural, electrical, or hydraulic failure. Vineyard Northeast will undergo an extensive and well-vetted structural design process to minimize the possibility of component failure. As noted in Section 7.2, a third-party CVA will conduct an independent assessment of the offshore facilities' design as well as fabrication, installation, and commissioning methods. The CVA's assessment will be based on site-specific conditions and applicable international and US standards (see Section 3.12 of COP Volume I). The Proponent will develop one or more Facility Design Reports (FDRs) containing the specific details of the offshore facilities' design and one or more Fabrication and Installation Reports (FIRs) that describe how the components will be fabricated, transported, installed, and commissioned. The FDRs and FIRs will be reviewed by the CVA and the Bureau of Safety and Environmental Enforcement.

The potential risk of significant infrastructure failure or corrective maintenance activities will be further reduced by the Proponent's rigorous inspection and maintenance program. To minimize equipment downtime, maximize energy production, and verify that the facilities remain in a safe condition, the Proponent will conduct regular inspections and preventative maintenance (see Section 4 of COP Volume I). The Proponent's operations and maintenance (O&M) plan and maintenance schedule for each primary component (i.e., WTG, ESP, etc.) will be developed based on original equipment manufacturers' (OEMs') recommendations and experience gained from similar projects operating globally. This inspection and preventive maintenance strategy will be reviewed regularly and continuously improved. Data collected from the continuous monitoring of the facilities will be analyzed to identify and correct potential equipment failures in advance. The Proponent will ensure that Vineyard Northeast's preventive maintenance strategy aligns with best industry practice.

7.4 Cable Displacement or Damage

The target burial depth of the offshore export, inter-array, and inter-link cables is designed to substantially reduce the risk of displacement or damage to the cables by anchors or fishing gear. The Proponent's engineers have determined that a target burial depth of 1.5 to 2.5 m (5 to 8 ft) [104] is more than twice the required burial depth to protect the cables from fishing

[104] Unless the final Cable Burial Risk Assessment (CBRA) indicates that a greater burial depth is necessary and taking into consideration technical feasibility factors, including thermal conductivity.

activities. Likewise, the target burial depth generally provides a maximum of 1 in 100,000 year probability of anchor strike,[105] which is considered a negligible risk. In the event that sufficient cable burial cannot be achieved, cable protection will be installed as described in Sections 3.5.5 and 3.6.5 of COP Volume I. Additionally, the OECCs were designed to avoid areas of higher risk for anchor strikes (e.g., traffic separation schemes [TSSs], anchorage areas, safety fairways), to the extent possible. Furthermore, the cables will be continuously monitored as described in Section 4.1.2 of COP Volume I. Accordingly, cable displacement or damage is not expected.

7.5 Offshore Spills/Inadvertent Releases

Offshore spills are not anticipated and would be accidental in nature. Some scenarios in which inadvertent releases could occur include:

- inadvertent releases resulting from vessel refueling during construction or operation;
- inadvertent releases resulting from routine maintenance activities required during operation of Vineyard Northeast;
- inadvertent releases due to equipment malfunction or breakage; or
- inadvertent releases resulting from a catastrophic event occurring at, or in proximity to, Vineyard Northeast.

Section 6 of COP Volume I describes the Proponent's Health, Safety, and Environmental (HSE) Management System, spill response plans and spill prevention measures, and guidelines for chemical use, waste generation, and disposal. The Proponent's draft Oil Spill Response Plan (OSRP), provided as Appendix I-F, describes spill prevention measures for the offshore facilities as well communication, notification, containment, removal, and mitigation procedures in the unforeseen event of an offshore spill. As described in the draft OSRP, the WTGs, ESP(s), and booster station will be equipped with secondary containment around oil-filled equipment to prevent a discharge of oil into the environment. The ESP(s) and booster station will also likely include an oil/water separator. Annex 10 of the draft OSRP provides an oil spill modeling study that assesses the trajectory and weathering of oil following a catastrophic release of all oil contents from the toppling of an ESP (the largest oil-containing component).

All solid and liquid discharges will be treated in accordance with all applicable federal, state, and local regulations. If grout is used during foundation installation, the grout level will be monitored to minimize overflow of grout outside the foundation.

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105 Based on a preliminary CBRA (see Appendix II-T), in portions of the Ocean Beach Approach and Niantic Beach Approach of the Connecticut OECC, a greater target burial depth of approximately 3 m (10 ft) is needed to achieve a 1 in 100,000 year probability of anchor strike.

Vessel fuel spills are not expected, and, if one occurred, it is likely to be limited in quantity. According to the Bureau of Transportation Statistics (2020), between 2000 and 2020, the average oil spill size for vessels other than tank ships and tank barges in all US waters was approximately 390 liters (103 gallons). A spill of this size has been calculated to dissipate at a rapid pace and evaporate within days of the initial spill. Therefore, impacts to resources would be localized and short-term. Further, vessels are expected to comply with USCG waste and ballast water management regulations, among other applicable federal regulations and International Convention for the Prevention of Pollution from Ships (MARPOL) requirements. Vessels covered under the Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) Vessel General Permit (VGP) are also subject to the effluent limits contained in the VGP. The risk of spills will be further minimized because vessels will be expected to comply with USCG regulations at 33 CFR § 151 relating to the prevention and control of oil spills.

7.6 Coastal and Onshore Spills and Accidental Releases

While not expected, spills or accidental releases related to coastal or onshore infrastructure and activities could come from lubricating or hydraulic oils in construction equipment, refueling activities, waste and/or chemicals stored onshore, releases associated with horizontal directional drilling (HDD) activities, or trash and debris.

Refueling and lubrication of construction equipment will be conducted in a manner that protects coastal habitats, wetlands, and resources such as local drinking water supplies, from accidental spills. Where practicable, vehicle fueling and all major equipment maintenance will be performed offsite at commercial service stations or a contractor's yard. Larger, less mobile equipment (e.g., excavators, paving equipment) will be refueled as necessary onsite. Any such field refueling will be performed in accordance with applicable on-site construction refueling regulations. The fuel transfer operation will be performed by well-trained personnel knowledgeable about the equipment, the location, and the use of the work zone spill kit. Proper spill containment gear and absorption materials will be maintained for immediate use in the event of inadvertent spills or leaks thereby minimizing the risk of potential impacts. Further, any solid waste, trash, and/or debris associated with Vineyard Northeast will be stored and properly disposed of in accordance with all applicable federal, state, and local regulations. In addition to this, the Proponent will develop a Spill Prevention, Control, and Countermeasure (SPCC) Plan for each onshore substation site as part of the state permitting process, which will describe onshore spill prevention and response procedures.

Lastly, HDD activities could result in temporary impacts to coastal habitats at the landfall sites. HDD operations will use bentonite or other non-hazardous drilling fluids beneath the coastal and nearshore habitats that are seaward of the HDD entry point. Crews are trained to closely monitor both the position of the drill head and the drilling fluid pressure to reduce the risk of inadvertent releases of pressurized drilling fluid to the surface (i.e., drilling fluid seepage). The Proponent will develop an HDD Inadvertent Release Response Plan, which will describe measures to reduce the risk of an inadvertent release and the immediate corrective actions that will be taken in the unlikely event of an inadvertent release. In the unlikely event of an inadvertent release, turbidity could occur. However, the impact of such an event is expected to be minor and temporary in nature. This is due to the fact that drilling fluid is a natural and inert substance and the amount of fluid used is typically low. Therefore, any released material is expected to pose little to no threat to water quality or ecological resources.

7.7 Terrorist Attacks

Although highly unlikely, Vineyard Northeast could be a target for terrorism. Impacts associated with a terrorist attack would depend on the magnitude and location of the attack. Potential impacts from this type of event would be similar to the potential outcomes listed in the above sections and the same mitigation measures would apply, as appropriate. Measures described above to contain offshore spills and releases would be followed and are expected to minimize the environmental impacts from a terrorist attack.

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