MAYFLOWER WIND

Construction and Operations Plan

Volume 2

Version E

Issue Date December 2022

Construction and Operations Plan

Mayflower Wind Energy LLC

Submitted To:

Bureau of Ocean Energy Management
Office of Renewable Energy Programs
45600 Woodland Road, VAM-OREP
Sterling, VA 20166

Submitted By:

Mayflower Wind Energy LLC
101 Federal Street, Suite 1900
Boston, MA 02110

Prepared By:

AECOM
9 Jonathan Bourne Drive
Pocasset, MA 02559

Tetra Tech, Inc.
10 Post Office Square,
Suite 1100
Boston, MA 02109

DNV Energy USA, Inc.
1400 Ravello Drive
Katy, TX 77449

With Support From:

Capitol Airspace Group
CR Environmental, Inc.
Fugro USA Marine Inc.
Gradient Corporation
Innovative Environmental Science and
Swanson Environmental
Integral Consulting, Inc.
JASCO Applied Sciences (USA) Inc.
LGL Ecological Research Associates
R. Christopher Goodwin & Associates, Inc.
Westslope Consulting, LLC

December 2022 | Volume 2

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS & ABBREVIATIONS

Abbreviation	Definition
$\mu g/m^3$	micrograms per cubic meter
µm	micrometer
µT	microTesla
ac	acre
AC	alternating-current
ACCSP	Atlantic Coastal Cooperative Statistics Program
ADLS	Aircraft Detection Lighting System
AERA	Avian Exposure Risk Assessment
Aerial HD	aerial high-definition
AIS	automatic identification system
AMAPPS	Atlantic Marine Assessment Program for Protected Species
AMSL	above mean sea level
APE	area of potential effect
APVI	Area of Potential Visual Impact
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASR	Airport Surveillance Radar
ATC	air traffic control
ATON	Aid to Navigation
AVEHP	Analysis of Visual Effects to Historic Properties
BIA	Biologically Important Area
BIWF	Block Island Wind Farm
BMPs	best management practices
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
BSFC	brake specific fuel consumption
BUAR	Massachusetts Board of Underwater Archaeological Resources
C	Celsius
CCC	Cape Cod Commission
CCS	Center for Coastal Studies
CEQ	Council on Environmental Quality
CFCRI	Commercial Fisheries Center of Rhode Island
CFR	Code of Federal Regulations
CH_4	methane
CMECS	Coastal and Marine Ecological Classification Standard
CMR	Code of Massachusetts Regulations
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide-equivalent
COA	Corresponding Onshore Area
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea
COP	Construction and Operations Plan
CPT	cone penetration tests

Abbreviation	Definition
CRC	Cultural Resource Consultant
CRMC	Rhode Island Coastal Resources Management Council
CVA	Certified Verification Agent
CWA	Clean Water Act
CWIS	Cooling Water Intake Structure
CZM	Massachusetts Office of Coastal Zone Management
dB	decibel
dB re 1 µPa	decibels reference at one micropascal
dBA	A-weighted decibels
DHS	Department of Homeland Security
DME	Distance Measuring Equipment
DMM	Discarded Military Munitions
DoD	Department of Defense
DP	Dynamic Positioning
DPS	Distinct Population Segment
DEM	Digital Elevation Model
DSM	Digital Surface Model
ECC	Export Cable Corridor
EEA	Executive Office of Energy and Environmental Affairs
EFH	essential fish habitat
EJ	environmental justice
EMF	electric and magnetic fields
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FAA	Federal Aviation Administration
FDR	Facility Design Report
FIR	Fabrication and Installation Report
FLO	Fisheries Liaison Officer
FMP	Fishery Management Plan
FOR	Fisheries Onboard Representative
FR	Fisheries Representative
ft	feet
FUDS	Formerly Used Defense Sites
FWRA	Freshwater Recharge Areas
G&G	geophysical and geotechnical
GARFO	Greater Atlantic Regional Fisheries Office
GDP	gross domestic product
GIS	gas-insulated switchgear
GPS	global positioning system
ha	hectare
HAP	hazardous air pollutant
HAPC	habitat area of particular concern
HDD	horizontal directional drilling

Abbreviation	Definition
HRG	high-resolution geophysical surveys
HSSE	Health, Safety, Security, and Environment
HVDC	high-voltage direct-current
Hz	Hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IBA	Important Bird Area
in	inch
IPaC	Information for Planning and Consultation
IPF	Impact Producing Factors
ISO	International Organization for Standardization
JASCO	JASCO Applied Sciences
JBCC	Joint Base Cape Cod
kHz	kilohertz
kJ	kilojoule
km	kilometer
km^2	square kilometers
knot	nautical mile per hour
KOPs	key observation points
KP	kilometer point or kilometer post
kV	kilovolt
kW	kilowatt
lb.	pound
Lease Area	Lease Area OCS-A 0521
Leq	Equivalent Sound Level
LiDAR	light detection and ranging
LNM	Local Notice to Mariners
m	meter
m/s	meters per second
MA CZM	Massachusetts Office of Coastal Zone Management
MA DMF	Massachusetts Division of Marine Fisheries
MA EFSB	Massachusetts Energy Facilities Siting Board
MA WEA	Massachusetts Wind Energy Area
MA/RI WEA	Massachusetts/Rhode Island Wind Energy Area
MARA	Marine Archaeological Resources Assessment
MARIPARS	Massachusetts Rhode Island Port Access Route Study
MARPOL	International Convention for the Prevention of Pollution from Ships
MassDEP	Massachusetts Department of Environmental Protection
MassWildlife	Massachusetts Division of Fish and Wildlife
Mayflower Wind	Mayflower Wind Energy LLC
MBES	multibeam echosounder
MCEC	Massachusetts Clean Energy Center
MCT	Marine Commerce Terminal
MDAT	Marine-life Data and Analysis Team
MESA	Massachusetts Endangered Species Act
mg/L	milligrams per liter

Abbreviation	Definition
MHC	Massachusetts Historical Commission
mi	mile
mi^2	square miles
MLA	Massachusetts Lobstermen's Association
MLLW	Mean Lower Low Water
mm	millimeters
MMPA	Marine Mammal Protection Act
MOVES	motor vehicle emission simulator
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSIR	Marine Site Investigation Report
MUHRS	multi-channel ultra-high-resolution seismic
MVA	minimum vectoring altitude
MVC	Martha's Vineyard Commission
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NARW	North Atlantic right whale
NAS	noise abatement systems
NAVAIDS	navigational aids
NBEP	Narragansett Bay Estuary Program
NBFSMN	Narragansett Bay Fixed-Site Monitoring Network
NBPA	New Bedford Port Authority
NCCA	National Coastal Condition Assessment
NDBC	National Data Buoy Center
NEAq	New England Aquarium
NEFSC	Northeast Fisheries Science Center
NEPA	National Environmental Policy Act
NHESP	Natural Heritage & Endangered Species Program
NHPA	National Historic Preservation Act
NLPS	Northeast Large Pelagic Survey
nm	nautical mile
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NORAD	North American Aerospace Defense Command
NO_X	oxides of nitrogen
NPDES	National Pollution Discharge Elimination System
NRHP	National Register of Historic Places
NROC	Northeast Regional Ocean Council
NSRA	Navigation Safety Risk Assessment
NWF	National Wildlife Federation
NWR	National Wildlife Refuge
NYSERDA	New York State Renewable Energy Development Authority
O&M	Operations and Maintenance
O_3	ozone

Abbreviation	Definition
Ocean SAMP	Special Area Management Plan
OCS	Outer Continental Shelf
OPAREA	Operating Area
OSHA	Occupational Safety and Health Administration
OSP	offshore substation platform
OSRP	Oil Spill Response Plan
PAPE	Preliminary APE
PATON	Private Aid to Navigation
Pb	lead
PDE	Project Design Envelope
PM_{10}	particulate matter smaller than 10 microns
$PM_{2.5}$	particulate matter smaller than 2.5 microns
POI	Point of Interconnection
ppb	parts per billion
ppm	parts per million
PSO	Protected Species Observer
psu	Practical Salinity Units
PTS	permanent threshold shift
PV	Plan View
QMA	Qualified Marine Archaeologist
RI EFSB	Rhode Island Energy Facility Siting Board
RIDEM	Rhode Island Department of Environmental Management
RIHPHC	Rhode Island Historical Preservation & Heritage Commission
RINHP	RIDEM National Heritage & Endangered Species Program
RODEO	Real-time Opportunity for Development Environmental Observation
ROSA	Responsible Offshore Science Alliance
ROV	remotely operated vessel
ROW	right-of-way
RSZ	rotor swept zone
SAR	search and rescue
SAV	submerged aquatic vegetation
SBP	Sub-bottom Profiler
SEL	sound exposure levels
SEL_{cum}	Cumulative Sound Exposure Level
SEM	Surface Elevation Model
SF_6	sulfur hexaflouride
SGCN	Species of Greatest Conservation Need
SHPO	State Historical Preservation Office
SMAST	School for Marine Science and Technology
SMS	Safety Management System
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasure
SPI	Sediment Profile Imaging
SPUE	sightings per unit effort
SQI	sediment quality index

Abbreviation	Definition
SSS	side scan sonar
st	street
STSSN	Sea Turtle Stranding and Salvage Network
SUHRS	single channel ultra-high-resolution seismic
SWPPP	Stormwater Pollution Prevention Plan
TARA	Terrestrial and Archaeological Resources Assessment
TCP	Traditional Cultural Properties
TOC	total organic carbon
TRACON	Terminal Radar Approach Control
TSS	traffic separation scheme
TTS	temporary threshold shift
TVG	transverse gradiometer
U.S.C.	United States Code
UCH	underwater cultural heritage
ULSD	ultra-low sulfur diesel
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UXO	unexploded ordnance
VHF	very high frequency
VIA	Visual Impact Assessment
VMS	Vessel Monitoring System
VOC	volatile organic compound
VOR	VHF Omnidirectional Range
VTR	Vessel Trip Report
WNS	white-nose syndrome
WTG	wind turbine generator

4 SITE GEOLOGY AND ENVIRONMENTAL CONDITIONS

4.1 SITE GEOLOGY

This section provides an overview of the regional geology within the proposed Offshore Project Area encompassing Lease Area OCS-A 0521 (Lease Area) and offshore export cable corridors. This evaluation is based on Appendix E, Marine Site Investigation Report (MSIR), which incorporates findings derived from geophysical and geotechnical surveys of the Offshore Project Area conducted in 2019, 2020, and 2021. These surveys cover the wind turbine generator (WTG) and offshore substation platform (OSP) locations and the corresponding north-south oriented corridors between WTGs within the Lease Area, as well as the Falmouth export cable corridor and the Brayton Point export cable corridor from the Lease Area to the landfall locations. Further details regarding survey work done in the Offshore Project Area can be found in Appendix E.1, Geohazard Report for Lease Area, Appendix E.2, Geohazard Report for Brayton Point Export Cable Corridor, and Appendix E.3, Geohazard Report for Falmouth Export Cable Corridor.

Technical appendices related to site geology include:

- Appendix E, Marine Site Investigation Report
- Appendix E.1, Geohazard Report for Lease Area
- Appendix E.2, Geohazard Report for Brayton Point Export Cable Corridor
- Appendix E.3, Geohazard Report for Falmouth Export Cable Corridor
- Appendix E.4, Geophysical Operations and Processing Report (2020 and 2021)
- Appendix E.5, (Attachment 1) Measured and Derived Geotechnical Parameters and Final Results: Mayflower Wind Geotechnical Investigation 2020
- Appendix E.5, (Attachment 2) Measured and Derived Geotechnical Parameters and Final Results: Mayflower Wind Geotechnical Investigation 2020
- Appendix E.6, Measured and Derived Geotechnical Parameters and Final Results: Mayflower Wind Geotechnical Investigation 2021
- Appendix Q, Marine Archaeological Resources Assessment

4.1.1 Regional Geology

The Offshore Project Area is located near the intersection of the Mid-Atlantic and North-Atlantic zone boundaries of the Atlantic Continental Shelf. The present offshore geological conditions of the Lease Area are the result of glacial processes resulting in sea level rises and falls over the past 27,000 years (Oldale, 1992; Uchupi and Oldale, 1994). The Mid-Atlantic and North-Atlantic Continental Shelf geometry formed from the cyclical rise and fall of sea levels since the Cretaceous period (Curray and Moore, 1963). The Cretaceous and Quaternary aged units present thicken toward the south with Triassic, Jurassic, and Paleozoic basement rocks lying approximately 0.62 to 1.86 miles (mi) (1 to 3 kilometers [km]) beneath the sea floor (Uchupi, 1970).

From a review of publicly available data and published research, hypotheses can be made regarding the geologic history of the North-Atlantic Continental Shelf. During the Last Glacial Maximum in the Wisconsin glacial period, ice sheets were at their greatest extent and the Laurentide Ice Sheet extended to the area north of the Lease Area. This created the ice-marginal deposits responsible for the formation of Cape Cod, Martha's Vineyard, and Nantucket island. Glacial features, including terminal moraines consisting of debris accumulated from glacier flow, formed at the leading edge of the glacial lobes. Moraine deposits related to the formation of Martha's Vineyard and Nantucket islands also left boulder fields along portions of the Falmouth export cable corridor and the Brayton Point export cable corridor (Baldwin et al., 2016; Oldale, 1980). These deposits are found at the surface and near surface of the seabed, primarily within and landward of the terminal moraines of Martha's Vineyard, Nantucket, and the Elizabeth Islands. Additionally, the Southwest Shoal off Martha's Vineyard and Browns Ledge off the Elizabeth Islands in Rhode Island Sound represent moraine features crossed by the Brayton Point export cable corridor.

Outwash plains formed through several mechanisms including: continuously, when fed by ice-melt; episodically, in the case of glacial lake dam bursts; or erosional, as the glacial ice drained to the south of the moraines, leaving finer grained glaciofluvial and glacio-lacustrine deposits (Oldale, 1992). These outwash deposits shallowly underlie marine sediments throughout much of the Offshore Project Area. Additionally, the portion of the Brayton Point export cable corridor within the Sakonnet River and Mount Hope Bay generally consists of river/estuary surficial sediments overlying older sediments, glacial tills, outwash deposits, and bedrock. Riverine inputs and tidal flows contribute to the reworking of the seabed, with finer-grained sediment being more prevalent within Mount Hope Bay and other areas with less energetic circulation.

During the interglacial period following the Last Glacial Maximum, land rebounded as the glaciers were removed, resulting in receding shorelines and erosion of the exposed continental shelf. As glaciers continued to melt, land elevation equilibrated, eustatic sea level rose, and the shoreline experienced an overall transgressive period. The complex interactions of eustatic sea level and glacial rebound caused smaller transgressive and regressive phases across the region's continental shelf, resulting in fluvial, estuarine, and barrier system sediments deposited on the erosional surface of the glacial drift. These deposits infilled the glacial outwash drainage systems with estuarine deposits present in the deeper, southern areas of the shelf. Geologically, modern reworking and additional deposition of marine sediments over the most recent transgressive ravinement surface have shaped the present seabed, but in many places the older, underlying sediments and morphology are exposed or still detectable under more recent sediments.

4.1.2 Geophysical Surveys

Data from three high-resolution geophysical (HRG) survey campaigns within the Lease Area, Falmouth export cable corridor, and Brayton Point export cable corridor were utilized to formulate this report and analysis: the 2019 reconnaissance geophysical survey and the 2020 and 2021 geophysical surveys; all are included in Appendix E, Marine Site Investigation Report. All surveys were conducted in accordance with Bureau of Ocean Energy Management (BOEM) *Guidelines for Providing Geophysical, Geotechnical and Geohazard Information Pursuant to 30 CFR Part 585* (2020a) and identify the geophysical characteristics within the Lease Area, Falmouth export cable corridor, and Brayton Point export cable corridor. The geophysical surveys and subsequent data processing and interpretation methodologies are designed to:

- Acquire accurate, high-resolution bathymetry and seabed imagery;
- Classify and provide information on seabed sediments;
- Map the seabed morphology;

- Develop a shallow seismic stratigraphic and structural model;
- Identify potential hazards through magnetic anomaly mapping;
- Identify natural and anthropogenic objects at or below the seabed for archaeological resource assessment;
- Provide data for environmental impact studies; and
- Map and assess geohazards.

A map of the surveyed area along the Falmouth export cable corridor and survey lines within the Lease Area can be found in **Figure 4-1**. **Table 4-1** summarizes the survey campaigns conducted along with overviews of the scopes.

TABLE 4-1. COMPLETED GEOPHYSICAL AND BENTHIC SURVEY CAMPAIGNS

Survey Campaign	Scope of Campaign	Survey Dates
2019 TerraSond Geophysical Survey	Reconnaissance survey of Lease Area	August - September 2019
2019 TerraSond Marine Archaeological Resource Assessment	Reconnaissance survey of Lease Area	August - September 2019
2020 Fugro Geophysical Survey	Lease Area HRG on 30 m spaced lines and tie lines at WTG/OSP locations	April - October 2020
	Falmouth export cable corridor HRG on 15 m (state) and 30 m (federal) spaced lines and 500 m tie	April - October 2020
2020 AECOM, Fugro, Integral Spring Benthic Sampling Program	Samples: 63 in Lease Area; 65 samples in Falmouth export cable corridor (ECC); 18 samples in Control Areas	May 2020
2020 AECOM, Fugro, Integral Summer Benthic Sampling Program	Samples: 53 in Lease Area; 54 samples in Falmouth ECC; 18 samples in Control Areas	August 2020
2020 AECOM, Fugro, Fall Benthic Sampling Program	Samples: 39 in Lease Area; 78 samples in Falmouth ECC; 18 samples in Control Areas	November 2020
2021 Fugro Geophysical Survey	Lease Area HRG at 30-m-spaced lines and 500-m-spaced tie lines for inter-array cable layout Falmouth and Brayton Point export cable corridor HRG on 15-m (state) and 30-m (federal)-spaced lines and 500-m tie	April - December 2021
2021 AECOM, Fugro, Integral Spring Benthic Sampling Program	Samples: 35 in Lease Area; 41 samples in Falmouth ECC; 18 samples in Control Areas	April 2021
2021 Fugro, Integral Summer Benthic Sampling Program	Samples: 86 in Brayton Point ECC; 2 samples in Falmouth ECC; 10 samples in Control Areas	July 2021
2022 Fugro, Integral Spring Benthic Sampling Program	Samples: 92 in Brayton Point ECC; 10 samples in Control Areas	March - April 2022

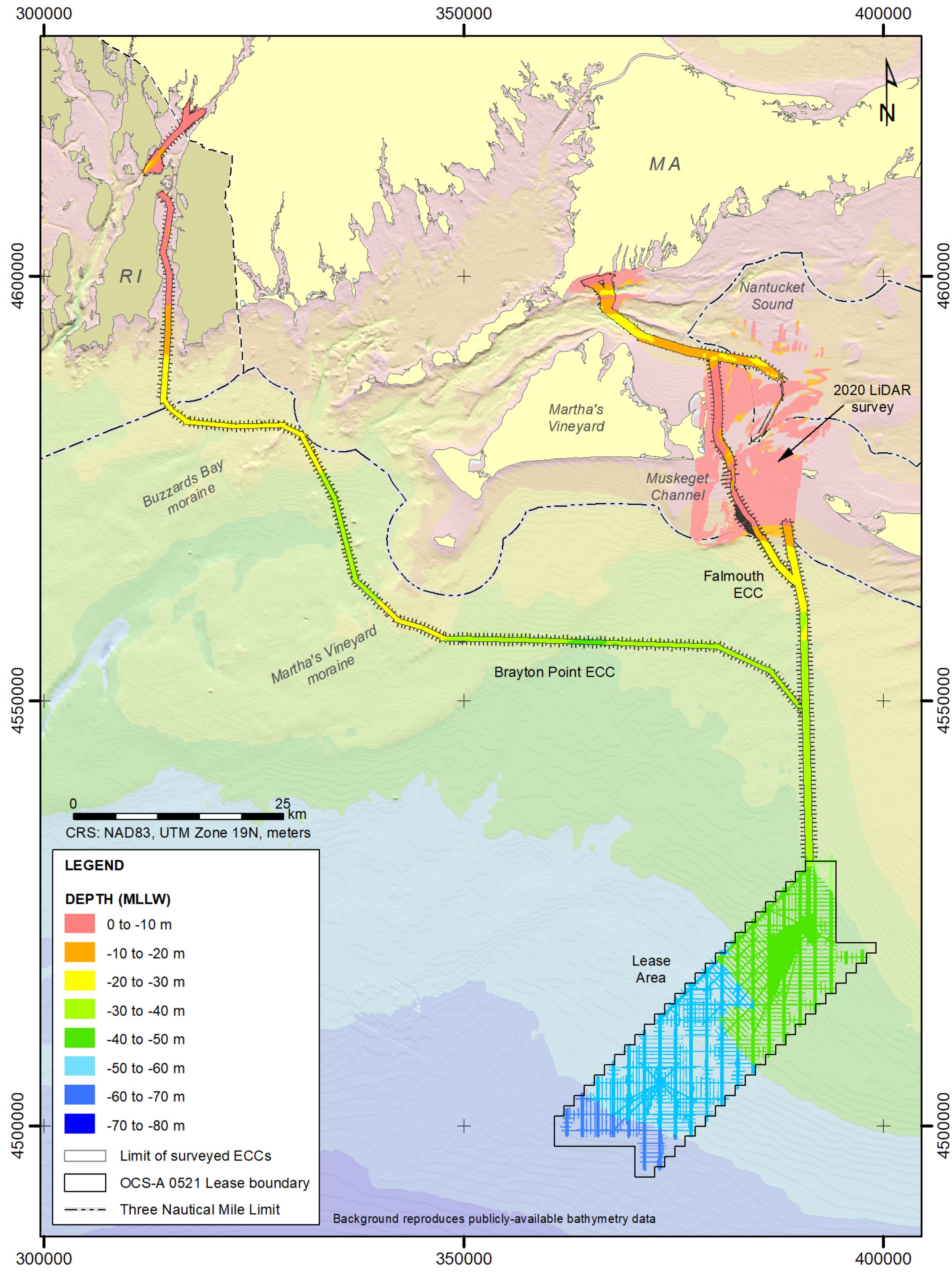


FIGURE 4-1. BATHYMETRY IN THE OFFSHORE PROJECT AREA

The first Lease Area geophysical survey was conducted by TerraSond in 2019 (TerraSond 2020b) with a more comprehensive survey completed by Fugro in 2020 (Fugro, 2022a) to gain an understanding of surficial conditions, subsurface conditions, and geohazards throughout the Lease Area (see Section 4.2.1).

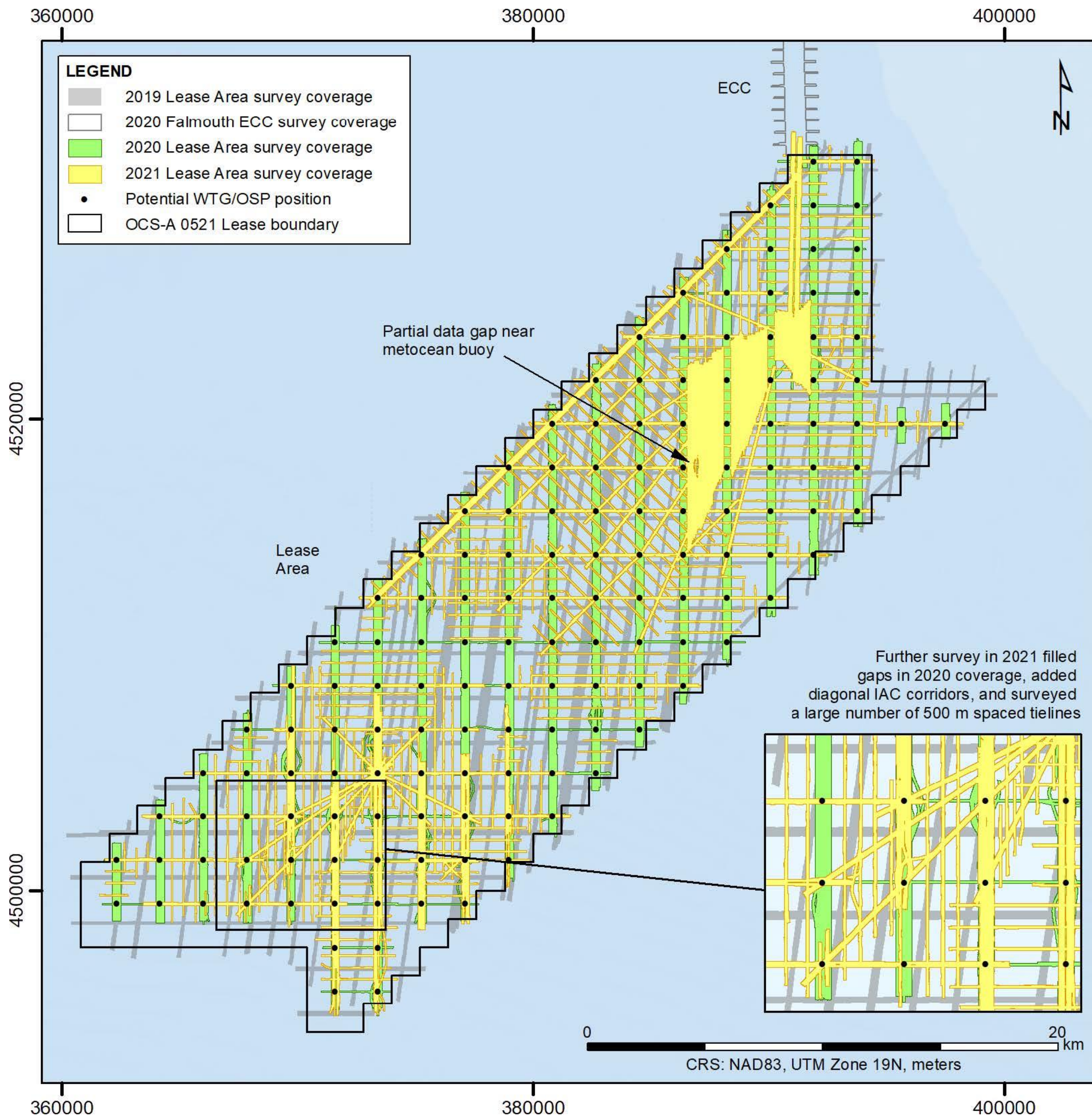
The 2020 geophysical survey included 20 north-south oriented, 984-foot (ft, 300-meter [m])-wide WTG corridors. Each corridor is comprised of 11 adjacent survey lines spaced 98.4 ft (30.0 m) apart. The survey also included single east-west oriented tie-lines every nautical mile, passing through each planned WTG location. In total, 1,926 mi (3,100 km) of lines were surveyed within the Lease Area in 2020.

The 2021 geophysical survey of the Lease Area included lines spaced at 98 ft (30 m) with tie lines every 1,640 ft (500 m). The survey coverage in the Lease Area is shown in **Figure 4-2**. Due to weather, vessel, and gear avoidance, a few locations were not surveyed in 2020 or were infilled later. A more detailed discussion of marine site characterization within the Offshore Project Area can be found in Appendix E, Marine Site Investigation Report. In total, 1,864 mi (3,000 km) of lines were surveyed within the Lease Area in 2021.

Fugro completed the 2020 offshore Falmouth export cable corridor geophysical survey to better understand surficial conditions, subsurface conditions, and geohazards along the corridor (see Section 4.2.2) (Fugro, 2022c). A total of 2,035 mi (3,275 km) of lines were surveyed within the Falmouth export cable corridor in 2020. Nominal primary survey line spacing was 49 ft (15 m) in state waters and 98 ft (30 m) in federal waters with nominal tie line spacing of 1,640 ft (500 m). The Falmouth export cable corridor geophysical survey lines were divided into two sections: deeper water depths and shallow water depths. The delineation of survey lines by water depth is to account for seabed impact of different Project-specific installation activities in the Project Design Envelope (PDE).

The 2021 geophysical survey included completing the survey of a revised Falmouth ECC featuring a more westerly route through the Muskeget Channel and completing survey of the Falmouth landfall approaches. In total 2,492 (2,492 km) of lines were surveyed along the Falmouth ECC in 2021. Nominal primary survey line spacing was 49 ft (15 m) in state waters and 98 ft (30 m) in federal waters with nominal tie line spacing of 1,640 ft (500 m).

In total 2,715 mi (4,370 km) were surveyed within the Brayton Point export cable corridor in 2021. Corridor width of the 2021-surveyed Brayton Point ECC was a nominal 500 m (1,640 ft) in federal waters and 700 m (2,297 ft) in state waters. The common Falmouth-Brayton Point ECC portion was surveyed in 2020 to a nominal width of 2,756 ft (840 m). Survey line spacing was 98 ft (30 m) in federal waters and 49 ft (15 m) in state waters. Tie-lines were spaced at 1,640 ft (500 m).



Source: Fugro, 2022b

FIGURE 4-2. ILLUSTRATION OF THE COVERAGE OF THE 2019, 2020, AND 2021 GEOPHYSICAL SURVEYS OF THE LEASE AREA

There were areas in the Falmouth export cable corridor too shallow to safely survey given the water depths and survey vessel drafts used in the 2020 campaign. For these areas, a topographic and bathymetric aerial light detection and ranging (LiDAR) survey was conducted through the Muskeget Channel and at the Falmouth landfall location(s) under consideration to better understand the bathymetry and aid in route planning ahead of the 2021 survey campaign. The airborne LiDAR bathymetry survey data supported export cable route engineering, selection, and optimizing the vessel-based survey by providing water depths, seabed slopes, and qualitative indication of potential seabed mobility. This data is not a substitute for multibeam echosounder (MBES) data, which has been collected along the entirety of the export cable corridors. For more information see Appendix E, MSIR. A more detailed discussion of marine site characterization along the Falmouth export cable corridor and Brayton Point export cable corridor can also be found in Appendix E, Marine Site Investigation Report.

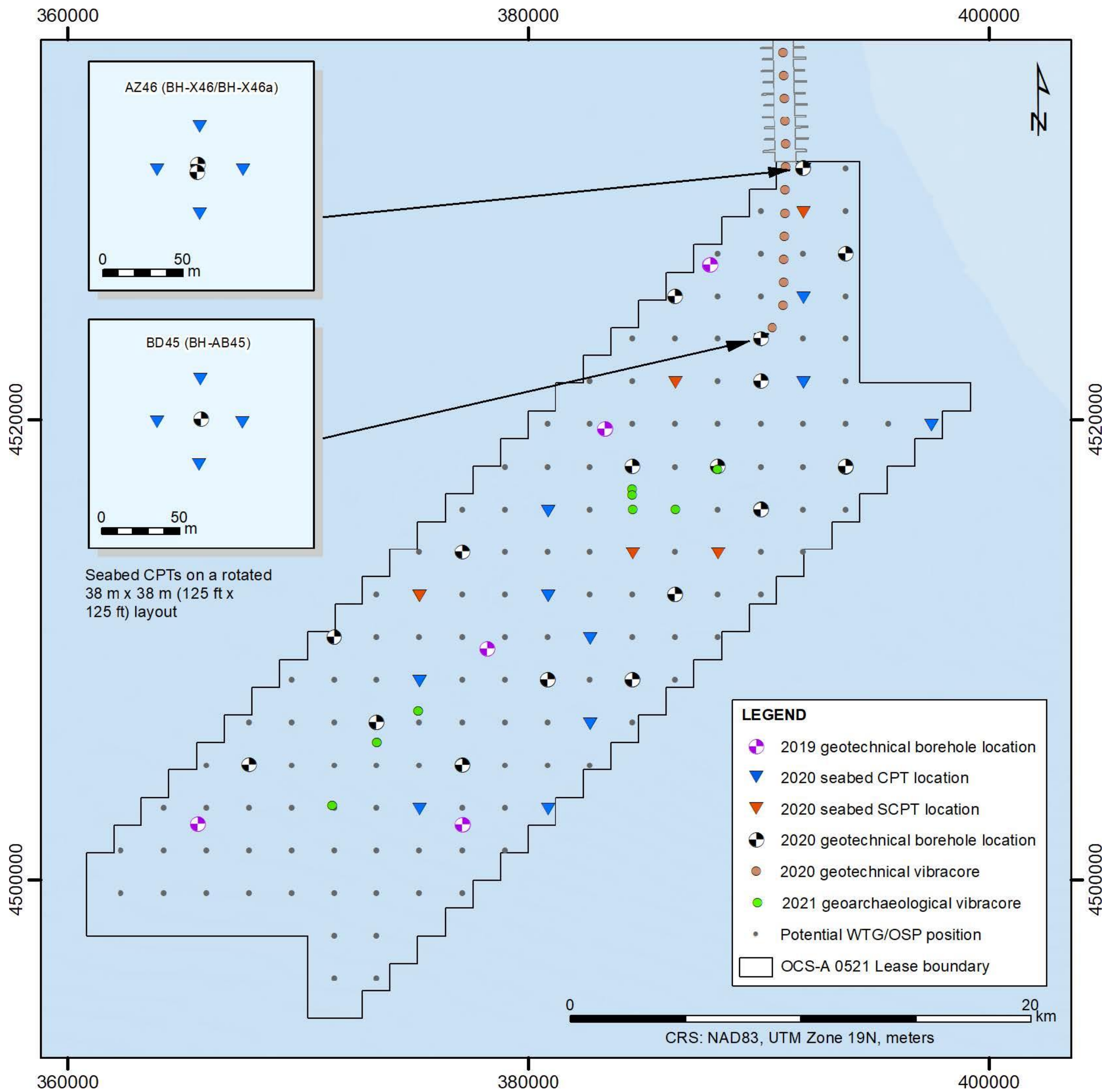
Additionally, geophysical surveys of the ultra-shallow sections of the Falmouth export cable corridor and the full Brayton Point export cable corridor were completed in 2021 and more information can be found in Appendix E, Marine Site Investigation Report.

4.1.3 Geotechnical Surveys

Geoquip Marine Operations AG completed a reconnaissance geotechnical investigation in 2019 within the Lease Area (Geoquip, 2019). The reconnaissance geotechnical survey investigated a maximum depth of 266 ft (81 m) below the seabed and utilized three boreholes (two with P-S logging), two seismic cone penetrometer tests, and five cone penetration tests (CPT).

In 2020, a geotechnical investigation for both geotechnical and archaeological purposes, including deep boreholes with downhole sampling and CPTs, seabed CPTs, and vibracoring was completed within the Lease Area and along the Falmouth export cable corridor (Appendix E, Marine Site Investigation Report). The 2020 Lease Area geotechnical investigation included 17 boreholes to a depth of 262 ft (80 m) each with alternating sampling and downhole CPTs, 10 seabed CPTs, and 5 seabed seismic electronic cone penetrometer tests spread throughout the Lease Area and 8 seabed CPTs at two potential OSP leg locations. Geotechnical investigation locations are shown in **Figure 4-3**. The testing positions were selected based on 2019 geophysical interpretations to gain further understanding of subsurface conditions. Mayflower Wind Energy LLC (Mayflower Wind)'s Qualified Marine Archeologist (QMA) cleared each geotechnical location for potential historic materials or archaeological impacts prior to geotechnical investigations.

A vibracoring campaign was conducted by Alpine in 2020 to gain an understanding of site conditions along the Falmouth export cable corridor. During this campaign, vibracores were taken to a depth of 9.8 ft (3.0 m) or 19.7 ft (6.0 m) every 1.6 mi (1.0 km) in federal waters and every 1,000 ft (305 m) in state waters. Additional vibracores were taken in state waters as determined with the QMA for geoarchaeological purposes.



Source: Fugro, 2022b

FIGURE 4-3. LOCATIONS OF THE LEASE AREA 2019 AND 2020 GEOTECHNICAL INVESTIGATION SITES

Additional geotechnical surveys of the ultra-shallow sections on the Falmouth export cable corridor, the full Brayton Point export cable corridor, and the Lease Area were completed in 2021. Information on the results of these surveys can be found in Appendix E, Marine Site Investigation Report. The geotechnical survey on the Falmouth export cable corridor (Alpine, 2021) includes 36 vibracores that are sampled to 19.7 ft (6.0 m) below seafloor for geotechnical classification and testing. Additional vibracore locations were assigned by the QMA for geoarchaeological purposes. The scope of work for the geotechnical survey on the Brayton Point export cable corridor was generally similar to the Falmouth export cable corridor survey. The scope details of the Lease Area site investigations are presented below in **Table 4-2**.

TABLE 4-2. COMPLETED AND PENDING GEOTECHNICAL SURVEY CAMPAIGNS

Survey Campaign	Scope of Campaign	Survey Dates
2019 Geoquip Geotechnical Investigation	5 boreholes at 20-80 m below seafloor across Lease Area	October – November 2019
2020 Fugro Geotechnical Investigation	17 boreholes to 80 m and 19 seabed CPTs to ~10 m across Lease Area at WTG locations	July – August 2020
2020 Alpine, GeoExpress Testing Geotechnical Investigation	161 vibracores 3-6 m below seafloor along Falmouth export cable corridor (80 geotechnical cores and 81 geoarchaeological cores)	July – August 2020 GeoExpress Testing (August – December 2020)
2021 RCGA Lab Testing for Geoarchaeological Cores	81 geoarchaeological cores	July – August 2020 RCGA Lab Testing (October – December 2020)
2021 Alpine Geotechnical Survey Geotesting Express (Geotechnical Lab Testing) RCGA Lab Testing (Geoarchaeological Lab Testing)	Vibracores – Falmouth ECC 138 (6 m) vibracores (36 geotechnical cores and 102 geoarchaeological cores)	Field work: June – August 2021 (Falmouth ECC) Geotesting Express Lab Testing: July to October, 2021 RCGA Lab Testing: August to October 2021
2021 Fugro, Alpine Geotechnical Survey Geotesting Express (Geotechnical Lab Testing) RCGA Lab Testing (Geoarchaeological Lab Testing)	Vibracores and CPT – Brayton Point ECC 33 (2 m) vibracores (12 geotechnical cores & 21 geoarchaeological cores) 57 (6 m) vibracores (47 geotechnical cores and 10 geoarchaeological cores) 100 Seabed CPTs 26 Seabed Thermal CPTs 3 Seabed Thermal Needle Probes	Field work: October – November, 2021 (Brayton Point ECC) Geotesting Express Lab Testing: October 2021 to January 2022 RCGA Lab Testing: October to November 2021
2021/2022 Fugro Geotechnical Survey	40 (70 m) boreholes 10 (70 m) CPT boreholes 60 (70 m) CPT boreholes	December 2021 ~ December 2022

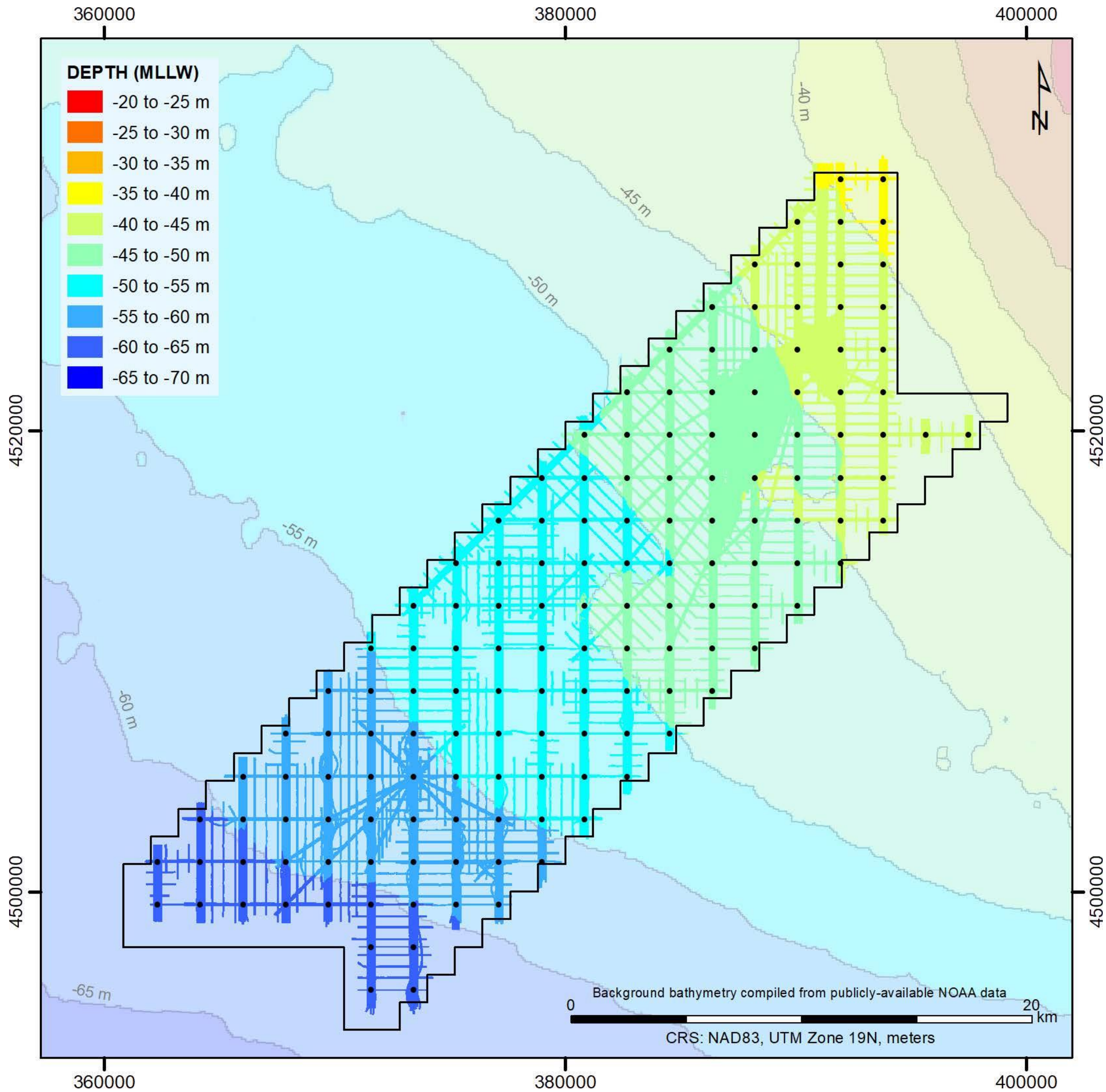
4.1.4 Affected Environment

4.1.4.1 Lease Area

4.1.4.1.1 Surficial Conditions

Water depth within the Lease Area increases in a relatively regular interval from 122.7 ft (37.4 m) relative to Mean Lower Low Water (MLLW) in one of the northernmost WTG locations to 207.0 ft (63.1

m) MLLW at one of the southernmost WTG locations. No large-scale seabed topographic features or bedforms larger than ripples are present within the Lease Area. MBES bathymetry data collected during the 2019 and 2020 HRG survey campaigns within the Lease Area is depicted in **Figure 4-4**.



Source: Fugro, 2022b

FIGURE 4-4. SURVEYED BATHYMETRY WITHIN THE LEASE AREA

Unconsolidated sediments make up the top-most layer of the seabed, which has been further characterized and quantified by geophysical data and ground-truthed by grab samples taken of the uppermost 0.16 to 0.33 ft (0.05 to 0.10 m) of the seabed. Sediment from grab samples were analyzed using the Simplified Folk scheme (Long, 2006). Under this scheme, surficial sediments within the Lease Area fall into either sand and muddy sand or coarse sediment classifications. The surficial seabed sediment is comprised of sand and muddy sand, except for a few distinct areas of more coarse sediment found in well-defined rippled scoured depressions. No boulder fields nor individual boulders have been mapped within the Lease Area based on the 2020 and 2021 HRG data.

4.1.4.1.2 Shallow Geology

The shallow subsurface of the Lease Area is characterized by a thick sequence of alternating Quaternary-aged deposits of coarse-grained and fine-grained sediments, overlying older pre-Quaternary age Coastal Plain Deposits. The Coastal Plain Deposits are interpreted to be between approximately 45 and 80 m below seafloor beneath the southwest portion of the Lease Area. Ravinement surfaces and associated channelized units infilled with transgressive deposits have been mapped across the Lease Area. The sediment type within these channels consists of both fine-grained clays and silts, as well as coarser-grained sands.

Within the Lease Area, four distinctive types of boundaries were determined to be of stratigraphic significance:

- Transgressive ravinement surface
- Regressive ravinement surface
- Holocene-Pleistocene Boundary
- Top of Coastal Plain Deposits

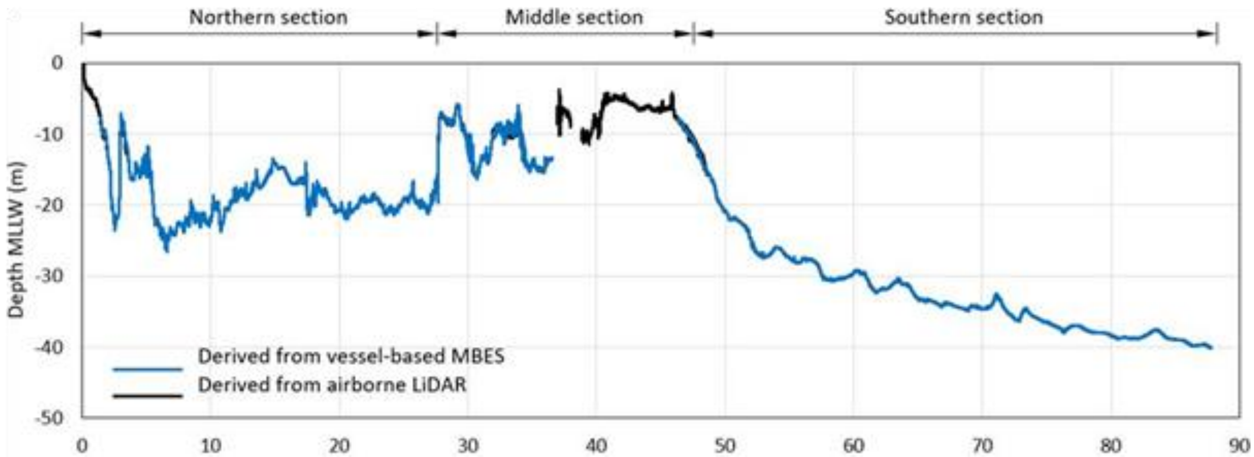
These boundaries were identified based on geophysical interpretations, corresponding geotechnical data, and age constraints from the QMA. Within these boundaries, internal geologic units track geotechnical properties across the Lease Area. The stratigraphic units described in the MSIR (Appendix E) have been identified due to distinct geophysical and geotechnical changes across the Lease Area.

Detailed information on the shallow geology of the Lease Area can be found Appendix E, Marine Site Investigation Report.

4.1.4.2 Falmouth Offshore Export Cable Corridor

4.1.4.2.1 Surficial Conditions

Figure 4-5 displays a bathymetric profile extracted nearby the Falmouth export cable corridor measured relative to MLLW, with the landfall on the left of the figure and the Lease Area at the right and the x-axis representing distance from the landfall in kilometers. The profile highlights a rapid water depth increase from zero at shore (kilometer post [KP] 0.1) to -32.8 ft (-10 m) at KP 1.6 relative to MLLW, with KP indicating distance from the landfall. A water depth range of 49.2 to 65.6 ft (15 to 20 m) was measured within Nantucket Sound (KP 2.5 to KP 5.5), shallowing to less than 32.8 ft (10 m) between Martha's Vineyard and Nantucket Islands (KP 27.7 to KP 47.1), and a uniform depth increase from the islands to the Lease Area with a depth maximum of -160 ft (-49.8 m) at KP 96.8.



Source: Fugro, 2022b

FIGURE 4-5. REPRESENTATIVE BATHYMETRIC PROFILE OF THE FALMOUTH EXPORT CABLE CORRIDOR BY KILOMETER ALONG THE ROUTE

Large current controlled bedforms, areas of scoured seabed, outcropping and subcropping glacial moraine are prevalent in the northern and middle sections of the Falmouth export cable corridor, with the seafloor becoming more uniform, smoother, and less complex in the southern section of the Falmouth export cable corridor.

Seabed characteristics within Nantucket Sound show irregular, erosionally resistant glacial till and sand bedforms. Between the islands, minimum water depth was observed to be -8.2 ft (-2.5 m) at the crest of a sandwave. Seabed sediment composition along the Falmouth export cable corridor was identified from particle size distribution analysis performed on benthic grab samples along with MBES backscatter, bathymetric, and side scan sonar (SSS) data. Seabed sediment was classified according to the Simplified Folk scheme and consists of sand and muddy sand, coarse sediment, mixed sediment, and glacial till (Long, 2006). Boulder fields and individual boulders have been mapped along the Falmouth export cable corridor and are typically associated with glacial moraines.

Additional information on the surficial features and seabed sediments of the Falmouth export cable corridor can be found Appendix E, Marine Site Investigation Report.

4.1.4.2.2 Shallow Geology

The subsurface geology of the Falmouth export cable corridor is heavily influenced by the glacial history of the continental shelf. Complex glacially influenced features are more prevalent along the inshore and middle portion of the Falmouth export cable corridor than the offshore southern portion closer to the Lease Area. Glacial till/moraine deposits outcrop and subcrop within the anticipated cable burial depth at several locations, and sand, muds, and gravel are the predominant soil type throughout. In the northern and middle sections of the Falmouth export cable corridor, mobile sand overlies dense to very dense, poorly graded sand with gravel. Several identified paleochannels have been mapped in the subsurface and channel fills may be coarse or fine-grained.

Additional information on the shallow geology of the Falmouth export cable corridor can be found in Appendix E, Marine Site Investigation Report.

4.1.4.3 Brayton Point Export Cable Corridor

4.1.4.3.1 Surficial Conditions

Water depths along the Brayton Point export cable corridor range from approximately 0 to 136 ft (0 to 41.5 m, MLLW), as shown in the bathymetric profile along the route centerline in **Figure 4-6**. Water depths increase from shore to the Lease Area, with several shallow water traverses due to the crossing of Aquidneck Island. The northern portion of the Brayton Point export cable corridor in the Sakonnet River and Mount Hope Bay are representative of river/estuary surficial conditions of Narraganset Bay, and primarily comprise muddy to sandy sediments in the lower portions of the Sakonnet River, and gravelly mud in the upper portions of Mount Hope Bay. Isolated bedrock outcrops are mapped within the Sakonnet River and lower Mount Hope Bay, along with one distinct mounded feature exhibiting shell-dominated substrate identified as Crepidula accumulations. The seabed varies between smooth and minor bedforms with isolated areas of rock dump or backfill over known pipelines.

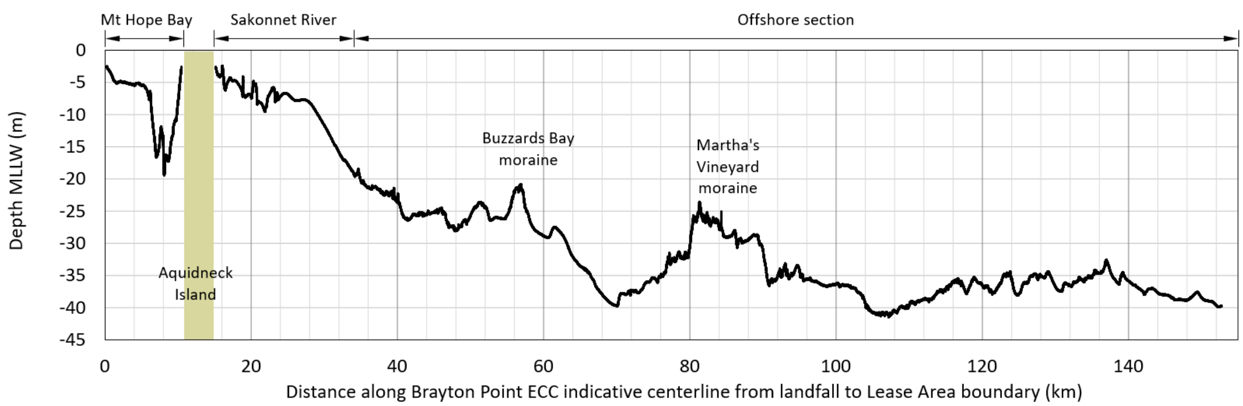


FIGURE 4-6. REPRESENTATIVE BATHYMETRIC PROFILE OF THE BRAYTON POINT EXPORT CABLE CORRIDOR BY KILOMETER ALONG THE ROUTE

Further offshore in Rhode Island Sound, water depths vary between approximately 66 ft (20 m) and 131 ft (40 m) MLLW. Seabed irregularity arises from the presence of erosionally resistant glacial till/moraine at or just below the seafloor, corresponding to the named Buzzards Bay moraine and Martha's Vineyard moraine that are crossed by the Brayton Point export cable corridor. The longer-period irregularity does not represent a geohazard or constraint, but the short-period irregularity from high-density boulder accumulations and large individual boulders may require avoidance. These features are characterized by shallowing bathymetry and outcropping and subcropping glacial sediment, commonly including harder soils, gravels, cobbles, and boulders exposed at the seabed. These regional features are not avoidable through route siting.

As the Brayton Point export cable corridor approaches the Lease Area, the surficial sediments consist of mostly sands with some mud to muddy sands and areas of gravels related to areas of known glacial moraine deposits. The seabed sediment and features along the offshore portions of the route are similar in character and origin to those within the Lease Area and along the southern section of the Falmouth export cable corridor.

Further details on the surficial conditions of the Brayton Point export cable corridor from the geophysical and geotechnical surveys were completed in 2021 and can be found in Appendix E, MSIR.

4.1.4.3.2 Shallow Geology

The subsurface geology of the northern portion of the Brayton Point export cable corridor was mapped over several quadrangles as defined by the Geological Survey Bulletin in 1971, including the Tiverton, Sakonnet Point, and Fall River quadrangles (Quinn, 1971). Known stratigraphic layers underlying the Tiverton quadrangle, which is the central portion of the Sakonnet River, include rocks of the Precambrian, Devonian, and Pennsylvanian ages (Pollock, 1964). Further offshore in Rhode Island Sound and approaching the Lease Area, the underlying geology along the Brayton Point export cable corridor is similar in character and origin to that observed within the Lease Area and along the Falmouth export cable corridor. Glacial till/moraine deposits outcrop and subcrop within the anticipated cable burial depth at several locations; elsewhere, Holocene sands and estuarine deposits comprise the most shallow geological units, underlain by Pleistocene outwash and glacio-lacustrine deposits mapped with filled channels.

Regional glacial moraine features must be crossed by the Brayton Point export cable corridor, including Southwest Shoal, located southwest of Nomans Land off Martha's Vineyard, and Browns Ledge, located southwest of the Elizabeth Islands. Both features represent the now subaqueous portions of the same glacial geological features that underly the adjacent landforms of Martha's Vineyard and the Elizabeth Islands, respectively. Increased coarse-grained sediment, including up to cobble and boulder size materials were identified at or near the seabed from KP 29 to 35, and exposed at the surface between KP 35 and KP 98. Surficial boulders and moraine deposits are seen to be more abundant between KP 75 and 85.

Further details on the stratigraphy and geology underlying the Brayton Point export cable corridor from the geophysical and geotechnical surveys completed in 2021 can be found in Appendix E, MSIR.

4.1.5 Potential Effects

Impact Producing Factors (IPFs) are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

IPFs listed in **Table 4-3** may affect the site geology present within the proposed Offshore Project Area as a result of Project-related activities. Detailed descriptions of IPFs and their connection to Project components can be found in Section 3.4, Impact Producing Factors. Natural hazards are defined as an IPF that can affect site geology but are unrelated to Project-related activities. Further discussion of natural hazards can be found in Section 3.4, Impact Producing Factors, Section 4.2, and Section 4.3. Measures to avoid, minimize, and mitigate potential effects on site geology were considered and may be implemented, when necessary and are described below and summarized in Section 16, Summary of Avoidance, Minimization, and Mitigation Measures.

TABLE 4-3. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON SITE GEOLOGY

IPF	Potential Effect	Period of Potential Effect		
	Project Component	Project Phase		
	Offshore Project Area	Construction	O&M	Decomm.
Seabed (or ground) Disturbance	Seabed preparation; offshore component installation and decommissioning; routine offshore O&M; vessel anchoring or spudding	X	X	X

4.1.5.1 Seabed Disturbance

Seabed disturbance linked to seafloor preparation, offshore component installation and decommissioning, routine offshore operations and maintenance (O&M) activities, and vessel anchoring or spudding have the potential to affect site geology during the construction, operation, and decommissioning phases of the proposed Project.

4.1.5.1.1 Construction

During construction, vessel anchoring or spudding is likely to disturb the seabed in turn disturbing sediments within the Offshore Project Area. Vessel anchoring will occur during substructure, WTG, and OSP installation, and installation of export cables along various extents of the Lease Area and export cable corridors. Depending on the region of anchoring and spudding, the seabed sediments may remain scarred or recover quickly as hydrodynamic conditions differ along portions of the export cable corridors and within the Lease Area. Mayflower Wind, when feasible, will use technologies that minimize sediment mobilization and seabed sediment alteration for cable burial operations. Additionally, Mayflower Wind, where practical and safe, will utilize dynamically positioned (DP) vessel.

Installation of inter-array and export cables will disturb the seabed within the Offshore Project Area as seabed preparation may be required and installation can involve pre-installation followed by burial, or post-lay cable burial to achieve cable placement at the targeted interval below the seabed. Substructure, WTG, and OSP installation within the Lease Area will also result in localized seabed disturbance as seabed preparation may be required and scour protection is expected to be placed. Anticipated area values of seabed disturbance from construction activities are provided in Section 3.4.1, Seabed (or Ground) Disturbance.

4.1.5.1.2 Operations and Maintenance

Vessel anchoring or spudding activities, though rarely anticipated and only for major maintenance activities, may contribute to seabed disturbance within the Offshore Project Area. While still causing seabed disturbance, vessel anchoring or spudding during the operational phase will be of a lesser magnitude than disturbance from vessel anchoring or spudding experienced during construction and decommissioning.

4.1.5.1.3 Decommissioning

The decommissioning phase will include seabed disturbance similarly to the construction phase as vessels are required to perform decommissioning activities and components are removed from the seabed. Impacts from decommissioning will only occur where decommissioning activities are required to remove Project infrastructure. The full decommissioning plan will be provided to BOEM for approval prior to decommissioning activities.

Measures to avoid, minimize, and mitigate potential effects on site geology were considered and may be implemented, when necessary.

4.2 SHALLOW HAZARD ASSESSMENT

A shallow hazard assessment of the proposed Offshore Project Area was conducted by Fugro in 2020 and 2021 and is detailed in Appendix E, Marine Site Investigation Report, which includes Appendix E.1, Geohazard Report for Lease Area, Appendix E.2, Geohazard Report for the Brayton Point Export Cable Corridor, and E.3, Geohazard Report for the Falmouth Export Cable Corridor. Shallow hazards identified in the Lease Area and the export cable corridors are described in this section.

Technical appendices related to site geology include:

- Appendix E, Marine Site Investigation Report
- Appendix E.1, Geohazard Report for Lease Area
- Appendix E.2, Geohazard Report for the Brayton Point Export Cable Corridor
- Appendix E.3, Geohazard Report for the Falmouth Export Cable Corridor
- Appendix E.4, Geophysical Operations and Processing Report (2020 and 2021)
- Appendix E.5, (Attachment 1) Measured and Derived Geotechnical Parameters and Final Results: Mayflower Wind Geotechnical Investigation 2020
- Appendix E.5, (Attachment 2) Measured and Derived Geotechnical Parameters and Final Results: Mayflower Wind Geotechnical Investigation 2020
- Appendix E.6, Measured and Derived Geotechnical Parameters and Final Results: Mayflower Wind Geotechnical Investigation 2021
- Appendix Q, Marine Archaeological Resources Assessment

4.2.1 Lease Area Hazards Evaluation

Regulation 30 Code of Federal Regulations (CFR) § 585.626 and related documents such as the BOEM *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information* (2020a) list geohazards that should be discussed when submitting a Construction and Operations Plan (COP). The geohazards listed in **Table 4-4** are not seen within the surveyed Lease Area as detailed in Appendix E, Marine Site Investigation Report.

TABLE 4-4. GEOHAZARDS NOT ANTICIPATED TO BE PRESENT IN THE LEASE AREA

Geohazard Not Present	Comment
Shallow faults, fault zones, fault activity, sediment deformation	The Offshore Project Area is tectonically quiescent and sedimentation rate is low; no faults deemed to be a potential hazard were identified.
Gas seeps, pockmarks and/or depressions	None expected and no evidence of fluid flow was seen in the seismic data, or in the form of seabed pockmarks and/or depressions. (Dispersed shallow gas accumulation is discussed in Section 4.2.1.5).
Slump blocks, slump sediments, sliding, slope instability, submarine canyons	The Lease Area is located on the shallow continental shelf and well back from the shelf break; none of these features are expected and none have been identified in the HRG data.
Gas hydrates, ice scour, subsea permafrost layers	The Lease Area is located within in a shallow water, temperate environment and not affected by such geohazards.

Geohazard Not Present	Comment
Subsidence, settlement and displacement, liquefaction, sediment reactions	The Lease Area is located south of the Late Wisconsinan ice margin (Last Glacial Maximum). The Lease Area is located near the inferred hinge-line; therefore, isostatic adjustment related to Late Wisconsinan glaciation and deglaciation is inferred to be low and subsidence, settlement, and displacement are anticipated be low. Karst and other features related to subsidence or uplift are not anticipated to be present at the site. The Lease Area is in an area that has low seismicity and with the closest reported evidence of Quaternary age liquefaction located approximately 108 nautical miles (nm, 200 km) north. Liquefaction is not anticipated to be a significant hazard for the proposed Project.
River channels, other seabed channels, shallow water flow, karst areas	No evidence of such surface features, or past or present fluid flow, were seen. (Shallow buried channels are discussed in Section 4.2.1.3).
Mobile bedforms (megaripples and sandwaves)	The seabed reflects its low energy environment and is generally smooth and featureless. The borders of the ripple scoured depressions have the potential to evolve through time and are discussed in more detail below.
Hydraulic instability	Turbulent water flow is not anticipated to pose a hazard to the Lease Area.
Ridges, steep seabed slopes, exposed rocky areas (hardground or hard bottom), surface boulders, buried boulders	The regularity of the shallow geological structure and composition of uncemented sand and mud sediments is reflected in a uniform seabed topography and a lack of boulder deposits. Regional seabed slope is less than 1:1,000 (0.06°), or “very gentle” in the terminology of BOEM (2020a).

A geohazard within the Lease Area can be defined as any characteristic of the seabed environment that could negatively affect the location, installation and/or long-term integrity of WTGs, OSPs, and inter-array cables, if not considered and accounted for. **Table 4-5** is a comprehensive list of geohazards anticipated to be present within the Lease Area.

TABLE 4-5. POTENTIAL GEOHAZARDS ANTICIPATED TO BE PRESENT IN THE LEASE AREA

Potential Geohazard	Comment
Scarps	While no true seabed scarps are identified in the HRG data, the distinct edge of rippled scour depressions represent a typical elevation change of approximately 1.6 ft (0.5 m) over a 32.8 ft (10 m) interval.
Biogenic mounds	Two different types of biogenic mound appear to be present. This section describes the morphology and known distribution of the biogenic mounds based on available geophysical data.
Shallow buried channels	Paleochannels filled with coarse and fine-grained sediments are seen at various locations within the Lease Area. Several generations of channels (older and younger) can be seen.
Buried anomalies	Scattered buried anomalies were interpreted in seismic data. They may represent potential glacial erratics. No evidence of buried moraine or glacial tills with abundant boulders were identified.
Shallow gas accumulation	Evidence of potential shallow gas was observed in seismic data. Shallow gas appears to be related to channelized and fluvial estuarine deposits are a likely biogenic related.
Organic sediments (low	Observations of seismic data suggest that Unit 20 may contain organic

Potential Geohazard	Comment
thermal conductivity)	materials and may encroach in depths ranges for cable burial.
UXO/Discarded Military Munitions (DMM)	Mayflower Wind is commissioning an evaluation of UXO/DMM in the Offshore Project Area; this information will be provided to BOEM when the study is completed.

4.2.1.1 Scarps

There are no seabed scarps (as the term is generally used) present within the Lease Area, but the distinct seabed features often found around the edges of zones or patches of wave generated ripples is described here. Zones or patches of wave generated ripples are commonly termed as rippled scoured depressions or coarse sand zones (Goff et al., 2005).

Rippled scoured depressions are slow growing as research performed by Diesing et al. (2006) and Goff et al. (2005) have found; edges of rippled scoured depression in the North Sea and along the southern coast of Martha's Vineyard, respectively, are stable on a decadal scale. The edges of these features represent an increased potential for seabed mobility and/or scour and will be further mapped and analyzed. The results of this analysis, including avoidance and/or potential mitigation such as scour protection will be detailed in the Facility Design Report/Fabrication and Installation Report (FDR/FIR). See Section 3, Description of Proposed Activities, for scour protection methods currently under consideration.

Detailed information on rippled scoured depressions can be found Appendix E, Marine Site Investigation Report.

4.2.1.2 Biogenic Mounds

Within the Lease Area there are two types of mounded seabed texture present, including high density mounds (well developed) and low density mounds (poorly developed). High density mounds are reported to have dimensions of approximately 16 (5 m) to 33 ft (10 m) in length and up to 1.6 ft (0.5 m) in height. The low density mounds are small, widely scattered, and may or may not be associated with the same polychaete species found in association with the larger mounds. The low density mounds have dimensions of approximately 3.3 ft (1 m) to 6.6 ft (2 m) in diameter and 0.33 ft (0.1 m) to 0.66 ft (0.2 m) high.

4.2.1.3 Shallow Buried Channels

Shallow buried channels are considered to be a potential hazard due to the heterogeneous nature of the deposits that fill the channels. Buried channel features can represent locations with:

- Abrupt changes horizontally or vertically in sediment types and properties
- Soft deposits that may cause uncontrolled settlement of an installation tool, subsea structure, legs of a jack-up vessel, or impacts to cable plow stability
- Deposits with high organic content and low thermal conductivity properties
- Gravel deposits

Multiple generations of shallowly buried paleochannels were interpreted within the Lease Area. Interpreted extents and approximated depth below seabed to the base of the buried paleochannels' thalweg for these units are presented in Appendix E, Marine Site Investigation Report.

Additional details regarding buried channels within the Lease Area can be found in Appendix E and Appendix E.1.

4.2.1.4 Potential Buried Anomalies

Buried anomalies were interpreted from collected seismic data to identify potential buried obstructions, including boulders, that could pose a hazard to cable installation, substructure installation, or installation vessel legs. The majority of the identified buried anomalies are in the southern and southeastern portions of the Lease Area. The interpreted buried anomalies are vertically and spatially scattered and figures listing the amount and position of anomalies identified can be found in Appendix E.1.

A selection of the observed shallow potential buried anomalies correlates with magnetic anomalies (see Section 4.2.1.7.1), which suggests most potential buried anomalies are likely related to anthropogenic objects. Potential buried anomalies deeper below the seabed are likely related to cobbles, boulders, or other natural objects.

4.2.1.5 Shallow Gas

Gas accumulation in shallow sediments is a potential hazard within the Lease Area for construction and long-term operation. As such, geophysical data were screened for anomalies representing potential shallow gas accumulations. The anomalies were verified in vertical sections to determine characteristics associated with gas accumulations. Geophysical indicators of possible gas include:

- Occurrence within geologic trends indicative of sand-prone deposits
- Presence of structural or stratigraphic traps
- Acoustic wipeout zones or loss of frequency beneath high-amplitude anomalies
- Velocity pull up or pulldown of reflectors beneath high-amplitude anomalies
- Steep amplitude gradients at margins of high-amplitude anomalies
- Polarity response similar to or opposite that of the seabed reflector
- Polarity reversal at downdip terminations of high-amplitude anomalies
- Evidence for internal fluid contact (flat spots)

Potential evidence of shallow gas was observed in the seismic data and was restricted to channelized and fluvial-estuarine deposits, indicating it is likely biogenic. These types of low-pressure gas concentrations do not pose a significant hazard to substructure installation but attest to the presence of gas in the subsurface within the Lease Area. No interactions with gas were reported from the 2020 geotechnical investigation program.

4.2.1.6 Organic Sediments (Low Thermal Conductivity)

Sediments with increased organic content have the potential to exhibit low thermal conductivity properties and represent a potential risk of overheating of buried cables due to reducing heat flow away from the cable. One seismostratigraphic unit was interpreted to contain shallow gas accumulations likely related to decaying organic materials; this unit occurs within a few meters of the seabed within the Lease Area. Based on the vibracore samples recovered in 2020, the potential for organic sediments with low thermal conductivity present in the cabling depth of interest appears to be very low.

4.2.1.7 Anthropogenic Hazards

As discussed in the *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information* (BOEM, 2020a), information is presented below on any other man-made potential obstruction or hazard including, but not limited to; disposal sites, dumping grounds, anchorage areas, shipwrecks, etc. **Table 4-6** lists potential anthropogenic hazards within the surveyed Lease Area (Fugro, 2022).

TABLE 4-6. POTENTIAL ANTHROPOGENIC HAZARDS WITHIN THE LEASE AREA

Potential Hazard	Comment
Debris	Minor items of anthropogenic debris are scattered throughout the Lease Area. Debris items may be located by the survey as side-scan sonar contacts, multibeam bathymetry anomalies, and/or magnetometer anomalies, and or a co-referencing of these items identified by multiple sensors and representing the same actual feature. Most of the debris identified are derelict lobster traps.
Bottom fishing activity	Describes lobster trap fishing and bottom trawling; neither activity is expected to pose a hazard to the WTGs or buried inter-array cables.
Shipwrecks	See Appendix Q, Marine Archaeological Resources Assessment.
Pipelines or cables	No existing pipelines or cables were observed in the HRG data within the Lease Area.
Anchorages, dumping grounds, or disposal sites	Nautical charts revealed no marked anchorages, dumping grounds or disposal sites. No evidence of these hazards was identified in the HRG data.
UXO/DMM	Mayflower Wind is commissioning an evaluation of UXO/DMM in the Offshore Project Area; this information will be provided to BOEM when the study is completed.

4.2.1.7.1 Debris

Magnetic anomalies were identified as any signatures greater than 5 nanotesla peak-to-trough from the total field data from the 2020 and 2021 magnetometer dataset. Magnetic anomalies and sonar contacts from 2020 and 2021 were correlated when they appeared to represent the same item. There is no trend to the distribution of magnetic anomalies within the Lease Area. Most small magnetic anomalies do not correlate with seabed evidence of debris. No linear trends indicative of buried cables were observed within the Lease Area.

Seafloor contacts were identified as discrete features in the side-scan sonar or as anomalies relative to the surrounding seafloor in the multibeam bathymetry data. All seafloor contacts were classified as anthropogenic, meaning that no surficial boulders were interpreted within the Lease Area. There is no trend to the distribution of sonar contacts within the Lease Area despite a slightly higher density of contacts present within the southern half of the Lease Area. The majority of mapped contacts have been identified as lobster traps.

Magnetic anomalies and seafloor contacts can potentially indicate the presence of man-made hazards, such as debris or even unexploded ordnance (UXO), and may negatively impact the installation or maintenance of the Project. A site-specific desktop UXO risk study was performed, to help inform the extent of vessel-based UXO surveys (if required) that will be performed prior to construction. The Desk Study for Potential UXO Contamination has been submitted to BOEM as Appendix E.7. The results of geophysical surveys performed in the Lease Area and export cable corridors in 2019, 2020, and 2021 will inform this UXO risk study. The primary strategy for UXO avoidance (if UXO is identified) will be micro-routing of cables within the export cable corridors.

4.2.1.7.2 Bottom Fishing Activity

Based on seabed evidence, three forms of bottom fishing occur within the surveyed Lease Area:

- Trap fishing for lobster
- Trawling for groundfish
- Dredging for shellfish

Lobster traps are often recognizable by their rectangular shape and standard dimensions in the sidescan sonar data. Traps are constructed of steel mesh and generate a magnetic anomaly if the magnetometer array passes close by. Active and derelict lobster traps comprise all recognizable anthropogenic debris on the seabed in the Lease Area.

Based on seabed scarring, trawling takes place throughout the Lease Area as well, though scars are better preserved in the sand and muddy sand substrate areas and less evident in areas of coarse sands, which may be due to differences in penetration and/or preservation across these areas. Based on analysis of the best-defined trawl scars seen in the 2020 survey data, the maximum depth of disturbance of the otter board trawls is estimated to be no more than 0.7 ft (0.2 m) and typically less than 0.3 ft (0.1 m). No definitive seabed evidence of hydraulic dredging, as sometimes used to target species such as ocean quahog or Atlantic surf clam, was seen. Some scars within the Lease Area are due to dredging for shellfish such as scallops. A typical scallop dredge does not use pressurized water to penetrate the seabed and would have comparable maximum vertical impacts on the seabed to that seen by trawl doors. Detailed discussion and data examples of observed fishing impacts within the Lease Area can be found in Appendix E, Marine Site Investigation Report. The potential penetration by fishing gear into the seabed poses a risk to surface laid and shallowly buried cables. The maximum potential penetration into the seabed due from bottom fishing gear will be considered during the evaluation of cable burial depth of lowering to mitigate against this threat.

4.2.1.7.3 Shipwrecks

Several HRG survey targets have been identified for further consideration by the QMA and submitted to BOEM for further review and/or investigation within the Lease Area; see Section 7, Cultural Resources and Appendix Q, Marine Archaeological Resources Assessment, for additional details.

4.2.2 Export Cable Corridor Hazards Evaluation

Regulation 30 CFR § 585.626 and related documents such as BOEM *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information* (BOEM, 2020a) list geohazards that should be discussed when submitting a COP. The geohazards listed in **Table 4-7** are not identified within the surveyed Falmouth export cable corridor nor within the Brayton Point export cable corridor as described in Appendix E, Marine Site Investigation Report.

TABLE 4-7. GEOHAZARDS NOT ANTICIPATED TO BE PRESENT WITHIN THE FALMOUTH AND BRAYTON POINT EXPORT CABLE CORRIDORS

Geohazard Not Present	Comment
Shallow faults, fault zones, fault activity, sediment deformation	Area is tectonically quiescent and sedimentation rate is low; no active shallow faults are expected, and none were interpreted in the seismic data.
Gas seeps, pockmarks and/or depressions	None expected and no evidence of fluid flow seen in the seismic data or in the form of seabed pockmarks and/or depressions. Shallow buried gas has been interpreted in the Falmouth export cable corridor and is described in Section 4.2.2.9 and Appendix E.2, Geohazard Report for Brayton Point Export Cable Corridor and Appendix E.3, Geohazard Report for the Falmouth Export Cable Corridor.
Slump blocks, slump sediments, sliding, slope instability, submarine canyons	Proposed Falmouth and Brayton Point export cable corridors are on the shallow continental shelf; none of these features are expected and none are present in the data analyzed to date.
Gas hydrates, ice scour, subsea permafrost layers	Proposed Falmouth and Brayton Point export cable corridors are in a shallow water, temperate environment and not affected by such geohazards. Although ice has formed in Nantucket Sound, the Sakonnet River, and Mount Hope Bay in the past, it has been relatively thin, short lived, and not deemed to present a hazard to the planned Falmouth export cable corridor.
Subsidence, settlement and displacement, liquefaction, sediment reactions	For a cable installation, reduction of sediment strength through dynamic loading, plastic deformation, and formation collapse, etc., are not expected to be an issue.
River channels, other seabed channels, shallow water flow, karst areas	No evidence of such features or activity. While the Brayton Point export cable corridor traverses the geographic feature known as the Sakonnet River, the Sakonnet would be more accurately described as a tidal strait. Risks from current-related processes are described further in the geohazards section below.

A geohazard can be defined as any unusual characteristic of the seabed environment that could affect cable routing, installation, and/or long-term integrity if not considered and accounted for. **Table 4-8** is a comprehensive list of geohazards anticipated to be present along the Falmouth export cable corridor.

TABLE 4-8. POTENTIAL GEOHAZARDS WITHIN THE FALMOUTH AND BRAYTON POINT EXPORT CABLE CORRIDORS

Potential Geohazard	Comment
Shallow water	Encompasses the unsurveyed passage between Martha's Vineyard and Nantucket, portions of the Sakonnet River, and Mount Hope Bay.
Scarps, ridges, and steep seabed slopes	Only minor scarps and ridges with total elevation change less than a few meters are present. Sandwave flanks exhibited slopes greater than 5° and were up to 25° in some areas of the Falmouth export cable corridor. A few localized areas of "steep" slope (i.e., greater than 10°) are associated with exposed rocky areas and/or hard ground, undulating seafloor topography within Mount Hope Bay and the Sakonnet River, and from human activity such as dredging and anchoring.
Exposed rocky areas (hard	Glacial till may be considered to represent "rocky" or hardground areas due to

Potential Geohazard	Comment
bottom)	entrained cobbles and boulders. Only two areas of crystalline bedrock were identified along the Brayton Point export cable corridor but should be mitigable through routing. Rocky areas could prevent cable burial to target depth.
Mobile bedforms (megaripples and sandwaves)	Megaripples and sandwaves are present throughout the northern half of the Falmouth export cable corridor; mobile sediments pose a hazard by leading to reduction in burial protection or cable exposure over time and may present seabed slope gradients that exceed the capabilities of the cable burial equipment. No megaripples or sandwaves were seen within the Sakonnet River, nor anywhere else within the surveyed Brayton Point export cable corridor.
Biogenic mounds	Two types of biogenic mound could represent a constraint along the Falmouth export cable corridor and the Brayton Point export cable corridor.
Surface boulders	Boulder fields are present at several locations within the northern half of the Falmouth export cable corridor; scattered surface boulders and boulder fields are common in areas where the export cable corridor passes over the offshore extensions of the Buzzards Bay and Martha's Vineyard moraines. Lesser numbers of surface boulders are found within Mount Hope Bay and the Sakonnet River.
Shallow buried channels	Paleochannels filled with coarse and fine-grained sediments are seen at various locations along the Falmouth export cable corridor and the Brayton Point export cable corridor. Several generations of channels (older and younger) can be seen along both corridors.
Buried boulders and hard ground	The presence of buried boulders can be inferred from the unmigrated single channel seismic data in the northern sections of the Falmouth export cable corridor in Nantucket Sound. Based on the single channel ultra-high-resolution seismic (SUHRS) data, subsurface or buried boulders may be present in the northern and central sections of the export cable corridor.
Shallow gas accumulation	Shallow gas and blanking can be seen in the northern sections of the Falmouth export cable corridor in Nantucket Sound. Offshore, no gas is interpreted. Interpreted shallow gas has been identified by survey within Mount Hope Bay and Sakonnet River between KP 0 and KP 27.
Sediments with low thermal conductivity	Fine-grained deposits with variable organic content were encountered at limited locations by vibracores along the Falmouth export cable corridor. Fine-grained deposits that contained organic material were also found in several vibracores within Mount Hope Bay and Sakonnet River. Such types of sediments may have low thermal conductivity properties and lead to reduced power transmission or overheating of cables
UXO/DMM	Mayflower Wind is commissioning an evaluation of UXO/DMM in the Offshore Project Area; this information will be provided to BOEM when the study is completed.

4.2.2.1 Shallow Water

The Falmouth export cable corridor passes through a zone of shallow water in the area of Muskeget Channel, which was surveyed for water depth using LiDAR ahead of a more detailed vessel-based survey in 2021 campaign on the defined Falmouth export cable corridor. Areas of very shallow water represent a challenge to the operation of the large vessels typically required to install and bury the export cable. In areas of shallow water, large, shifting bedforms also become risks to cable installation and long-term integrity of the installed cable.

Areas of shallow water were identified and mapped along the Brayton Point export cable corridor, especially within the Sakonnet River and Mount Hope Bay, however these areas did not exhibit the large, shifting bedforms that were observed along portions of the Falmouth export cable corridor.

The location and details regarding these features along the Falmouth export cable corridor are described where covered by survey in the Appendix E, Marine Site Investigation Report.

4.2.2.2 Scarps, Ridges, and Steep Seabed Slope Areas

There were no real scarps or ridges within the Falmouth export cable corridor. Seabed slope gradient was evaluated using multibeam data. Seabed slope gradient was calculated using multibeam data binned at a 9.8 ft (3 m) cell size. Areas with steepest seabed slope gradients are associated with flanks of sandwaves and megaripple bedforms. Flanks of sandwaves and megaripples are typically between 9° and 14°, but in some areas, they appear to be up to approximately 25° as a result of exceptionally high sandwave formations.

Steep slopes and abrupt changes in the seabed increase the risk of stability issues for cable burial tools and may also negatively impact performance of cable burial tools. Mapping of these features will allow for micrositing to optimize route avoidance. Additionally, evaluation of cable installation tools and equipment will ensure seabed slopes and abrupt changes in elevation can be tolerated by the planned equipment and methodologies. Preliminary micrositing and cable installation tool evaluation, informed by processed survey data and ground model development, will be performed by the Project in conjunction with the cable installation contractor prior to the FDR/FIR submission. Cable installation tools under consideration are summarized in Section 3, Description of Proposed Activities.

The features along the Brayton Point export cable corridor were less pronounced relative to those observed along the Falmouth export cable corridor. The most severe areas have been avoided by cable route siting designed to avoid the area between the Stone Bridge and Railroad Bridge known to have significant bathymetry relief. Most areas of steeper seabed were isolated to the flanks of sand veneers or ripple scoured depressions, where localized seabed slopes may increase 12° to 15° over distances of 6.5 ft to 16.4 ft (2.0 m to 5.0 m).

The location and details regarding these features along the export cable corridors are described in the Appendix E, Marine Site Investigation Report.

4.2.2.3 Hard Bottom

Glacial till may be expected at or beneath the seabed within the interval relevant to cable burial, from the cable landfall to approximately KP 12 within the Falmouth export cable corridor. Exposed harder soils and coarse-grained materials are likely to be encountered in the shallow-water areas between Martha’s Vineyard and Nantucket along the Falmouth export cable corridor and may correspond to areas of scoured seabed. The presence of hard bottom at or just below the seabed can be inferred from seabed irregularity and the presence of boulders. Ongoing survey and analysis will better map these areas and evaluate the potential hazard.

Seabed scour may expose shallowly buried hardgrounds or may winnow fine sediment leaving coarse sediment, cobble, and boulders. Hard seabed can pose a risk to achieving targeted cable depths of lowering, if not properly considered during route siting and cable burial planning and tool selection.

Along the Brayton Point export cable corridor, areas of shallowly buried bedrock were mapped from the seismic data. In southern Mount Hope Bay, between KP 8 and KP 10, the top of bedrock was less than 6.6 ft (2 m) below the seafloor. However, what was mapped as shallow buried bedrock in this area could also correspond to shallow buried glacial till, as the two were difficult to distinguish in some areas. Some areas within the Sakonnet River also displayed shallow buried bedrock, such as between KP 28 and KP 32 where the top of bedrock rose to within 6.6 ft (2 m) of the seafloor and at KP 66 and KP 71, bedrock was interpreted to be within 16.4 ft (5 m) of the seafloor. In addition to the bedrock outcrops described above, several areas of outcropping or subcropping glacial till were identified along the Brayton Point export cable corridor, and are described in detail within Appendix E.2, Geohazard Report for the Brayton Point Export Cable Corridor.

The location and details regarding these features along the Falmouth export cable corridor and the Brayton Point export cable corridor are described in the Appendix E, Marine Site Investigation Report.

4.2.2.4 Mobile Bedforms and Seabed Scour

The Falmouth export cable corridor lies within two distinctly different hydrodynamic environments. KP 0 to KP 47 falls within Nantucket Sound and Muskeget Channel areas. This area experiences strong ebb and flood tidal currents that amplify between Martha's Vineyard and Nantucket Islands. From KP 47 to the Lease Area, the Falmouth export cable corridor lies on the open continental shelf where hydrodynamic conditions are considered to be storm dominated with weaker bottom currents driven by waves and circulation.

Mobile bedforms can result in a change in depth of cover of cable burial protection or may potentially lead to exposure of cables on the seabed after installation, which can be mitigated through avoidance or minimization of these areas through micrositing cables within the export cable corridor, increasing depth of lowering to mitigate impacts of scour and mobility, and potentially the application of external protection. Changing seabed also creates a risk of differing conditions between survey and installation, and could result in the exposure of shallowly buried hardgrounds, creating a challenge to proper installation planning. Mapping of these features will allow avoidance and further analysis of the potential for seabed, mobility, scour and associated mitigation measures will be based on these findings. This mapping will feed into ongoing development of engineering scopes around sediment mobility within the export cable corridors. Future surveys and studies (combined with data from existing surveys and studies) will allow for quantitative measurements of seabed mobility to be made.

As detailed in Appendix E.1 and Appendix E.3, seabed mobility within the Lease Area and at the offshore end of the Falmouth export cable corridor occurs less than 2 percent of the time. The northern portion of the Falmouth export cable corridor experiences seabed mobility more than 54 percent of the time in Muskeget Channel and 18 percent in Nantucket Sound. Bedforms and morphology inshore of approximately KP 47 are characterized by sandwaves, megaripples, and a prominent ebb/flood tidal delta complex in Muskeget Channel. Megaripples and sandwaves are found only in the northern portion of the Falmouth export cable corridor within Nantucket Sound and are the product of tidal currents.

Bedform migration detection is variable within the Falmouth export cable corridor. The maximum sandwave height within the surveyed Falmouth export cable corridor is estimated at approximately 27 ft (8.1 m) in the Muskeget Channel area. The maximum slope associated with the sandwaves is 25°. Additional details can be found in Appendix E.3.

There were no megaripples or sandwaves within the Brayton Point export cable corridor. Only smaller-scale bedforms such as ripples, sand ribbons and lineations were identified. There were no existing seabed features identified within the survey data that would suggest that scour may be a problem for the Project. Within the Sakonnet River, areas such as the Stone Bridge and Railroad Bridge, which locally intensify currents and enhance seabed mobility and scour, were avoided by the siting of the Brayton Point export cable corridor.

4.2.2.5 Biogenic Mounds

Two zones in the northern portion of the Falmouth export cable corridor, between KP 15 and KP 16 and KP 26 and KP 27, appear to have positive relief due to an armoring effect against erosion by a veneer of dead and living *Crepidula fornicata* or slipper limpet shells. A series of sediment profile imaging (SPI) photographs taken near KP 26.5 reveal a one shell thick sheet overlying a muddy, fine-grained sediment. The mounds are typically 3.3 ft (1 m) high relative to the surrounding seabed.

Possible biogenic mounds between KP 52 and KP 56 are associated with polychaete worms as opposed to shells, measure less than 1.6 ft (0.5 m) high, and not expected to represent a geohazard. Another zone of smaller, more widely scattered poorly developed low-density mounds that eventually grade into a pitted seabed is located between KP 75 and KP 85. The pits or depressions have an irregular edge, are 16.4 to 32.8 ft (5 to 10 m) in size but only 0.33 to 0.66 ft (0.1 to 0.2 m) deep. Based on SPI/Plan View (PV) imagery, this seabed style could be a product of both biotic and erosional factors. These mounds are not expected to constrain or present any risk to the cables but are mentioned for the sake of completeness and to forestall any misinterpretation as boulders. Additional information on biogenic mounds within the Falmouth export cable corridor can be found in Appendix E and Appendix E.3.

Along the Brayton Point export cable corridor several benthic sample stations located in southern Mount Hope Bay and along the northern to central Sakonnet River revealed a “shell-dominated” substrate that includes either living or dead slipper (*Crepidula fornicata*) shells in a muddy matrix, though the shell-dominated substrate did not generally exhibit a distinctive geophysical signature or clear textural boundary. Some regions along the eastern shoreline of the Sakonnet River are classified as “hummocky”, which, based on their morphology, could correspond to a *Crepidula* veneer, but those areas were not sampled during the benthic campaign. Similar biogenic mounds associated with polychaete worms as identified along the Falmouth export cable corridor were also identified along the Brayton Point export cable corridor, primarily between KP 104 and KP 110, and KP 130 and KP 135, albeit not as well developed, generally appearing more as a hummocky seafloor texture than well-defined, individual features. Comparison between multiple seasons of survey indicated that these features may be transient in nature and may appear or degrade on yearly timescales.

The location and details regarding these features along the Falmouth export cable corridor and the Brayton Point export cable corridor are described where covered by survey in the Appendix E, Marine Site Investigation Report.

4.2.2.6 Surface Boulders

The Falmouth export cable corridor will interact with the offshore extension of two onshore-recognized terminal moraine systems:

- The Martha's Vineyard/Nantucket moraine, a relatively broad deposit which marks the maximum extent of the Laurentide ice sheet, deposited from approximately 60,000 to 25,000 years before present
- The Buzzards Bay moraine, deposited during a temporary equilibrium stage in the retreat of the Laurentide ice sheet, between approximately 18,000 and 12,000 years ago

Surface and subsurface boulders may be expected within the passage between Martha's Vineyard and Nantucket, and along the cable section between KP 10 and the Falmouth landfall. No boulders are expected south of the passage, and none were seen in the 2020 survey data from KP 47 onwards.

Surficial and buried boulders pose a potential risk of destabilizing or damaging cable burial tools and/or limiting the performance of the burial tools, if not adequately considered in the cable burial tool selection and burial program design. Detailed mapping will allow avoidance and reduction of the risk through micrositing cables within the export cable corridor, and selection of suitable burial methodology, potentially including seafloor preparation or boulder clearance, can further mitigate this risk. Preliminary micrositing and cable installation tool evaluation, informed by processed survey data and ground model development, will be performed by the Project in conjunction with the cable installation contractor prior to the FDR/FIR submission. Cable installation tools under consideration are summarized in Section 3, Description of Proposed Activities.

Low density boulder fields comprise scattered, large boulders within a sandy substrate. This occurs between KP 23 and KP 25 where the seabed sediments are mobile. Occurrences of smaller additional boulders may be buried beneath the seabed in these areas. High density boulder fields are found in areas where the glacial till or moraine deposits are undergoing erosion. High density boulder fields are found in the vicinity of KP 3 and in the area from KP 4 to KP 11. The distribution of surface boulders along the extent of the Falmouth export cable corridor can be found in Appendix E, Marine Site Investigation Report. No clearly isolated boulders or erratics have been mapped along the Falmouth export cable corridor.

The Brayton Point export cable corridor crosses the mapped offshore extension of the Buzzards Bay moraine at approximately KP 50 to KP 60 and the Martha's Vineyard moraine at approximately KP 76 to KP 85, along with an un-named moraine nearer the mouth of the Sakonnet River between KP 35 and KP 40. Boulder distribution varied greatly near and within these ranges and have been mapped and presented in detail for the Brayton Point export cable corridor within the Appendix E, Marine Site Investigation Report.

The location and details regarding these features along the Falmouth export cable corridor are described where covered by survey in the Appendix E, Marine Site Investigation Report.

4.2.2.7 Shallow Buried Channels

Along the Falmouth export cable corridor, paleochannels containing late Pleistocene and Holocene fluvio-estuarine deposits are interpreted to contain both coarse and fine-grained deposits. As sea level rose and seas transgressed further inland, these paleochannels were subsequently flooded. These buried channels are a potential hazard due to the heterogeneous nature of the deposits. Buried channel features may represent locations with:

- Abrupt changes horizontally or vertically in sediment types and properties,

- Soft deposits that may cause uncontrolled settlement of an installation tool,
- Deposits with high organic content and low thermal conductivity properties, and
- Gravel deposits.

Encountering abrupt lateral and vertical changes in soils can cause stability issues to cable installation tools and increase the risk of decreased performance of cable burial equipment. These risks can be reduced through micrositing cables within the export cable corridor to avoid these features where possible. These risks can be further mitigated through proper planning and selection of cable burial tools and methodologies capable of tolerating the identified conditions. Preliminary micrositing and cable installation tool evaluation, informed by processed survey data and ground model development, will be performed by the Project in conjunction with the cable installation contractor prior to the FDR/FIR submission. Cable installation tools under consideration are summarized in Section 3, Description of Proposed Activities.

Multiple generations of buried paleochannels were interpreted along the Falmouth export cable corridor. The units containing these features along the Falmouth export cable corridor can be found in Appendix E, Marine Site Investigation Report.

More information regarding the units containing shallow buried channels can be found in Appendix E.3.

The location and details regarding these features along the export cable corridors are described in the Appendix E.2 and Appendix E.3.

4.2.2.8 Potential Buried Boulders and Hard Ground Conditions

Buried anomalies were interpreted from collected seismic data. Point diffractions were interpreted from non-migrated Single Channel Ultra-High-Resolution Seismic (SUHRS) and Sub-bottom Profiler (SBP) data and are inferred to represent potentially buried boulder or cobbles. Other subsurface features may also be the source of the diffractions. Buried anomalies coincide with glacial moraine/drift deposits exposed on the seabed or shallowly buried at the northern Falmouth export cable corridor within Nantucket Sound.

Potential buried boulders and buried hardgrounds represent a similar risk can cause stability issues to cable installation tools and increase the risk of decreased performance of cable burial equipment. These risks can be reduced through micrositing cables within the export cable corridor to avoid these features where possible. These risks can be further mitigated through proper planning and selection of cable burial tools and methodologies capable of tolerating the identified conditions. Preliminary micrositing and cable installation tool evaluation, informed by processed survey data and ground model development, will be performed by the Project in conjunction with the cable installation contractor prior to the FDR/FIR submission. Cable installation tools under consideration are summarized in Section 3, Description of Proposed Activities.

Buried boulders and buried hardgrounds are anticipated to underly portions of the Brayton Point export cable corridor; however, the nature and location of these features are difficult to predict without Project-specific sub-bottom data.

The location and details regarding these features along the Falmouth export cable corridor and the Brayton Point export cable corridor are described where covered by survey in the Appendix E, Marine Site Investigation Report.

4.2.2.9 Shallow Gas

Biogenic gas was interpreted in the northern portion of the Falmouth export cable corridor. Between KP 14 and KP 17, a widespread gas zone severely impedes the interpretation of seismic data in that area. Two vibracores in the gas zone encountered clay and organic materials at the surface which support the interpretation that the gas may be biogenically related. Between KP 19 and KP 21, smaller gas zones obscured seismic interpretations.

One area between KP 26 and KP 27 correspond to the *Crepidula* veneer overlying anoxic mud. SPI images reveal methane bubbles within the sediment just below the seabed (Appendix M, Benthic and Shellfish Resources Characterization Report). A vibracore penetrated the *Crepidula* veneer and logged a 3.3 to 6.6 ft (1 to 2 m) thick surface layer of clayey and silty sand. The biogenic gas is not anticipated to present any hazard to cable installation but signals a change in the properties of the seabed sediments.

Along the Brayton Point export cable corridor, within Mount Hope Bay and the Sakonnet River, shallow gas was widespread from KP 0 to KP 27, as interpreted from blanking within the seismic data. Geoarcheaological and geotechnical cores were located within mapped shallow gas zones and their vibracore and CPT logs showed the presence of organic clays, silts, as well as fine sands containing organic material that causes biogenic gas to accumulate.

The location and details regarding these features along the export cable corridors are described where covered by survey in the Appendix E, Marine Site Investigation Report.

4.2.2.10 Organic Sediments (Low Thermal Conductivity)

Sediments with variable amounts of organic material were encountered by vibracores in localized areas of the Falmouth export cable corridor. Sediments with organic content may exhibit low thermal conductivity properties as discussed in Section 4.2.1.6.

Where adequately mapped, the organic rich soils may be avoidable. In any case, cable design will account for the thermal properties of the soils identified along the export cable during the detail design phase of the Project.

The location and details regarding organic-rich soils along the Falmouth export cable corridor and the Brayton Point export cable corridor are described where covered by survey in the Appendix E, Marine Site Investigation Report.

4.2.2.11 Shallow Deformation (Faults and Folds)

No subsurface faults or deformation were interpreted at depths of potential cable impact in either the Falmouth or Brayton Point export cable corridors. Faulting and deformation are not anticipated to pose a hazard within the export cable corridors.

These features are also not anticipated to present a hazard along the Brayton Point export cable corridor. Further information on these features was obtained in the geophysical and geotechnical surveys completed in 2021 with results detailed in Appendix E, MSIR.

4.2.2.12 Anthropogenic Hazards

As requested in BOEM *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information* (BOEM, 2020a), other man-made potential obstructions or hazards were also identified, including, but not limited to; disposal sites, dumping grounds, anchorage areas, shipwrecks, etc. **Table 4-9** lists potential anthropogenic hazards within the surveyed export cable corridors.

TABLE 4-9. POTENTIAL ANTHROPOGENIC HAZARDS ALONG THE FALMOUTH AND BRAYTON POINT EXPORT CABLE CORRIDORS

Potential Geohazard	Comment
Existing and planned cables and pipelines	The proposed Falmouth export cable corridor crosses three existing cables (probably out-of-service telecommunications cables) and, as far as is known at the time of this report, one planned cable (proposed Vineyard Wind export cable[s]). The Brayton Point export cable corridor will cross three identified existing cables and three pipelines, as described in Section 4.2.2.12.1.
Shipwrecks	See Appendix E, Marine Site Investigation Report and Appendix Q, Marine Archaeological Resources Assessment.
Debris	See Appendix E, Marine Site Investigation Report and Appendix Q, Marine Archaeological Resources Assessment.
Bottom fishing activity	Describes lobster trap fishing, bottom trawling, and shellfish dredging – these activities are not expected to pose a hazard to a sufficiently buried cable.
Anchorages, dumping grounds, or disposal sites	Nautical charts do not identify marked anchorages, dumping grounds, or disposal sites
Dredged Channels	Dredged channels are not charted nor identified within the Falmouth export cable corridor. Dredged and maintained federally authorized navigation channels are charted within Mount Hope Bay.
UXO/DMM	Mayflower Wind is commissioning an evaluation of UXO/DMM in the Offshore Project Area; this information will be provided to BOEM when the study is completed.

Additional information on potential historical significance of seafloor contacts or avoidance distances for marine archaeological purposes can be found in Section 7.1 Marine Archaeology and Appendix Q.

4.2.2.12.1 Existing and Planned Cables and Pipelines

Two surface-laid power cables are mapped near KP 4 and approaching the Shore Street landfall option. The cables are parallel to one another and run from mainland Massachusetts to Martha's Vineyard at Oak Bluffs. The proposed Falmouth export cable corridor overlaps with these cables. Crossing of these cables will be avoided to the extent practicable, however crossing may be required if the Shore Street landfall option in Falmouth is selected.

Three unidentified cable-like features were mapped between KP 47 and KP 49, these cables are not marked on the nautical charts or recorded within any global cable database.

The Brayton Point export cable corridor crosses three cables within Mount Hope Bay and are parallel to and just north of the Mount Hope Bridge. The three cables were exposed within the deep, central part of the bay but were buried as they approached the shoreline near KP 10.4 to KP 10.5. Concrete mattresses were used to stabilize the cables in some places in this location. Three pipelines crossed the Sakonnet River within two charted Pipeline Areas; all pipelines were buried and their position was mapped from the magnetic data. The northern charted Pipeline Areas in the Sakonnet River between Sandy Point and High Hill Point contained two buried water mains, while the other Pipeline Area just south of Black Point contained one identified gas pipeline.

Future planned cables and pipelines along the export cable corridors will be tracked by the Project for deconfliction and crossing design, as appropriate. Section 14, Other Marine Uses, discusses known existing and planned subsea assets in more detail.

4.2.2.12.2 Shipwrecks

Debris fields within the export cable corridors may be representative of shipwrecks. Additional information regarding shipwrecks along the export cable corridors can be found in Section 7, Cultural Resources and Appendix Q.

4.2.2.12.3 Debris

Magnetic anomalies were identified as any signatures greater than 5 nanotesla peak-to-trough from the total field data of the 2020 and 2021 magnetometer dataset. Seafloor contacts were identified as discrete features in the side-scan sonar or as anomalies relative to the surrounding seafloor in the multibeam bathymetry data. Magnetic anomalies and sonar contacts are correlated when they appear to represent the same item (see Section 7, Cultural Resources, Appendix E, and Appendix Q, for additional information).

Along the Falmouth export cable corridor, high anomaly-densities between KP 7 and KP 16 correspond with the main shipping channel through Nantucket Sound used by local vessels accessing fishing grounds on Georges Bank. Magnetic anomalies related to the fishing industry are likely to represent assorted items of minor ferrous debris. The majority of small magnetic anomalies cannot be correlated with any seafloor debris identified by the side-scan sonar survey. It is likely that minor items of debris can be rapidly buried in areas of mobile sediments. Larger anomalies can be correlated with apparent shipwrecks or other anthropogenic debris. Boulders and boulder fields within the mapped glacial till and boulder zones of the Falmouth export cable corridor can generate a magnetic signature. This is a result of geologic units present in the boulders, cobbles, and gravel having a degree of magnetic susceptibility.

Due to the long history of anthropogenic uses along the Brayton Point export cable corridor within Mount Hope Bay, the Sakonnet River, and Rhode Island Sound, as well as the occurrence of natural features capable of generating magnetic anomalies, such as surface and buried boulders, numerous magnetic anomalies were detected by the 2020 and 2021 survey campaigns. Further information can be found in Appendix E, MSIR.

Seafloor contacts were classified as either anthropogenic debris or isolated boulders (Appendix E.1). Large anomalies can be correlated with shipwrecks or other anthropogenic debris. Within the southern portion of the Falmouth export cable corridor, all sonar contacts are assumed to be anthropogenic debris and can be recognized as lobster traps. Mapped traps may no longer be present and new traps may be placed by the time of cable installation.

The location and details regarding seafloor contacts and magnetic anomalies along the Falmouth export cable corridor and the Brayton Point export cable corridor are described where covered by survey in the Appendix E, Marine Site Investigation Report.

To date, regional UXO risk analysis has been performed by Mayflower Wind as part of various desktop studies, in order to avoid known and designated UXO sites in siting the Project components. A site-specific desktop UXO risk study will be performed by the Project prior to the FDR/FIR submission, in order to inform the extent of vessel-based UXO surveys (if required) that will be performed prior to construction. The results of geophysical surveys performed in the Lease Area and export cable corridors in 2019, 2020, and 2021 will inform this UXO risk study. The primary strategy for UXO avoidance (if UXO is identified) will be micro-routing of cables within the export cable corridors.

4.2.2.12.4 Bottom Fishing Activity

Seafloor evidence shows two forms of bottom fishing occurring within the surveyed Falmouth export cable corridor, trap fishing for lobsters and potentially crabs and trawling for groundfish and potentially scallops. No seabed evidence of hydraulic dredging was identified along the Falmouth export cable corridor.

Based on seafloor evidence, three forms of bottom fishing take place within the Brayton Point export cable corridor: trap fishing for lobster, crabs, and whelks; dredging for shellfish such as scallops and quahogs; and trawling, likely for groundfish and squid.

Lobster traps are constructed from steel mesh and generate a magnetic anomaly if present near a magnetometer array. Active and derelict lobster traps comprise nearly all anthropogenic debris on the seafloor within the Falmouth export cable corridor. Smaller, square contacts in the nearshore region may represent crab traps. Trap fishing is not expected to pose a hazard to an adequately buried cable.

Based on seabed scarring, trawling takes place throughout the Lease Area as well, though scars are better preserved in the sand and muddy sand substrate areas and less evident in areas of coarse sands, which may be due to differences in penetration and/or preservation across these areas. Based on scars visible along the southern extent of the Falmouth export cable corridor and analysis of the best-defined trawl scars seen in the 2020 survey data, the maximum depth of disturbance of the otter board trawls is estimated to be no more than 0.7 ft (0.2 m) and typically less than 0.3 ft (0.1 m). Trawling for groundfish may be expected along most of the length of the Brayton Point export cable corridor, except for areas of seafloor boulders, as indicated by heavily scared areas of seabed in parts of Mount Hope Bay and the Sakonnet River.

No definitive seabed evidence of hydraulic dredging, as sometimes used to target species such as ocean quahog or Atlantic surf clam, was reported in the Appendix E, Marine Site Investigation Report along the survey data available along the Falmouth export cable corridor.

Some scars within the northern portion of the Falmouth export cable corridor are due to dredging for shellfish such as scallops. A typical scallop dredge does not use pressurized water to penetrate the seabed and would have comparable maximum vertical impacts on the seabed to that seen by trawl doors. Detailed discussion and data examples of observed fishing impacts within the Falmouth export cable corridor can be found in Appendix E, Marine Site Investigation Report.

An unusual pattern of circular seabed scarring at the northern end of Mount Hope Bay along the Brayton Point export cable corridor was observed and is believed to be caused by use of a rocking chair dredge to target hard clams or quahogs. The scars were approximately 3 ft (1 m) wide. Their depth was not measurable, but the rocking chair dredge appears to be a heavy device and could potentially penetrate up to 1.6 ft (0.5 m) into the soft sediments of northern Mount Hope Bay.

The potential penetration by fishing gear into the seabed poses a risk to surface laid and shallowly buried cables. The maximum potential penetration into the seabed due from bottom fishing gear will be considered during the evaluation of cable burial depth of lowering to mitigate against this threat.

The location and details regarding seafloor evidence of fishing activity along the Falmouth export cable corridor and Brayton Point export cable corridor are described in detail where covered by survey in Appendix E, Marine Site Investigation Report.

4.3 PHYSICAL OCEANOGRAPHY AND METEOROLOGY

This section describes the physical oceanography and meteorological conditions present within the Lease Area and along the export cable corridors. Data discussed will include observed and modeled data on meteorological and oceanic conditions.

Data collected from Mayflower Wind's metocean buoy was also integrated into this assessment along with information from existing literature. In addition, a preliminary evaluation of oceanographic and meteorological conditions prepared for Mayflower Wind was used.

Technical appendices related to physical oceanography include:

- Appendix F1, Sediment Plume Impacts from Construction Activities, which includes modeling of hydrodynamic conditions related to sediment dispersion
- Appendix F2, Scour Potential Impacts from Operational Phase and Post-Construction Infrastructure, which includes modeling of hydrodynamic conditions related to scour
- Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment
- Appendix E, Marine Site Investigation Report

4.3.1 Affected Environment

4.3.1.1 Oceanographic Conditions

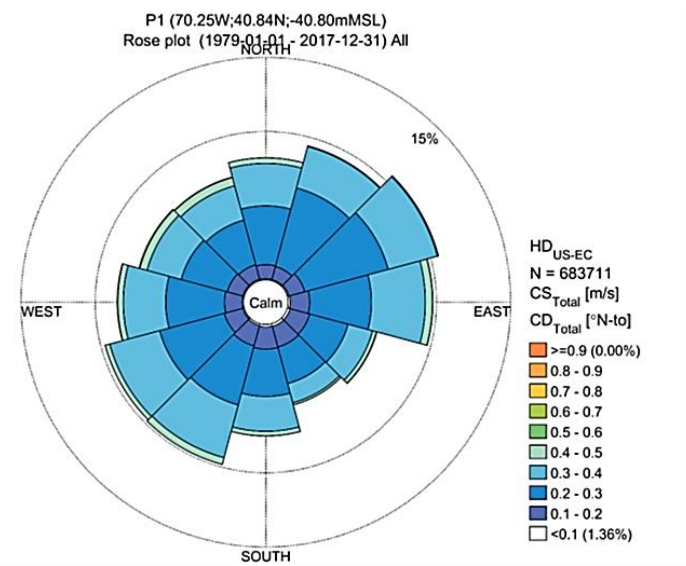
Water depths, in relation to MLLW, within the Lease Area range from 121.7 ft (37.1 m) to 208.3 ft (63.5 m), with deeper waters in the southwestern portion. The average depth is 164.0 ft (50.0 m). The WTG/OSP positioned at AQ35, located at latitude 40.602469 and longitude -70.51783, will be the deepest position in the Lease Area, placed at a depth of 206.7 ft (63.1 m). A bathymetric map is included in **Figure 4-1**.

The Falmouth export cable corridor lies within two distinctly different hydrodynamic regimes. The Lease Area and the Falmouth export cable corridor south of Muskeget Channel lie on the open continental shelf where conditions are storm dominated with weaker bottom currents driven by waves and circulation. In contrast, the northern Falmouth export cable corridor segment running through Muskeget Channel and Nantucket Sound is subjected to strong ebb and flood tidal currents that amplify in Muskeget Channel between Martha's Vineyard and Nantucket islands.

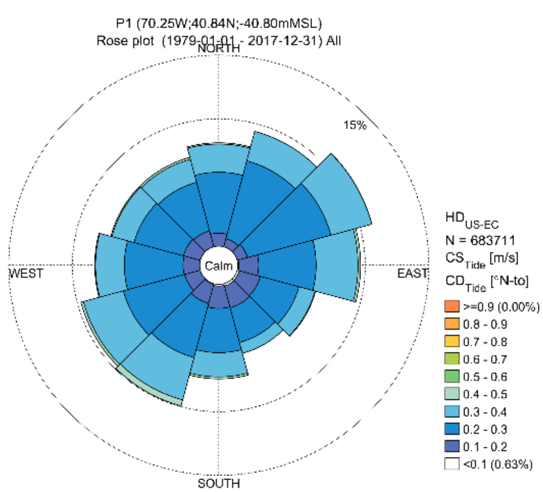
Similarly, the Brayton Point export cable corridor lies within two distinctly different hydrodynamic regimes, including the open continental shelf detailed above, as well as river/estuarine setting, within Narragansett Bay, in which the northern portion of the Brayton Point export cable corridor is located. Narragansett Bay is also subject to ebb and flood tidal currents.

The tide is semi-diurnal in the Offshore Project Area, with a tidal range of approximately two to three ft (0.6 to 0.9 m) in Nantucket Sound. Tidal currents are highest in Muskeget Channel as Nantucket Sound flows into the Atlantic Ocean, with speeds exceeding 3.5 nautical miles per hour (knots, 6.5 kilometers per hour; BOEM, 2018).

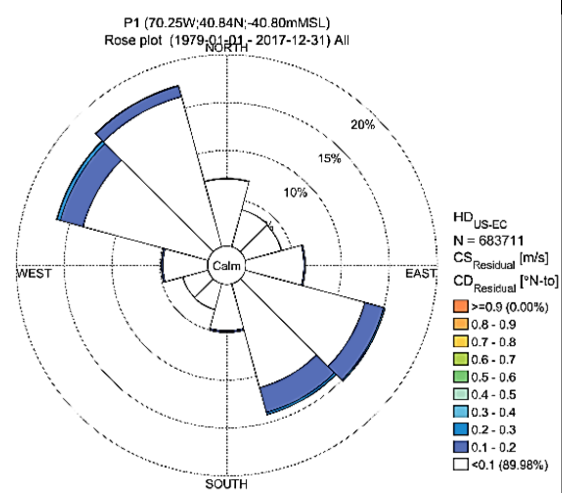
Rose plots showing model-estimated depth-averaged current direction and speeds in the Lease Area are depicted in **Figure 4-7.** The direction is indicated by the position of the shaded "spokes" on the compass rose. The percentage of time flow is from the spoke direction and is indicated by the concentric circles. The magnitude is indicated by colors. Depth-averaged currents are tidally dominated with residual components mainly aligned in the north-western and south-easterly directions.



A. Rose Plot of the Total Depth-Averaged Current Speed (Given as coming from °N)



B. Tidal Component



C. Residual (Non-tidal) Component

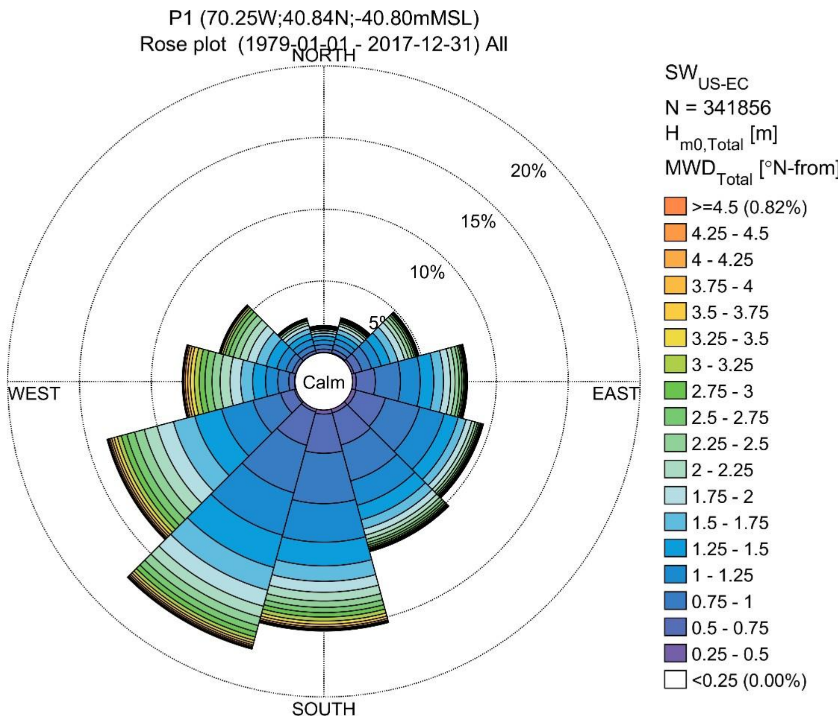
Figure A depicts the total depth averaged current speed; Figure B depicts the tidal component of the total; Figure C depicts the residual, or non-tidal component of the total.

Source: SDHI, 2020

FIGURE 4-7. ROSE PLOTS DEPICTING MODEL-ESTIMATED DEPTH-AVERAGED CURRENTS—ESTIMATED DIRECTION AND SPEED

4.3.1.2 Swells

Swells are typically generated from hurricanes or tropical storm low-pressure systems occurring in the southern part of the Atlantic Ocean (Gleen, 1992). Swells in the Lease Area occur mainly from the south and southwesterly directions. In **Figure 4-8** the total estimated sea swell in the Lease Area was visualized on a rose-plot using data spanning 1979 to 2017.



Source: DHI, 2020

FIGURE 4-8. ROSE-PLOT OF SWELL HEIGHT ACCORDING TO MEAN WAVE DIRECTION

4.3.1.3 Sediment Mobility

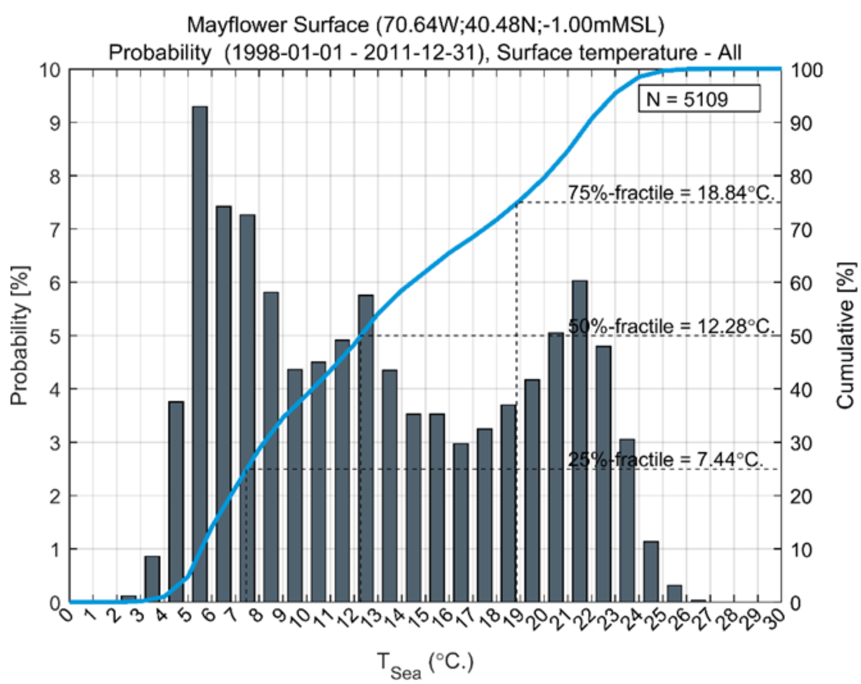
A high-resolution, site-specific wave and current model was developed to simulate the metocean conditions over the Lease Area and Falmouth export cable corridor. The model was verified and validated against site-specific measurements and then applied to evaluate sediment mobility, scour potential, and sediment plume dispersion from trenching and dredging activities. The hydrodynamic model and sediment plume dispersion evaluation are described in Appendix F1, Sediment Plume Impacts from Construction Activities. The evaluation of scour potential is presented in Appendix F2, Scour Potential Impacts from Operational Phase Post-Construction Infrastructure. Results of a hydrodynamic and sediment model analysis simulating metocean conditions over the Brayton Point export cable corridor are presented in Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment.

The analysis of sediment mobility potential revealed a very limited potential for sediment transport in the Lease Area and southern part of the export cable corridors. In the Lease Area, modeled results show conditions producing an active seabed occur less than two percent of the time. Clear water conditions prevail overwhelmingly over live bed conditions.

By contrast, a very dynamic condition is indicated for some of the shallower areas along the Falmouth export cable corridor especially in the vicinity of Muskeget Channel and the Vineyard Sound. This northern, shallower part of the Falmouth export cable corridor has higher active seabed mobility, with high bed shear stresses. The presence of sand waves also indicates a highly mobile seabed. More dynamic conditions are anticipated along the shallower areas of the Brayton Point export cable route within the Sakonnet River and parts of Mount Hope Bay. However, the most dynamic areas are associated with constrictions to flow within the Sakonnet River and are largely avoided due to cable routing across Aquidneck Island rather than through the northernmost Sakonnet River.

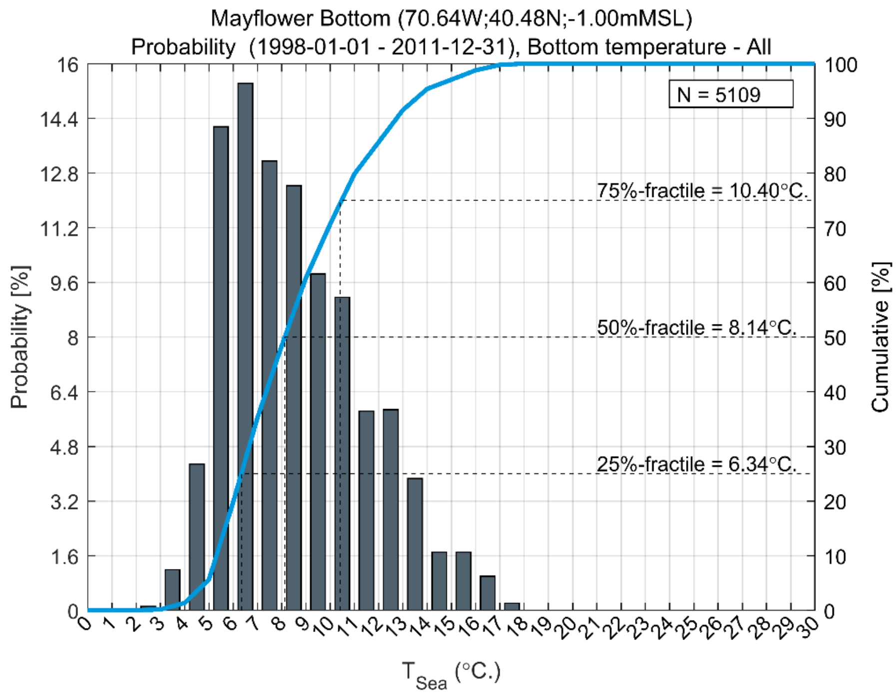
4.3.1.4 Water Temperature

Water temperatures across the Lease Area display large variations near the surface from 35.6° to 80.6° Fahrenheit (F) (2° to 27° Celsius [C]) with a 50 percentile of 54.1°F (12.3°C). Closer to the seafloor at water depths of 196.9 ft (60 m), water temperatures range from 35.6°F to 64.4°F (2°C to 18°C) with a 50 percentile of 46.4°F (8°C). **Figure 4-9** shows the distribution of water temperature on the sea surface, and **Figure 4-10** shows the distribution of water temperature near the seafloor for the Lease Area.



Source: DHI, 2020

FIGURE 4-9. SEA SURFACE WATER TEMPERATURE IN THE LEASE AREA



Source: DHI, 2020

FIGURE 4-10. SEAFLOOR WATER TEMPERATURE IN THE LEASE AREA

4.3.1.5 Meteorological Conditions

4.3.1.5.1 Wind

The predominant wind direction in the Offshore Project Area is from the west-southwest, as depicted in the wind rose chart in **Figure 4-11**. Wind direction and speeds can change dramatically during "Nor'easter" storms, when the wind direction is from the north-northeast.

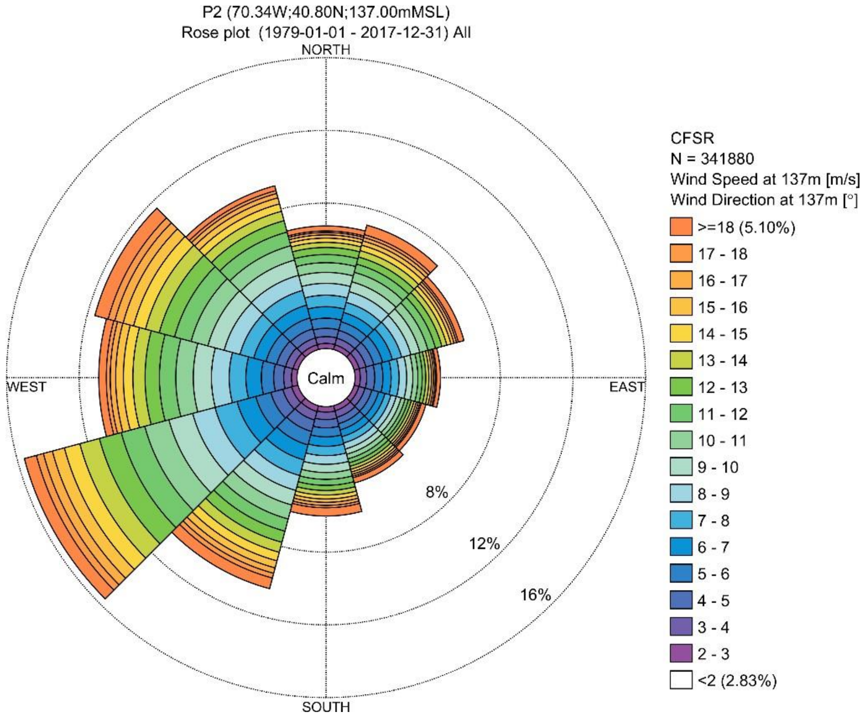


FIGURE 4-11. LEASE AREA WIND ROSE BASED ON 39 YEARS OF DATA FROM 1979 TO 2017 (DHI, 2020)

4.3.1.5.2 Storms

The Lease Area location is prone to hurricanes and extra-tropical storms. The two main types of synoptic scale storm events that occur along the U.S. East Coast are hurricanes or tropical storms and Nor'easters. These storm events control the extreme wind and wave conditions present within the Lease Area.

Hurricanes and tropical storms are warm-core low-pressure systems which form over warm water, typically between June and November. Rising warm air in the core of a hurricane cools and condenses, releasing latent heat and fueling the system (NOAA, 2018). Nor'easters are cold-core low-pressure systems which are typically larger and slower moving events than hurricanes. They can typically occur from November to April and have a higher frequency of occurrence than hurricanes in the Lease Area (NOAA, 2020). Historical storms identified as hurricanes crossing the Lease Area spanning from 1982 to 2017 are listed in **Table 4-10**.

TABLE 4-10. HISTORICAL STORMS FROM 1982 TO 2017 IN THE VICINITY OF THE LEASE AREA (NHS, 2019)

Name	Year	Start Time	End Time	Duration (hour [hr.])
UNNAMED	1982	18-06-1982 00:00	22-06-1982 00:00	96
UNNAMED	1982	13-11-1981 18:00	18-11-1981 18:00	120
DIANA	1984	13-09-1984 12:00	17-09-1984 12:00	96
GLORIA	1985	25-09-1985 16:00	29-09-1985 18:00	98
CHARLEY	1986	16-08-1986 18:00	21-08-1986 06:00	108
BOB	1991	17-08-1991 12:00	22-08-1991 00:00	108

Name	Year	Start Time	End Time	Duration (hour [hr.])
UNNAMED	1992	29-10-1991 00:00	02-11-1991 06:00	102
EMILY	1993	30-08-1993 18:00	04-09-1993 00:00	102
BERTHA	1996	12-07-1996 00:00	16-07-1996 00:00	96
EDOUARD	1996	31-08-1996 00:00	04-09-1996 12:00	108
GUSTAV	2002	09-09-2002 12:00	13-09-2002 12:00	96
NOEL	2007	01-11-2007 18:00	06-11-2007 00:00	102
CRISTOBAL	2008	20-07-2008 06:00	24-07-2008 06:00	96
KYLE	2008	26-09-2008 12:00	30-09-2008 12:00	96
BILL	2009	21-08-2009 00:00	25-08-2009 00:00	96
EARL	2010	02-09-2010 00:00	06-09-2010 06:00	102
SANDY	2012	27-10-2012 18:00	31-10-2012 18:00	96
ARTHUR	2014	02-07-2014 18:00	07-07-2014 00:00	102
HERMINE	2016	03-09-2016 12:00	10-09-2016 18:00	174
JOSE	2017	18-09-2017 06:00	27-09-2017 06:00	216

4.3.1.5.3 Ice Accretion

The two main processes that result in icing or ice accretion on WTGs are meteorological conditions including freezing rain, snow, and freezing fog and ocean conditions including freezing sea spray from breaking waves. Low wind speeds of 32.8 feet per second (10 meters per second [m/s]) or lower and cooler air temperatures -4 to 32°F (-20 to 0°C) allow for an environment conducive to icing (ISO19906, 2010). Supercooled water droplets landing on sub-zero surfaces results in icing, which could reach diameters of 0.4-0.8 inches (in, 1-2 centimeters). Conditions that produce freezing sea spray include sub-zero air temperatures 28.4°F (-2°C) or lower and water temperatures being less than 46.4°F (8°C). When the water droplets contact a sub-zero surface, icing is likely to occur. Water droplets from freezing marine spray can reach altitudes of up to 65.6 ft (20 m) above sea level (ISO 19906, 2010).

The probability of ice occurrence modeled from 39 years of data at each sampling location within the Lease Area was averaged to be 2.32 percent. These percentages were calculated by plotting data points of air temperature and water temperature and calculating the frequency of points located within temperature ranges that could produce ice.

4.3.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cables, and onshore export cables), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020b). IPFs were adapted from BOEM's (2020b) *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build-out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

Potential effects of the proposed Project on ocean and meteorological conditions are listed in **Table 4-11**.

TABLE 4-11. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON OCEAN AND METEOROLOGICAL CONDITIONS

IPF	Potential Effect	Period of Potential Effect		
	Project Component	Project Phase		
	Offshore Project Area	Construction	O&M	Decomm.
Seabed (or ground) Disturbance	Offshore Project component installation; Presence of offshore Project components; Offshore Project component decommissioning	X	X	X

4.3.2.1 Seabed (or ground) Disturbance

4.3.2.1.1 Construction

Cable installation and burial activities for the inter-array cables and offshore export cables, including horizontal directional drilling (HDD) exit pit dredging, will contribute to seabed disturbance in the form of sediment suspension, dispersion, and redeposition (see Appendix F1 and F3). Modeled total suspended solids concentrations associated with installation activities decrease rapidly following construction disturbance. As reported in Appendix F1, the maximum total suspended solids level drops below 10 milligrams per liter (mg/L) in two hours for any of the simulated scenarios, while it drops below 1 mg/L after less than four hours. However, as reported in Appendix F3, in Mount Hope Bay and the Sakonnet River where the bed materials have high silt and clay contents, it can take up to 50 hours for total suspended solids concentrations to decrease below 10 mg/L due to resuspension of bottom sediments. The redeposition of the sediment occurs relatively locally. Most of the released mass settles out quickly and is not transported by the currents for long. Deposition thicknesses exceeding 0.20 inch (5 millimeters) are generally limited to a corridor of maximum width 79 ft (24 m) around the cable corridor centerline, although such thicknesses can be locally observed up to 590 ft (180 m) from the Falmouth export cable corridor centerline.

Modeling of dredging effects at the HDD exit pit is expected to have very limited effects in terms of re-deposited sediment, with deposits exceeding 0.20 inch (5 millimeters) thickness found at respective maximum distances of 85 ft and 105 ft (26 m and 32 m) for the Neap and Spring Tide scenarios in Falmouth (Appendix F1). However, in very close proximity to the HDD exit pit in Falmouth, the thickness of deposits can exceed 0.3 ft (0.1 m) (Appendix F1). Sediment deposits exceeding 0.20 inch (5 millimeters) extended slightly further in the HDD exit pits in Mount Hope Bay and the Sakonnet River, with estimated distances up 138 ft (42 m) (Appendix F3).

For HDD trajectories in Falmouth see Appendix P1. Note that HDD trajectory details will be refined (and may change slightly within the PDE) as the Project progresses.

Seabed disturbances during construction will have no effects on metocean conditions.

4.3.2.1.2 Operations and Maintenance

As presented in Appendix F2, Scour Potential Impacts from Operational Phase Post-Construction Infrastructure, seabed disturbance resulting from the presence of offshore Project components could develop during the operational phase of the proposed Project as hydrodynamic forces act on structures, creating scour holes. Model results indicate that scour holes would develop slowly as there is little seabed mobility in the Lease Area; however, no scour effects at WTG and OSP foundations are anticipated, as scour protection will be placed on the seabed within the area of modeled scour potential.

Mobile seabed sediments could potentially expose buried submarine cables if placed in an area of high seabed mobility. Cables will be buried at depths to guard against exposure from seabed mobility (see Section 3.3.1, Substructures, for more information on scour protection).

The thermal plume associated with the discharge of cooling water from the OSP (up to 90°F [32.2°C] at the end of the discharge pipe) was modeled using CORMIX® to predict and analyze the water temperature changes under a full range of seasonal, tidal, and Metocean conditions (e.g., velocity, temperature, and salinity) within a mixing zone of the cooling water discharge. The modeling results indicate minimal thermal impacts to the surrounding water column. During maximum ocean current speeds in Winter and Summer, a 0.3°F (0.2°C) temperature change (or delta, ΔT) in ambient water temperature was modeled at the edge of the plume, which would extend approximately 300 feet (91 m) from the diffuser in both seasons. In contrast, the maximum anticipated temperature change from ambient water at the end of the discharge pipe is a ΔT of 18°F (10°C). During minimum current speeds, the temperature delta at the plume edge is estimated to be 0.3°F (0.2°C) in Winter and 0.0°F (0.0°C) in Summer. This minimal temperature change is estimated to extend much further during slow current speeds (1,426 feet [435 m] in Winter and 2,661 feet [811 m] in Summer) due to the buoyancy of discharged warmer water and reduced mixing. However, this slight temperature change may not be detectible (within the expected error range) using standard temperature monitoring sensors. Additional detail on the methods and results associated with the CORMIX modeling are included in National Pollutant Discharge Elimination System (NPDES) Permit Application Appendix A (Mayflower Wind CORMIX Mixing Zone Results), submitted to EPA Region 1.

The proposed Project will be designed based on metocean conditions. While localized wake effect is known to occur due to the presence of WTGs, this effect is not expected to have an impact on the regional metocean conditions. No effects associated with the proposed Project are anticipated on physical oceanography and meteorological conditions.

4.3.2.1.3 Decommissioning

Offshore export cables and portions of project substructures (e.g., those below the seafloor) may be retired in place in order to limit additional disturbance to seabed. In the event that offshore export cables are removed during decommissioning, impacts to the seabed will be similar to those during installation of the cable.

4.4 GEOLOGICAL RECOMMENDATIONS AND DESIGN CRITERIA

In accordance with 30 CFR § 585.626(a)(6) and based on the comprehensive analysis of subsurface character in Section 4.1, an overview of shallow hazards in Section 4.2, further detail provided in Appendix E, Marine Site Investigation Report, and insights in Appendix F2, Scour Potential Impacts from Operational Phase and Post-Construction Infrastructure, recommendations and appropriate design criteria can be made for the proposed Project within the Offshore Project Area on the basis of the geologic and environmental findings. Project components reflecting the selected design criteria are listed and described in Section 3.3, Project Components and Project Stages.

4.4.1 Design Criteria

Within the BOEM COP Guidelines (BOEM, 2020), a "design-basis" of criteria and standards applied and justified for appropriateness is required for submission. Engineering properties of soils and potential hazards identified throughout the proposed Offshore Project Area can be found in Appendix E, Marine Site Investigation Report and were utilized to inform decisions made regarding design criteria. Further details regarding design criteria and design standards that will be applied to the proposed Project can be found in the Hierarchy of Codes & Standards located in Appendix B, Certified Verification Agent (CVA).

Mayflower Wind will select appropriate design criteria for geological and environmental conditions present within the Lease Area and will coordinate with the CVA to verify the appropriateness of the design standards.

4.4.2 Lease Area

Presently, the Lease Area experiences mobile sediment in instances of episodic storms, modeled to be only one to two percent of the time. The relatively low seabed mobility in the Lease Area was modeled using PDE substructure and cable parameters in Appendix F2, Scour Potential Impacts from Operational Phase and Post-Construction Infrastructure. Modeled scour potential results were taken into consideration for the addition of scour protection to substructures. Additional information regarding considerations for scour protection and cable installation can be found in Section 3.3.4, Inter-Array Cable and 3.3.5, Offshore Export Cables, respectively.

Shallow buried channels within the Lease Area have been mapped and sampled to assist in planning the most appropriate configurations for substructures and cabling. These shallow buried channels are not expected to pose a significant risk to the installation and long-term operation of the proposed cables. See Appendix E, Marine Site Investigation Report and Appendix E.1, Geohazard Report for Lease Area, for further details on the shallow buried channels mapped within the Lease Area.

Potential debris and buried anomalies, including obstructions such as boulders, have been identified and mapped within the Lease Area to ensure they are avoided during construction and are mapped and discussed in Appendix E, Marine Site Investigation Report. Shallow gas accumulations were also mapped within the Lease Area and were assessed to not pose a significant hazard to substructure installation. See Appendix E.1, Geohazard Report for Lease Area, for further details on buried anomalies and shallow gas accumulations mapped within the Lease Area.

Mayflower Wind will follow appropriate standards and practices to ensure Project cables will be suitably designed and installed for the conditions encountered in the Lease Area, including design of cables for a range of anticipated soil conditions.

4.4.3 Export Cable Corridors

The export cable corridors extend from the Lease Area in the Outer Continental Shelf (OCS) to mainland Massachusetts and encounter seabed exhibiting different geological and geotechnical properties and constraints at different intervals along the routes. Seabed mobility assessments were performed along the Falmouth export cable corridor. The southern, further offshore portion of the Falmouth export cable corridor encounters seabed mobility less than two percent of the time. In contrast, the northern, inshore portion of the Falmouth export cable corridor experiences seabed mobility more than 54 percent of the time and 18 percent of the time through Muskeget Channel and Nantucket Sound, respectively. Additional information regarding sediment mobility can be found in Section 4.1, Section 4.2, Section 4.3, and Appendix E, Marine Site Investigation Report. See Appendix E, Marine Site Investigation Report, Appendix E.2, Geohazard Report for Brayton Point Export Cable Corridor, and Appendix E.3 Geohazard Report for Falmouth Export Cable Corridor for further details. Mobile bedforms as a result of higher seabed mobility can lead to a change in depth of cover for buried cables if not accounted for in design considerations.

No largescale mobile seabed features, such as megaripples or sandwaves have been identified along the Brayton Point export cable corridor by geophysical survey. Only small scale bedforms such as ripples, sand ribbons and lineations were identified on the bathymetry and side-scan sonar data. The survey did not identify any features that indicate significant seabed scour along the Brayton Point export cable corridor. As such, the survey indicates that the risk to the cable due to sediment mobility along the Brayton Point export cable corridor is low. Tidally-drive currents are known to cause scour and seabed mobility in other areas within the Sakonnet River and Mount Hope Bay outside of the Brayton Point export cable corridor, and future evaluation will be conducted to assess the need for additional mitigation and protection.

Cable installation and burial tools should take into consideration the slopes on the sandwaves and direction the tool(s) traverses the sandwave to avoid potential instability issues (e.g., rollover) where applicable. Steeper slope gradients may warrant particular caution, preparatory works, and/or dictate the type and depth of tooling used for burial to achieve suitable long-term protection. Cable protection methods along the export cable corridors are detailed in Section 3.3.5, Offshore Export Cables.

Seabed preparation or alternate burial methods may be required in the northern portion of the Falmouth export cable corridor in Muskeget Channel and Nantucket Sound, where surficial boulders, subsurface boulders, geological units representing hardgrounds or glacial tills, or shallowly buried channels with variable soil properties have been identified. Seabed preparation may also include dredging or leveling steep and/or mobile seabed features to facilitate achieving the targeted depth of lowering to ensure adequate burial over the life of the Project.

Methods and tools that may be utilized for seabed preparation and boulder removal are listed in Section 3.3.5, Offshore Export Cables. See Appendix E, Marine Site Investigation Report and Appendix E.1, Geohazard Report for Lease Area, Appendix E.2, Geohazard Report for the Brayton Point Export Cable Corridor, and Appendix E.3, Geohazard Report for the Falmouth Export Cable Corridor for additional details on the identified locations of these features on the available survey coverage. Locations of any boulders along portions of the Brayton Point export cable corridor were investigated as part of geophysical surveys completed in 2021. Further information can be found in Appendix E, MSIR. It is likely that the same seabed preparation methods may be employed to portions of the Brayton Point export cable corridor.

Mayflower Wind will follow appropriate standards and practices to ensure Project cables will be suitably designed and installed for the various conditions encountered in the export cable corridors, including design of cables for a range of anticipated soil conditions and consideration of multiple installation techniques on a case-by-case basis along the sections of the routes.

5 PHYSICAL RESOURCES

5.1 AIR QUALITY

This section provides a description of the sources of air emissions to be included in the OCS Air Permit application for the proposed Project. It also includes the methods employed to quantify emissions for the OCS Air Permit for the construction and operational phases of the proposed Project. Mayflower Wind has elected to not include decommissioning in the OCS Air Permit application and will instead submit a separate permit application to cover that phase at a later date. The modeled scenario assumes the maximum design scenario of up to 147 WTGs, up to five OSPs, and the maximum length of inter-array and export cables that would be installed for the proposed Project, operating during the planned 33-year O&M period.

Approximately 62 percent of projected fuel usage will occur during the pre-construction and construction periods of the proposed Project. The construction period is scheduled to last a maximum of three years and includes various pre-construction activities. Pre-construction in the air emissions report and calculations represents all activities that take place before the foundations or substructures are installed; for example, site surveys and seabed preparations. Air emissions modeling was based on the projected construction schedule, and vessel activity was estimated by construction year. It was assumed that all onshore construction activities will be completed in 24 months over the projected three-year construction period which spans four calendar years. The emissions estimate for the construction phase utilizes the port with the longest transit distance to and from the Lease Area within U.S. waters. The air emissions modeling presented in Appendix G will be updated as anticipated vessel trips for the construction and O&M phases of the Project are further refined.

Technical appendices related to air quality include:

- Appendix G, Air Emissions Report

5.1.1 Affected Environment

The U.S. Environmental Protection Agency (EPA), under the Clean Air Act of 1970, 42 United States Code (U.S.C.) §§ 7401 *et seq.*, amended in 1977 and 1990, developed National Ambient Air Quality Standards (NAAQS) that include primary standards to protect human health and the health of sensitive subpopulations, including children, elderly, and those with chronic respiratory problems. NAAQS also contain secondary standards designed to protect public welfare, including economic interests, visibility, vegetation, animal species, and other concerns not related to human health. Standards developed by the EPA for the NAAQS involving carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter, and sulfur dioxide (SO_2) are listed with their specific standard, timing, level, and form in **Table 5-1**.

The EPA has classified all regions of the U.S. into attainment, nonattainment, or unclassified for the pollutants listed in **Table 5-1** (EPA, 2021a). Attainment areas comply with NAAQS, nonattainment areas do not meet NAAQS for one or more pollutants, and unclassified areas are treated as attainment areas but lack data for official classification.

Designations of air quality status for defined geographic areas are promulgated at 40 CFR Part 81. Several counties containing port cities and other coastal counties near the Massachusetts/Rhode Island Wind Energy Area (MA/RI WEA) are designated as nonattainment areas. Dukes County, Massachusetts is a nonattainment county for O_3. Rhode Island does not have any nonattainment counties. Within Connecticut, all counties are nonattainment for ozone, New Haven and Fairfield counties in Connecticut are maintenance areas for particulate matter smaller than 2.5 microns ($PM_{2.5}$), and New Haven County is a maintenance county for CO.

TABLE 5-1. EPA NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Standard	Timing	Level	Form
Carbon Monoxide (CO)	Primary	8 hours	9 parts per million (ppm)	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	Primary and Secondary	Rolling 3-month average	0.15 micrograms per cubic meter (µg/m^3)	Not to be exceeded
Nitrogen Dioxide (NO_2)	Primary	1 hour	100 parts per billion (ppb)	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary and Secondary	1 year	53 ppb	Annual mean
Ozone (O_3)	Primary and Secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particulate Matter ($PM_{2.5}$)	Primary	1 year	12.0 µg/m^3	Annual mean, averaged over 3 years
	Secondary	1 year	15.0 µg/m^3	Annual mean, averaged over 3 years
	Primary and Secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
Particulate Matter (PM_{10})	Primary and Secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on an average over 3 years
Sulfur Dioxide (SO_2)	Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

Source: EPA, 2016

5.1.2 Permitting Applicability

40 CFR § 55.2 establishes air pollution control requirements for OCS sources, including an OCS Air Permit process to which some air emissions from the proposed Project are regulated. OCS sources located within 25 nautical miles (nm, 46 km) of states' seaward boundaries (which are three nautical miles for most states) are subject to all requirements of this subpart. Per 40 CFR § 55.2, an OCS source is defined as any equipment, activity, or facility which:

- Emits or has the potential to emit any air pollutant,
- Is regulated or authorized under the OCS Lands Act (43 U.S.C. §§ 1331 *et seq.*), and
- Is located on the OCS or in or on the waters above the OCS.

Air emission estimates in the OCS Air Permit application must include emissions from OCS sources, vessels while within the Lease Area, vessels traveling to and from the Lease Area when within 25 nm (46 km) of the Lease Area's centroid, and vessels operating along the export cable corridor within 25 nm (46 km) of the Lease Area's centroid. These emissions were calculated for the construction and operational phases of the proposed Project.

40 CFR §§ 55.13 and 55.14 outline federal, state, and local requirements of the Corresponding Onshore Area (COA), to which OCS sources located within 25 nm (46 km) of a states' seaward boundary are subject. After a Notice of Intent (NOI) is submitted to the EPA for the proposed Project, 40 CFR § 55.5 requires the EPA to designate the COA. Mayflower Wind is submitting an NOI for the proposed Project to the EPA Regional Office, Massachusetts Department of Environmental Protection (MassDEP), Rhode Island Department of Environmental Management (RIDEM) Office of Air Resources, and New Hampshire Department of Environmental Services Air Resources Division in Q3 2022. Mayflower Wind engaged with the EPA for a Project introduction meeting in Q1 2021. It is anticipated that the EPA will designate Massachusetts as the COA. The proposed Project's OCS sources will be required to comply with the applicable Massachusetts air quality regulations, which include Best Available Control Technology and Lowest Achievable Emission Rate under 310 Code of Massachusetts Regulations (CMR) § 7.00.

5.1.3 Emission Modeling

5.1.3.1 Emissions Sources

Engines and auxiliary equipment will be the main source of emissions during construction activities. Emissions experienced during the proposed Project's approximately 33-year O&M phase will come from vessels and generators. A complete description of all emission points associated with construction and O&M of the proposed Project are listed in **Table 5-2**. More information regarding vessels, vehicles, and aircraft projected for use over the course of the proposed Project is in Section 3.3.14, Vessels, Vehicles, and Aircrafts.

TABLE 5-2. DESCRIPTION OF EMISSION SOURCES MODELED

Emission Source	Description
Crew transfer/service vessels	Transport crew and equipment to the Project site.
Heavy lift crane vessels	Lift, support, and orient foundations during installation. Lift, support, and orient the components of WTGs and OSPs during installation.
Heavy transport vessels	Transport WTG and OSP components from overseas to the construction staging area.
Cable installation vessels	Lay and bury offshore export and inter-array cables in the seafloor.
Scour protection installation vessels	Deposit a layer of stone around the WTG foundations to prevent the removal of sediment by hydrodynamic forces.
Multi-purpose support vessels	Clear the seabed floor of debris prior to laying export and inter-array cables general support.

Emission Source	Description
Tugboats	Transport equipment and barges to the Lease Area, port operations, if required.
Barge	Transportation of components to Site from staging port
Anchor handling tug supply vessels	Install noise mitigation equipment, such as bubble curtains.
Jack-up vessels	Extend legs to the sea floor to lift vessels out of the water for stability during transfer/installation of foundation and/or WTG components; vessel type could also be used for accommodation vessel.
DP accommodation vessel	Commissioning activities
Dredging vessels	Used in certain areas prior to cable laying to remove the upper portions of sand waves.
Survey vessels	Used to perform site characterization, as built, and inspection surveys.
Pile driving hammer	Drive the substructures into the seafloor.
Air compressors	Supply compressed air to noise mitigation devices.
Temporary diesel generators	Temporarily supply power to a WTG prior to the WTG commissioning into the integrated power system to the OSPs and grid. Supply power to the temporary vessel equipment, if needed.
Airplane	Marine mammal watch, general support
Helicopters	Transport crew and equipment to and from the Lease Area; will be used sparingly with preferred use only in urgent or emergent scenarios, including time-critical repairs.
Solvents, paints, and coatings	Fugitive emissions from solvent, paint, and coating applications during pre-commissioning.
Non-road construction and mining equipment	Backhoes, bore/drill rigs, compactors, concrete trucks, concrete saws, cranes, excavators, forklifts, front-end loaders, graders, light duty off-highway trucks, reach stackers, and pavers.
Non-road commercial equipment	Generators, pumps, and welders.
Non-road industrial equipment	Air conditioning units and aerial lifts.
Worker vehicles	Transportation of workers.
Delivery and heavy-duty vehicles	Transport materials and equipment.
Construction dust	Particulate emission.

5.1.3.2 Emission Calculation Methods

Emissions from commercial marine vessels were calculated using the BOEM Offshore Wind Energy Facilities Emission Estimating Tool (BOEM, 2021). When needed, information from EPA's Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories and EPA's 2017 National Emissions Inventory Technical Support Document (Chang & Billings, 2017) were used as supplements to the BOEM methodology.

5.1.3.2.1 BOEM Emissions Model

Four calculations were made for each vessel based on the vessel's estimated hours of operation in the Lease Area; distance traveled, speed, total number of round trips, engine size, load factor, and emissions factor. These calculations, consistent with the BOEM Emissions Estimating Tool, include the following:

- Emissions from the main engines while in transit,
- Emissions from the main engines while maneuvering within the Lease Area,
- Emissions from the auxiliary engines while in transit, and
- Emissions from the auxiliary engines while maneuvering within the Lease Area.

All vessels utilized for installation within the Lease Area and subject to the OCS Air Permit will use the jurisdictionally required compliant fuel, e.g., ultra-low sulfur diesel fuel (ULSD) or a less carbon intense fuel. Vessels utilized for long-term O&M can incorporate other emissions mitigation technology including, but not limited to, shore-side charging, hybrid battery energy storage, and Internet of Things-based onboard vessel performance optimization.

None of the ports to be used by the proposed Project are located within 25 nm (46 km) of the Lease Area's centroid; consequently, emissions from vessels while maneuvering and hoteling in port are not included in the OCS Air Permit application. Factors, inputs, and calculations that build the emissions model are detailed in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.2 Greenhouse Gases

Greenhouse gas emission estimations from commercial marine vessels, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), were conducted using the same methodology as performed in the BOEM Emissions Estimating Tool. Greenhouse gas emissions as carbon dioxide equivalent (CO_2e) were calculated using global warming potential factors provided by BOEM's Emission Estimating Tool. CO_2e emissions were calculated separately for each of the calculations scenarios for each vessel utilizing BOEM's Emissions Estimating Tool.

5.1.3.2.3 Hazardous Air Pollutants

Hazardous air pollutants (HAPs) were calculated within the Lease Area and within 25 nm (46 km) of Massachusetts during the construction and the O&M phase of the proposed Project. BOEM's Emission Estimating Tool does not provide emission factors for HAPs emitted from commercial marine vessels. The equation utilized for these calculations can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.4 Power-Based Fuel Estimation

Brake specific fuel consumption (BSFC) rates for the main and auxiliary engines of ocean-going vessels for various engine types and fuels are provided in EPA's Port-Related Emission Guidance (2009). According to the 2017 National Emissions Inventory (EPA, 2020), the dominant propulsion engine configuration for large Category 3 vessels is the slow-speed diesel engine and has a corresponding BSFC of 185 grams per kilowatt-hour. It was assumed that Category 3 auxiliary engines will fire primarily marine diesel oil or marine gas oil and will have a BSFC of 217 grams per kilowatt-hour.

Equations utilized to calculate power-based fuel estimations and detailed emission estimations for power-based fuel can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.5 Limited Use/Emergency Transportation (Helicopters)

BOEM's Emission Estimating Tool was also used to calculate air emissions from aviation (including helicopters), which were all assumed to be heavy- or medium-sized, twin-engine, or single-engine helicopters. It was assumed that all construction activity utilized heavy-sized, twin-engine helicopters, while operations and maintenance activity utilized medium-sized, twin-engine helicopters. The single engine helicopter classification was also used as a conservative approximation for "airplanes" as a general category. The default speed for helicopters in BOEM's Emission Estimating Tool is 183 miles per hour (294.5 kilometers per hour). Total hours in flight were based on the total distance each helicopter is expected to travel while within the 25 nm (46 km) OCS Air Permit boundary and the default speed.

As Martha's Vineyard Airfield and Providence Airport are both farther than 25 nm (46 km) from the Project site, the helicopters would travel 25 nm (46 km) while in the airspace subject to the OCS Air Permit. The emission factors used to generate the emission estimates for twin-engine, or single-engine, heavy- or medium-sized helicopters from BOEM's Emission Estimating Tool are listed in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.6 Non-Road Engines

Non-road engines include but are not limited to cranes, excavators, and drilling rigs. Emission factors and fuel consumption rates for non-road engines were calculated based on the engines' hours of operation, engine size, load factor, and EPA's Motor Vehicle Emission Simulator (MOVES) emission factors. The load factors were obtained from EPA's Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (2010). The equation used for this calculation can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.7 Stationary Sources – Backup/Process Generators

Four portable diesel offshore generator sets, and five portable diesel onshore generator sets are anticipated for use on the WTGs during construction. Each generator is expected to be rated at 500 kilowatts (kW). During O&M, each WTG could contain a 60-kW diesel emergency generator that could operate up to 100 hours per year. Emissions from these generators were estimated based on a 50 kW, Tier 3, non-road diesel engine firing ULSD.

Each OSP could contain one 600-kW emergency diesel engine that could operate up to 100 hours per year. Emissions from these emergency generators were estimated based on an 800-kW Tier 2 non-road diesel engine firing ULSD. Detailed emission factors for stationary sources can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.8 Noise Mitigation Installation

Up to ten 450-kW diesel generator sets will be utilized during offshore construction to operate the noise abatement systems (NAS) (likely bubble curtains). These generators are conservatively assumed to operate for up to six hours a day, each day, for nine months. Air emissions for oxides of nitrogen (NO_x), volatile organic compounds (VOCs), CO, and particulate matter are based on Tier 4 emission factors for 130 ≤ kW < 560 Tier 4 non-road compression-ignition engines firing ULSD per 40 CFR § 1039.102. Size, applicable regulatory tier, and fuel usage were determined from the equipment specification sheet of a diesel air compressor that is representative of the type of compressor typically used for noise mitigation in offshore wind projects. The proposed Project is anticipated to use up to ten 450-kW air compressors for NAS operations. Detailed emissions factors for NAS system installation can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.9 Substructure Installation

It was assumed that the pile driving hammer engines utilized for substructure installation could operate for up to four hours per foundation. For this estimation, it was conservatively assumed that 50 percent of the WTG substructures will be four-pile jacket foundations and 50 percent of substructures would be monopiles. Scenarios of 100 percent monopile or 100 percent piled jacket substructures could also be installed and fit inside of these estimates. Estimates also included five conventional OSPs. The five conventional OSPs will have between four and nine foundations, with up to three piles per foundation. Emissions factors developed for substructure installation are based on Tier 2 emission factors. More detailed information regarding air emissions modeled for substructure installation are listed in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.10 Fugitive Emissions – VOC and SF_6

During the construction phase, fugitive emissions will be emitted from the use of solvents, paints, and coatings. It was estimated that this will result in one ton of VOC emissions. During the operational phase, fugitive emissions will be emitted from the use of up to 50 gallons of marine paint for touch-ups each year.

Sulfur hexafluoride (SF_6) will also be emitted from insulated equipment on the WTGs and OSPs. The amount of SF_6 emissions was estimated based on the storage capacity of SF_6 within the equipment and the maximum permissible annual leak rate of one percent per 310 CMR 7.72(5)(a). However, modern gas-insulated equipment has a leakage rate of 0.0089 (i.e., less than one percent) per year. There will be a total of eighteen 220 kilovolt (kV) gas-insulated switchgear (GIS) and twenty-two 66 kV GIS located on the OSPs. The 220 kV GIS are anticipated to contain 275.6 pounds (125 kilograms) of SF_6. The 66 kV GIS are expected to contain 187.4 pounds (85 kilograms) of SF_6. Greenhouse gas emissions of SF_6 as CO_2e were calculated using a global warming potential of 23,500 from the most recent Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC, 2014).

5.1.3.2.11 Fugitive Emissions – Construction Dust

Fugitive particulate dust emissions from onshore construction activities are proportional to the size of the construction area and the level of construction activity. These emissions were calculated according to EPA's AP-42, Chapter 13.2.3: Heavy Construction Operation (EPA, 1995). Fugitive construction dust emissions were calculated for onshore export cables installation, HDD, and onshore substation construction. Additional information regarding calculating fugitive construction dust emissions can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.12 On-Road Vehicles – Crew Commutes and Material Transports

On-road engines (vehicles) include but are not limited to passenger trucks, flatbed trucks, and dump trucks. Vehicles were modeled using a mix of diesel-fueled and gasoline-fueled engines for a July morning using Bristol County Project-level inputs. Air emissions from on-road engines were calculated based on the distance each vehicle is expected to travel and emission factors from MOVES. Detailed emission calculations for on-road vehicles can be found in the preliminary submission of Appendix G, Air Emissions Report.

5.1.3.2.13 Sulfuric Acid Emissions – Compression Ignition Engines

Total sulfuric acid mist emissions were estimated to determine the applicability of Prevention of Significant Deterioration review as part of the OCS Air Permit. Most emission sources for the proposed Project will be compression-ignition engines. Based on the overview of diesel combustion and pollutant formation, EPA's (2007) Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 7.9 gallons (30 liters) per cylinder, it was assumed that three percent of fuel sulfur is oxidized to ionic sulfate and all fuel will be ULSD with a 15-parts per million sulfur content in order to determine the potential emissions of sulfuric acid mist.

5.1.4 General Conformity

Unlike emissions considered for the OCS Air Permit occurring within 25 nm (46 km) of the Lease Area's centroid, conformity emissions are only considered for Project activities that occur within non-attainment areas. Every five years, the EPA reviews NAAQS and identifies areas within the country that appear to have higher ambient emissions than the NAAQS issued. Each state is then required to plan regulatory actions to bring the non-attainment areas into compliance with the NAAQS. These regulatory actions are codified in the State Implementation Plan. As the proposed Project will occur on federal land, the applicability of the General Conformity rule (codified in 40 CFR 93 Subpart B and 40 CFR 51 Subpart W) was evaluated. For proposed Project emissions that are subject to General Conformity, the lead federal agency must make a formal determination of conformity to ensure that the proposed Project does not interfere with the Massachusetts and Rhode Island State Implementation Plans.

In 2012, the EPA designated Dukes County, Massachusetts as marginal non-attainment area for the 2008 Ozone NAAQS standard. Dukes County was able to attain the 2008 standard by the 2015 reassessment deadline and is now in a marginal planning area for the 2008 and 2015 NAAQS (MassDEP, 2018).

To determine the applicability of General Conformity, direct and indirect emissions outside the 25 nm (46 km) OCS Air Permit Boundary and within a maintenance or nonattainment area must be determined. **Figure 5-1** indicates the areas subject to the OCS Air Permit Boundary and General Conformity.

Attainment designations for all counties where proposed Project emissions may occur are summarized in **Table 5-3**. Although Pb, SO_2, and NO_2 are not included in the following table, all counties potentially affected by the proposed Project's air emissions are in attainment with the NAAQS for these pollutants.

TABLE 5-3. AIR QUALITY DESIGNATIONS WHERE PROJECT-RELATED EMISSIONS MAY OCCUR

Area/County	2015 Ozone Standard	2008 8-Hour Ozone Standard	1997 & 2006 $PM_{2.5}$	1987 PM_{10} Standard	1971 CO Standard
Barnstable County, MA	Attainment	Attainment	Attainment	Attainment	Attainment
Bristol County, MA	Attainment	Attainment	Attainment	Attainment	Attainment
Nantucket County, MA	Attainment	Attainment	Attainment	Attainment	Attainment
Dukes County, MA	Attainment	Dukes County Marginal Non-Attainment Area	Attainment	Attainment	Attainment
Newport County, RI	Attainment	Attainment	Attainment	Attainment	Attainment
Bristol County, RI	Attainment	Attainment	Attainment	Attainment	Attainment

Source: EPA, 2021a

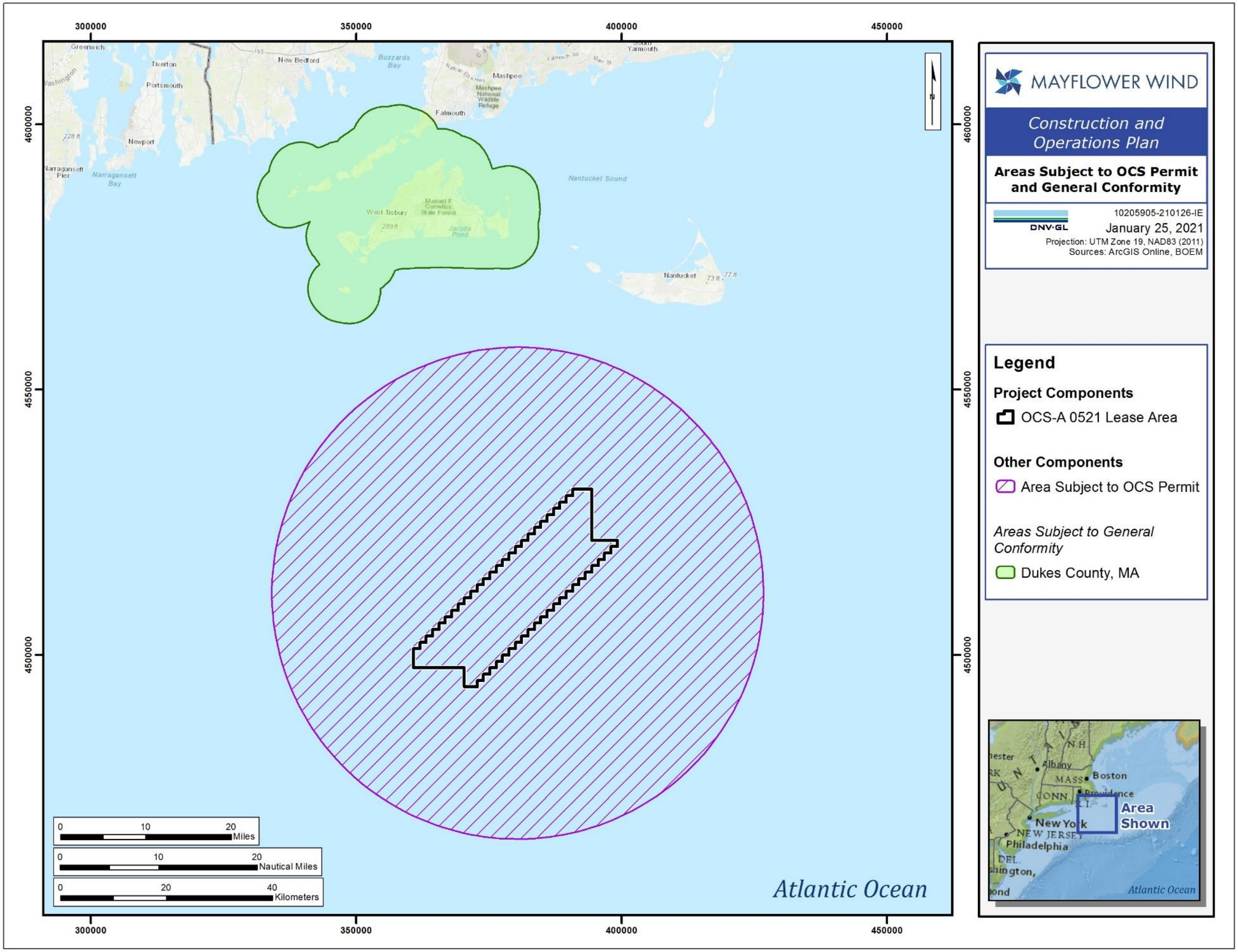


FIGURE 5-1. AREAS SUBJECT TO OCS AIR PERMIT AND GENERAL CONFORMITY

For the construction phase, the air emissions subject to General Conformity will depend on the combination of ports used. The proposed Project plans to use one or more ports to stage construction activities in Massachusetts and other North Atlantic commercial seaports. The New Bedford Marine Commerce Terminal (MCT) accounts for the farthest terminal transit distance and distance through the Dukes County nonattainment area. For the October 2021 air emissions modeling, emission estimates were based on all construction activities using the New Bedford MCT. More details regarding ports considered for the proposed Project are listed and shown in Section 3.3.13, Port Facilities.

The New Bedford MCT is not located in a nonattainment area. Vessels must only pass through the Dukes County nonattainment area (i.e., the region subject to General Conformity) when traveling from the Lease Area to ports in the New Bedford area.

The majority of the emissions from the proposed Project that are potentially subject to General Conformity will come from engines on marine vessels used during construction activities.

Emission sources used during offshore construction and O&M accounted for in the General Conformity emissions estimate include:

- Crew transfer/service vessels
- Heavy transport vessels
- Heavy lift crane vessels
- Cable installation vessels
- Scour protection installation vessels
- Multi-purpose support vessels
- Tugboats
- Anchor handling tug supply vessels
- Jack-up vessels
- Dredging vessels
- Diesel generators
- Service operations vessel
- Survey vessels
- Helicopters

The emissions estimate for General Conformity includes vessel emissions that occur outside of the OCS Air Permit Boundary and within a maintenance or nonattainment area. Commercial marine vessel emissions were calculated for General Conformity using the same methodology used for the OCS Air Permit. Equipment, including large heavy lift and jack-up vessels used for substructure, OSP, and WTG installation were excluded from the General Conformity estimate because those vessels are expected to travel directly to and from an international port to the Lease Area, and therefore do not enter nonattainment or maintenance areas.

Mayflower Wind does not expect to rely on helicopter or drone travel, and will prefer to use helicopters for possible urgent or emergent scenarios. Dukes County, Massachusetts is the only local area subject to conformity evaluation and the distance traveled by each helicopter only includes airspace over this county (including waters three nautical miles from shore) that is outside of the 25 nm (46 km) OCS Air

Permit Boundary. Dukes County is north of the Lease Area and out of the probable path for a helicopter traveling to the Offshore Project Area from the northwest.

Emission factors from MOVES were used to calculate emissions from each pollutant for non-road engines used at the construction staging area (EPA, 2021b). MOVES was also used to calculate emissions for each pollutant from vehicles used by port workers.

Per preliminary calculations detailed in Appendix G, Air Emissions Report, the proposed Project is expected to surpass the NO_x threshold during construction, but not annually during O&M. The proposed Project will not surpass VOC thresholds. Emission estimates per calendar year are based on the proposed Project construction schedule.

Per 40 CFR Part 55 and Appendix B of 310 CMR 7.00, offshore wind projects with Massachusetts designated as the COA will have to acquire emission offsets for every ton of NO_x and VOC forecast by the proposed Project annually if that annual forecast is over the ozone nonattainment threshold of 100 tons per year of NO_x or VOC. As described in the preliminary submission of Appendix G, Air Emissions Report, Mayflower Wind anticipates a need for NO_x offsets during the construction phase. However, NO_x emission levels drop below the conformity threshold for the O&M phase, so no further offset acquisitions would be required.

5.1.5 Total Air Emissions

The preliminary air emissions modeled for the proposed Project within the U.S. are presented in Appendix G, Air Emissions Report. The air emissions modeling will be updated for the Project once construction and O&M vessel trips are further refined. Calculations of total emissions include:

- OCS Emissions (within 25 nm [46 km] of the Lease Area centroid)
- General Conformity Emissions within Dukes County, Massachusetts
- Non-OCS Offshore Emissions, including General Conformity Emissions
- Onshore Emissions
- Total Emissions not Subject to General Conformity or OCS Air Permit

Three possible locations for O&M facilities are being evaluated, which include existing working harbors in Fall River, Martha's Vineyard, and New Bedford. At this time, Appendix G, Air Emissions Report, does not include air emissions resulting from the installation of the Brayton Point export cable. Once Brayton Point export cable installation air emissions have been inventoried, the appendix will be updated. In addition to the ongoing evaluation of locations, Mayflower Wind is also evaluating emissions reduction technologies to reduce emissions from certain vessels. Emission calculations will be updated in the future to reflect actual equipment and locations, if needed.

5.1.6 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects. As Mayflower Wind has decided to submit a separate permit and study for decommissioning, potential effects of the proposed Project on air quality are focused on the construction and O&M phases. Potential effects of the proposed Project on air quality are summarized in **Table 5-4**.

TABLE 5-4. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON AIR QUALITY

IPF	Potential Effect		Period of Potential Effect	
	Project Component		Project Phase	
	Onshore Emissions	Offshore Emissions	Construction	O&M
Planned Discharges: Air Emissions	Vehicles, onshore construction equipment, drones, and helicopters	Vessels, offshore construction equipment, helicopters, and generators	X	X

5.1.6.1 Planned Discharges: Air Emissions

5.1.6.1.1 Construction

Air emissions during the construction phase of the proposed Project will be mostly influenced by fuel combustion from engines and auxiliary equipment. The preliminary Air Emissions Report, Appendix G, modeled emissions associated with a three-year construction timeline over four calendar years. Emissions generated from vessels will depend on the primary port used. The scenario modeled assumed exclusive use of the New Bedford MCT.

The primary sources of offshore air emissions for the construction phase include crew transfer/service vessels, heavy lift crane vessels, heavy cargo vessels, cable installation vessels, scour protection installation vessels, multi-purpose support vessels, tugboats, anchor handling tug and supply vessels, jack-up vessels, dredging vessels, survey vessels, pile driving hammer, air compressors, temporary diesel generators, helicopters, drones, and fugitive emissions from solvents, paints, and coatings. Onshore air emissions during construction are mostly tied to stationary construction equipment including cranes, on-road and off-road transport vehicles, and generators. Vessels in or near port may also contribute to onshore air emissions during construction.

5.1.6.1.2 Operations and Maintenance

Emissions experienced during the proposed Project's approximately 33-year O&M phase will come predominantly from vessels and generators. The primary sources of air emissions during operation include multipurpose support vessels, transfer/service vessels, backup diesel generators, helicopters (in the case of urgent or emergent operations), and fugitive emissions from solvents, paints, and coatings for routine scheduled or unscheduled maintenance.

5.1.6.2 Avoided Emission Factors

As the proposed Project will not inherently add to pollution during operation, the use of power generated will avoid, minimize, and mitigate emissions in New England of CO_2, NO_x, and SO_2 associated with conventional power generation. Avoided, minimized, and mitigated emission factors are listed in **Table 5-5** and calculations for these metrics are in Appendix G, Air Emissions Report.

TABLE 5-5. AVOIDED EMISSION FACTORS

Pollutant	CO_2	NO_X	SO_2
Annual Avoided Emissions in New England (tons per /year)	4,038,482	692	313
Avoided Emissions over Project Lifespan in New England (tons)	133,269,904	22,825	10,324

5.2 Water Quality

This section discusses existing water quality conditions in the proposed Project Area and the identification of potential effects on water quality that may occur as a result of proposed Project activities. Information utilized for this section includes publicly available resources for coastal and offshore marine waters, onshore surface waters, groundwaters, and sediment chemistry. This section also includes a discussion of avoidance, minimization, and mitigation measures for water quality effects related to the proposed Project.

Technical appendices related to water quality include:

- Appendix H, Water Quality Report
- Appendix F1, Final Sediment Plume Impacts from Construction Activities
- Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment
- Appendix AA, Oil Spill Response Plan

5.2.1 Affected Environment

For this section, the Offshore Project Area is defined as the Lease Area and the proposed offshore export cable corridors, as shown in **Figure 5-2**. The proposed Falmouth export cable corridor extends from the Lease Area through Muskeget Channel and Nantucket Sound, ending at the proposed Project's landfall location(s) in Falmouth, Massachusetts (Worcester Avenue with alternate sites at Shore Street and Central Park). The proposed Brayton Point export cable corridor extends from the Lease Area through Rhode Island Sound, the Sakonnet River, and makes an intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island before entering Mount Hope Bay to make landfall at Brayton Point, in Somerset, Massachusetts (at the preferred Western landfall location, with an alternate site at the Eastern landfall location).

The specific route of the export cables will be determined based on geophysical and geotechnical data, engineering design, and environmental considerations. HDD will be used for installation of the offshore export cables under nearshore areas at the landfall location(s). Mayflower Wind is evaluating several offshore export cable landfall sites in Falmouth and Somerset (Brayton Point), Massachusetts for interconnection with the existing electrical grid. The landfall locations will be selected following engineering assessment. The specific route of the underground transmission cables from the landfall to the onshore substation in Falmouth and the onshore converter station in Somerset will be determined based on the final selection of landfall location and the onshore substation and converter station sites. One alternate onshore substation site in Falmouth is under consideration. See Section 3.3, Project Components and Project Stages, for further details regarding proposed Project components.

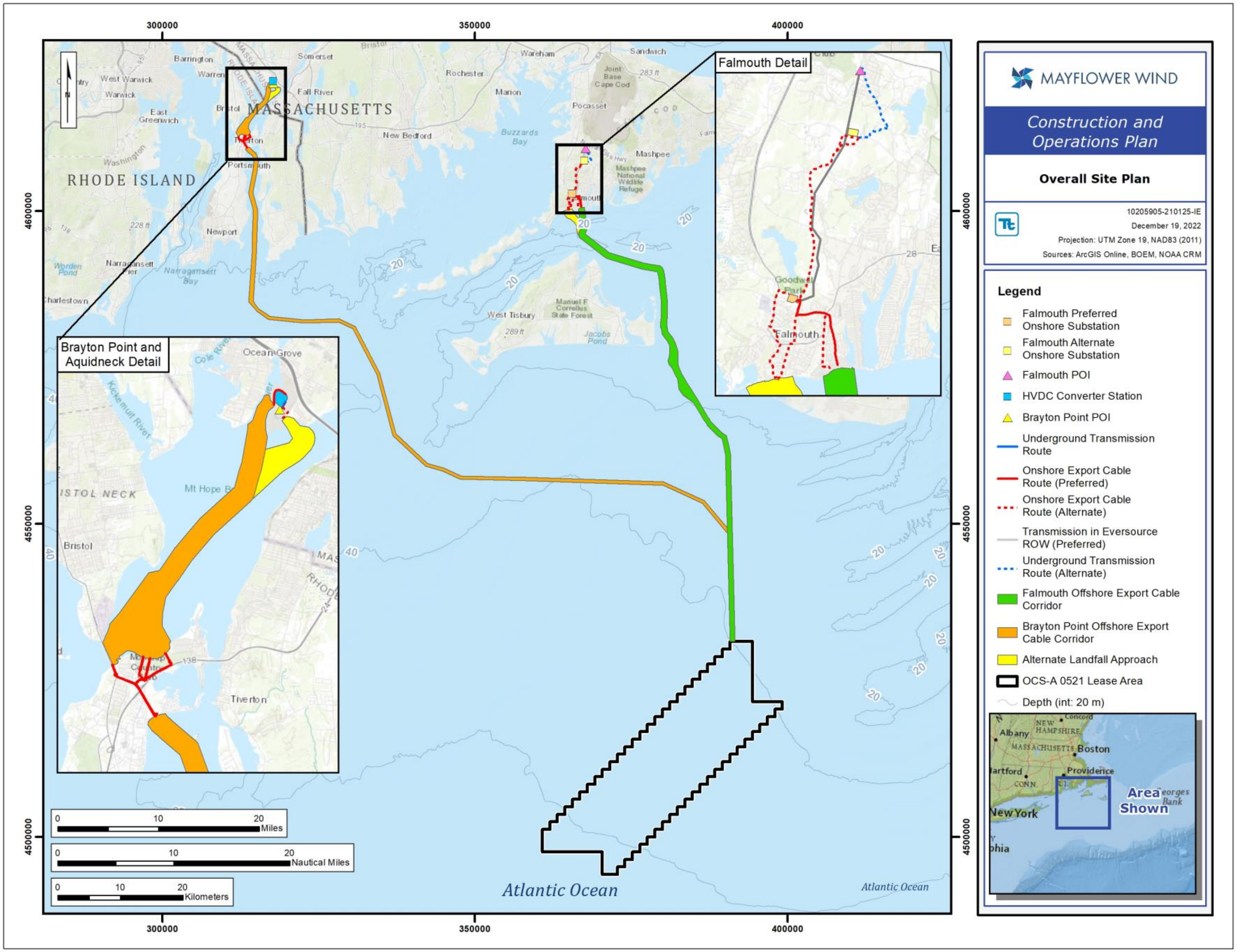


FIGURE 5-2. OFFSHORE PROJECT AREA

The Falmouth alternate underground transmission route for the proposed Project passes in proximity to several fresh and coastal water resources such as ponds, wetlands, and streams, as well as groundwater resources. These include multiple Zone I and Zone II Wellhead Protection Areas, as well as surface water supply protection areas primarily surrounding Long Pond. The portion of the Brayton Point export cable corridor that crosses Aquidneck Island is in close proximity to small freshwater streams, ponds, and coastal bays. Groundwater along the route is classified as suitable for drinking water, although the area is not considered a priority area for groundwater resources (RIDEM GIS, 2020; RIDEM, 2009).

Additional details of the water resources that could be affected can be found in Appendix H, Water Quality Report.

5.2.1.1 Coastal and Offshore Data Sources

This section summarizes available water quality data from within coastal and offshore marine waters in the vicinity of the proposed Project which have been collected by government and private entities, including the Center for Coastal Studies (CCS), the Northeast Fisheries Science Center (NEFSC), National Oceanic and Atmospheric Administration (NOAA), EPA, U.S. Geological Survey (USGS), and MassDEP.

5.2.1.1.1 Center for Coastal Studies

The CCS data set includes eight sampling locations pertinent to the Project Area. There are four sampling sites, NTKS-1, NTKS-6, NTKS-8, and NTKS-10, within Nantucket Sound with data available from 2010 to 2016 and four sampling sites in coastal pond and inlet areas, Oyster Pond-Falmouth, Falmouth-Inner Harbor, Long Pond (LP-2), and Great Pond, with data available from 2014 to 2016 (CCS, 2020). Water monitoring stations are shown in **Figure 5-3**. No CCS water monitoring stations occur along the Brayton Point export cable corridor.

Table 5-6 and **Table 5-7** present the seasonal results for Nantucket Sound and coastal sampling stations respectively. The average seasonal results are summarized for water temperature, salinity, dissolved oxygen, chlorophyll *a*, turbidity, total nitrogen, and total phosphorus.

TABLE 5-6. MEAN AND STANDARD DEVIATION FOR WATER QUALITY PARAMETERS MEASURED IN NANTUCKET SOUND BY CCS (2010-2016)

Season a/	Water Temp. (°C) b/	Salinity (psu) b/	Dissolved Oxygen (mg/L) b/	Chlorophyll *a* (µg/L) b/	Turbidity (NTU) b/	Total Nitrogen (µm) b/	Total Phosphorus (µm) b/
Spring (n=27)	12.9 ± 2.3	32.1 ± 0.25	9.8 ± 1.1	1.2 ± 0.53	0.47 ± 0.31	10.1 ± 3.5	0.61 ± 0.27
Summer (n=142)	20.5 ± 2.4	31.5 ± 1.4	7.6 ± 0.75	1.9 ± 0.83	0.59 ± 0.46	11.7 ± 4.8	0.71 ± 0.31
Fall (n=83)	18.2 ± 3.0	31.9 ± 0.25	7.7 ± 0.58	2.2 ± 1.1	0.51 ± 0.37	10.4 ± 3.1	0.76 ± 0.22

Notes:

a/ n= number of samples (not all samples were analyzed for all parameters). Nantucket Sound samples include NTKS-1, NTKS-6, NTKS-8, and NTKS-10. Winter data not collected in this survey.

b/ Results show mean ± 1 standard deviation. psu = Practical Salinity Units; mg/L = milligrams per liter; µg/L = micrograms per liter, NTU = Nephelometric Turbidity Units; µm = micrometers

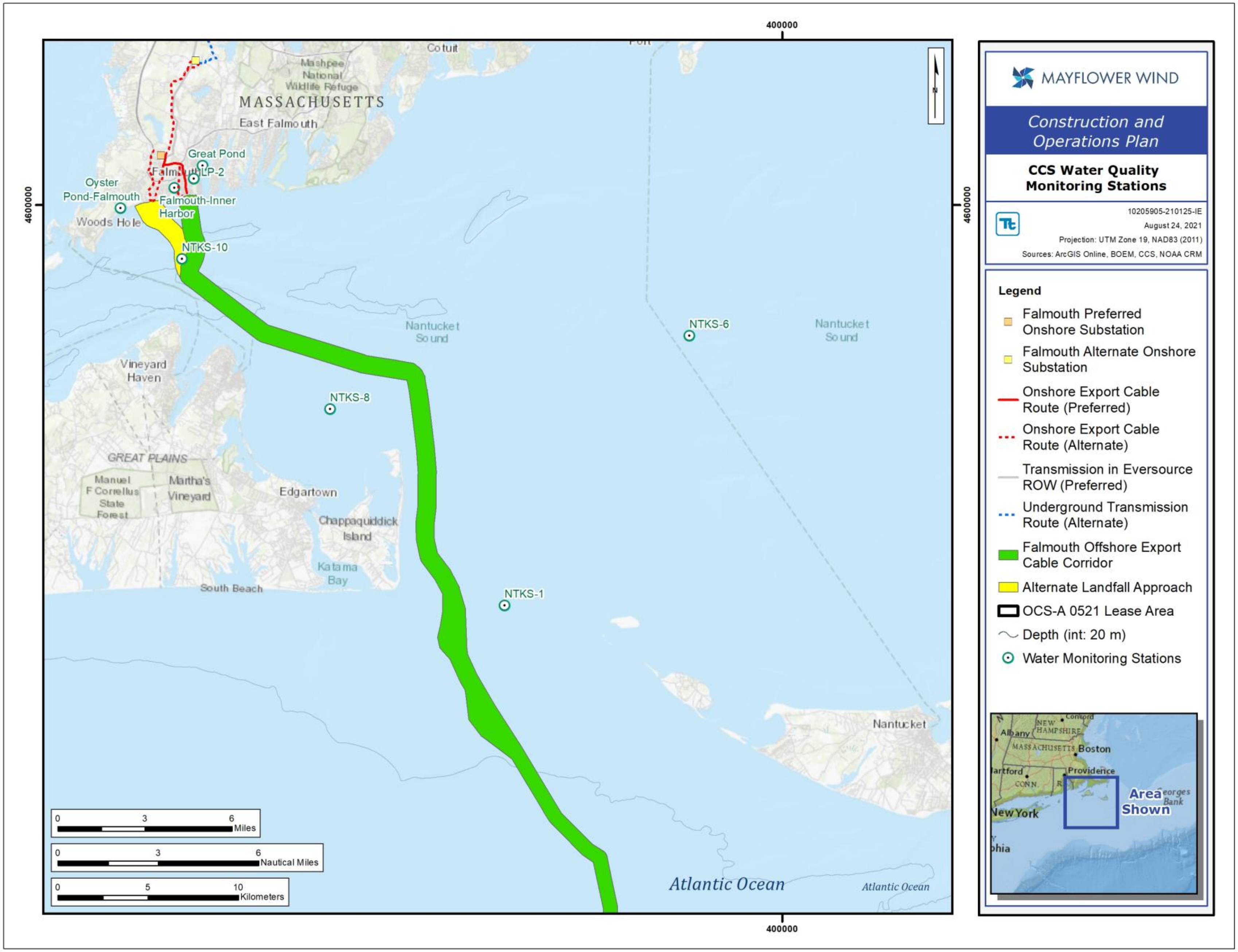


FIGURE 5-3. CCS WATER QUALITY MONITORING STATIONS

TABLE 5-7. MEAN AND STANDARD DEVIATION FOR WATER QUALITY PARAMETERS MEASURED IN COASTAL LOCATIONS BY CCS (2010-2016)

Season a/	Water Temp. (°C) b/	Salinity (psu) b/	Dissolved Oxygen (mg/L) b/	Chlorophyll *a* (µg/L) b/	Turbidity (NTU) b/	Total Nitrogen (µm) b/	Total Phosphorus (µm) b/
Spring (n=10)	18.4 ± 1.3	21.1 ± 13.3	7.0 ± 1.3	5.4 ± 2.2	2.2 ± 1.1	not sampled	not sampled
Summer (n=62)	24.1 ± 2.5	21.2 ± 12.6	6.7 ± 1.8	10.0 ± 6.3	2.3 ± 1.5	35.0 ± 12.5	1.4 ± 0.58
Fall (n=33)	19.2 ± 4.1	21.8 ± 12.6	7.2 ± 2.0	13.0 ± 12.8	2.8 ± 3.0	42.3 ± 21.5	1.4 ± 0.82

Notes:
a/ n= number of samples (not all samples were analyzed for all parameters). Coastal samples include Oyster Pond-Falmouth, Falmouth Inner Harbor, LP-2, and Great Pond. Winter data not collected in this survey.
b/ Results show mean ± 1 standard deviation. psu = Practical Salinity Units; mg/L = milligrams per liter; µg/L = micrograms per liter, NTU = Nephelometric Turbidity Units; µm = micrometers

5.2.1.1.2 Northeast Fisheries Science Center

The NEFSC data, collected between 1963 and 2019 (NEFSC, 2020), includes salinity and temperature measurements from the bottom and surface of the water column. These data were collected during seasonal multispecies bottom trawl surveys occurring in the spring, fall, and winter. Sampling locations are displayed in **Figure 5-4** and the measurements are detailed in **Table 5-8**.

TABLE 5-8. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER TEMPERATURE AND SALINITY DATA FROM THE NEFSC MULTISPECIES BOTTOM TRAWL SURVEYS (1963-2019)

Season a/	Average Water Depth (ft [m])	Layer	Water Temperature (°C) b/	Salinity (psu) b/
Winter (n=355) c/	292.7 (89.2)	Bottom	6.9 ± 3.5	33.5 ± 1.2
		Surface	5.2 ± 1.7	32.7 ± 0.5
Spring (n=1621) c/	278.2 (84.8)	Bottom	6.7 ± 3.2	33.3 ± 1.2
		Surface	5.7 ± 1.8	32.7 ±0.6
Fall (n=1704) c/	285.1 (86.9)	Bottom	12.7 ± 2.4	33.4 ± 1.4
		Surface	16.5 ± 3.6	32.9 ± 1.3

Notes:
a/ Summer data not collected in this survey.
b/ Results show mean ± 1 standard deviation.
c/ n= number of samples (not all samples were analyzed for all parameters).

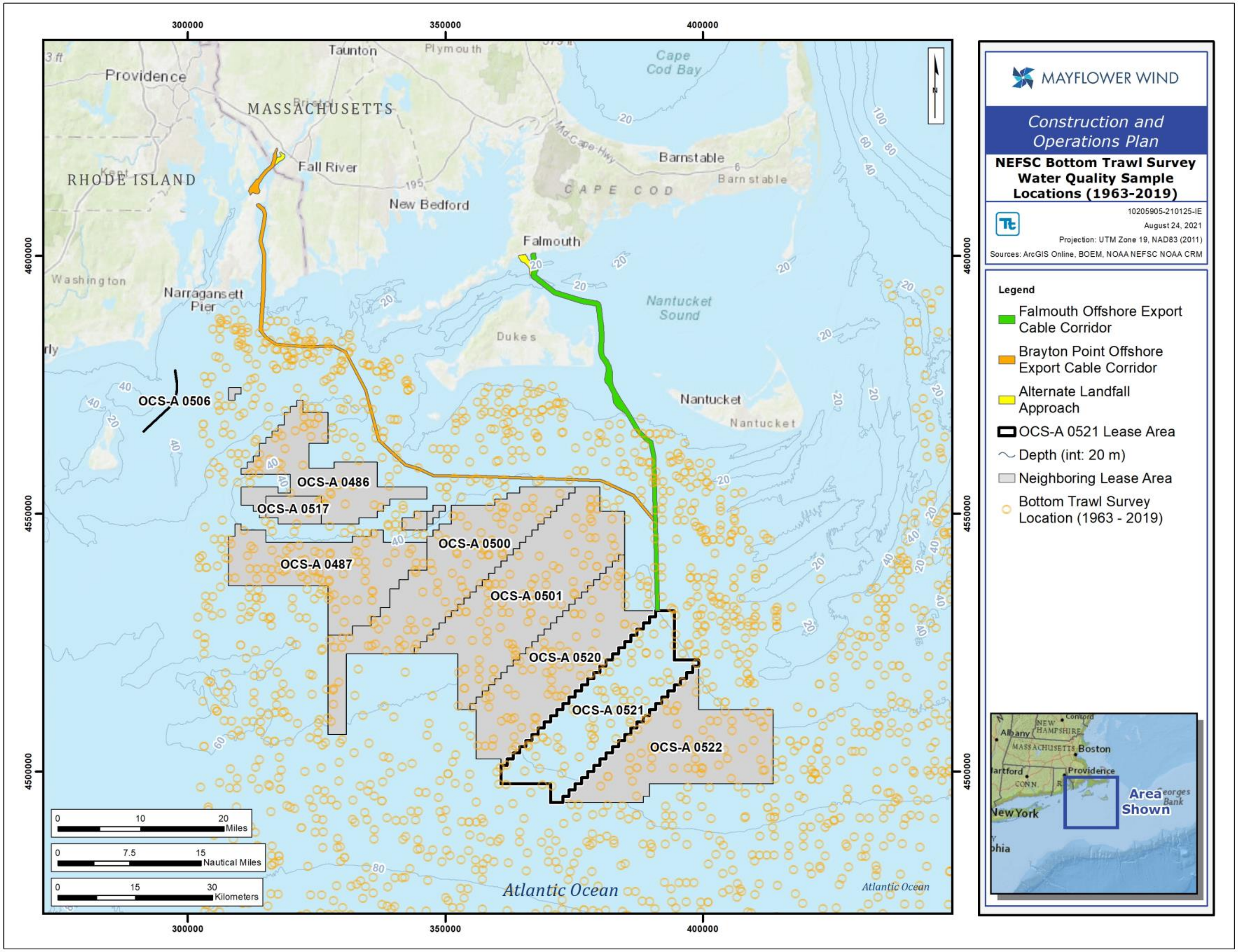


FIGURE 5-4. BOTTOM TRAWL SURVEY – WATER QUALITY SAMPLE LOCATIONS (1963-2019)

5.2.1.1.3 National Oceanic and Atmospheric Administration National Data Buoy Center

Long-term water temperature data are available via the NOAA National Data Buoy Center (NDBC) for two buoys located in the vicinity of the Offshore Project Area. Station 44020 is in Nantucket Sound at a water depth of 46.9 feet (14.3 m) and Station 44097 is located near Block Island at a water depth of 158 feet (48.16 m). Water temperature data were downloaded from the NDBC website (NOAA NDBC, 2020) for the period from 2009 through 2019 with seasonal values summarized in **Table 5-9** for Station 44020 and **Table 5-10** for Station 44097.

Long term water temperature data were also collected at NOAA buoy FRVM3 in Mount Hope Bay near the proposed Brayton Point landfall sites (NOAA NDBC, 2020). **Table 5-11** summarizes annual sea temperature data from the buoy beginning in 2004 through 2012. **Figure 5-5** shows the locations of the three buoys.

TABLE 5-9. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER TEMPERATURE DATA FROM NOAA NDBC STATION 44020 (2009-2019)

Season	Number of Samples	Water Temperature (°C) a/
Spring	35,207	7.9 ± 3.9
Summer	45,520	20.9 ± 3.2
Fall	45,395	15.7 ± 4.8
Winter	33,529	3.9 ± 2.3

Note:
a/ Results show mean ± 1 standard deviation

TABLE 5-10. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER TEMPERATURE DATA FROM NOAA NDBC STATION 44097 (2009-2019)

Season	Number of Samples	Water Temperature (°C) a/
Spring	39,154	7.6 ± 3.3
Summer	39,122	19.6 ± 3.3
Fall	32,521	17.0 ± 2.9
Winter	34,735	8.2 ± 2.8

Note:
a/ Results show mean ± 1 standard deviation.

TABLE 5-11. MEAN AND STANDARD DEVIATION FOR SEASONAL WATER TEMPERATURE DATA FROM NOAA NDBC FOR MOUNT HOPE BAY (2011-2020)

Season	Number of Samples	Water Temperature (°C) a/
Spring	210,308	9.4 ± 4.2
Summer	207,469	22.7 ± 2.8
Fall	207,819	16.5 ± 4.8
Winter	209,750	4.5 ± 2.5

Note:
a/ Results show mean ± 1 standard deviation.

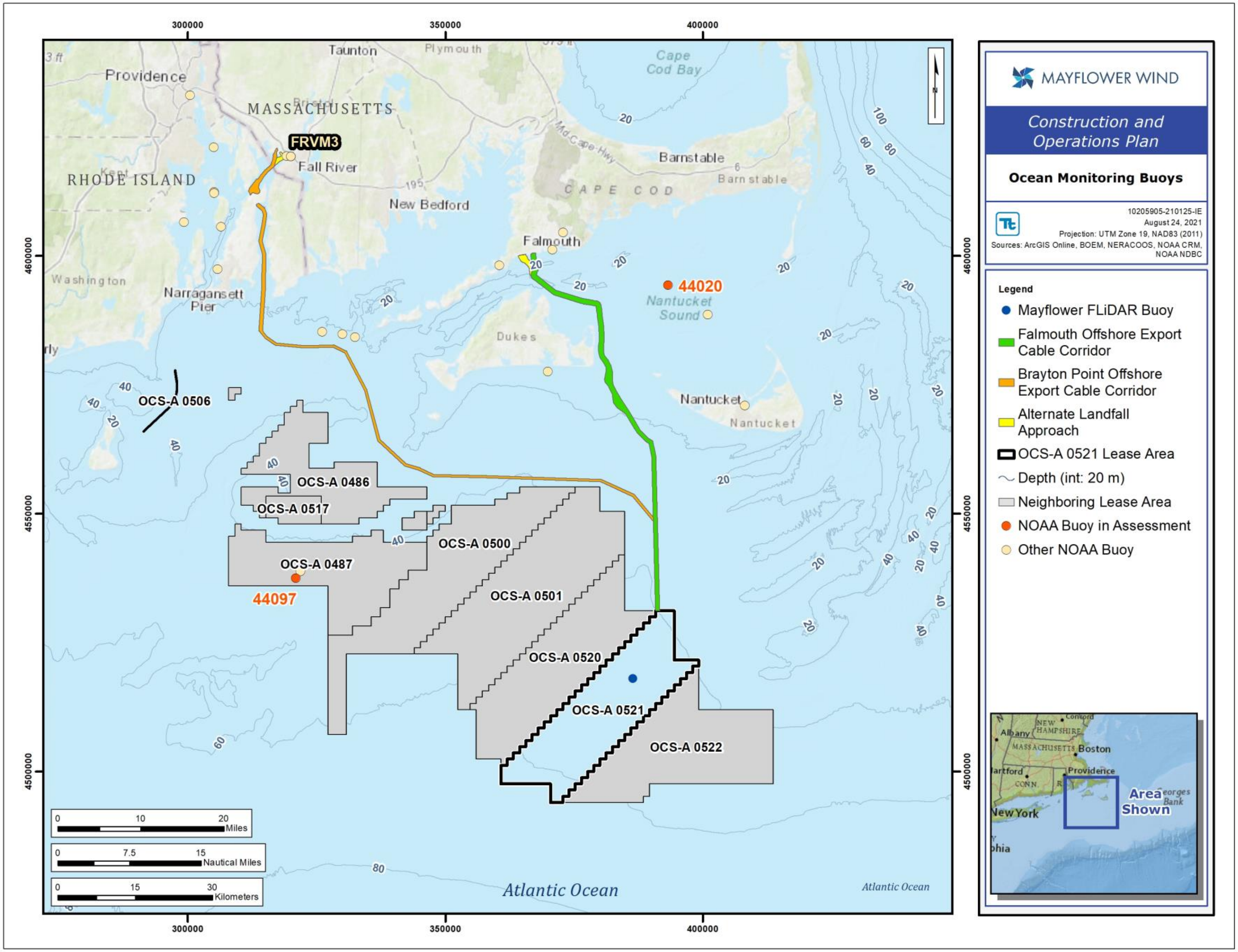


FIGURE 5-5. LOCATION OF OCEAN MONITORING BUOYS 44020, 44097, AND FRVM3

5.2.1.1.4 Environmental Protection Agency

The condition of coastal water was assessed by the EPA in the 2010 National Coastal Condition Assessment (NCCA; EPA, 2015). Water quality data from the 2010 NCCA are available for eight stations within Nantucket Sound.

This assessment included chlorophyll *a*, dissolved inorganic nitrogen, dissolved inorganic phosphorus, dissolved oxygen at the bottom of the water column, and light transmissivity measurements. Water quality results for the Nantucket Sound data set is provided in **Table 5-12** and sample locations are provided in **Figure 5-6**. Four NCCA water quality sample locations were identified along the Brayton Point export cable corridor.

TABLE 5-12. MEAN AND STANDARD DEVIATION FOR WATER QUALITY PARAMETERS MEASURED IN THE 2010 NCCA

Area	Chlorophyll *a* (ug/L) a/	Dissolved Inorganic Nitrogen (mg/L) a/	Dissolved Inorganic Phosphorus (mg/L) a/	Dissolved Oxygen (mg/L) a/	Light Transmissivity (% at 1 m depth) a/
Nantucket Sound (n=8) b/	3.9 ± 1.1	0.019 ± 0.002	0.017 ± 0.003	6.5 ± 1.3	63.1 ± 5.1

Notes:
a/ Results show mean ± 1 standard deviation. Mg/L = milligrams per liter; µg/L = micrograms per liter
b/ n= number of samples (not all samples were analyzed for all parameters)

5.2.1.1.5 United State Geological Survey

The USGS assessed river water quality in the Sakonnet River along the Brayton Point export cable corridor. The data were collected at USGS buoy monitoring station 413642071125701 near Gould Island, Rhode Island in 2018 and 2019; the station location is shown on **Figure 5-7** (USGS, 2019). Data collected for water temperature, salinity, dissolved oxygen, chlorophyll a, turbidity, total nitrogen, and total phosphorus are provided in **Table 5-13**.

TABLE 5-13. MEAN AND STANDARD DEVIATION FOR WATER QUALITY PARAMETERS MEASURED IN THE SAKONNET RIVER NEAR GOULD ISLAND BY USGS (2018-2018)

Season	Water Temp. (°C) a/	Salinity (psu) a/ b/	Dissolved Oxygen (mg/L) a/	Chlorophyll *a* (µg/L) a/	Turbidity (NTU) a/ b/	Total Nitrogen (mg/L) a/	Total Phosphorus (mg/L) a/
Spring (n=8) c/	15.9 ± 2.4	29 ± 0.8	7.3 ± 0.4	5.9 ± 3.1	1.7 ± 0.7	0.23 ± 0.04	0.04 ± 0.01
Summer (n=28) c/	22.9 ± 1.7	30.9 ±0.3	5.9 ± 0.8	6.5 ± 5.5	2.2 ± 0.5	0.29 ± 0.07	0.07 ±0.01
Fall (n=14) c/	15 ± 4.4	29.3 ± 1.1	7.4 ± 0.9	2.7 ± 0.7	2.5 ± 0.7	0.34 ± 0.08	0.08 ± 0.01

Notes:
a/ Results show mean ± 1 standard deviation. psu = Practical Salinity Units; mg/L = milligrams per liter; µg/L = micrograms per liter, NTU = Nephelometric Turbidity Units
b/ Values for turbidity and salinity were only measured in 2018
c/ n= number of samples (not all samples were analyzed for all parameters).

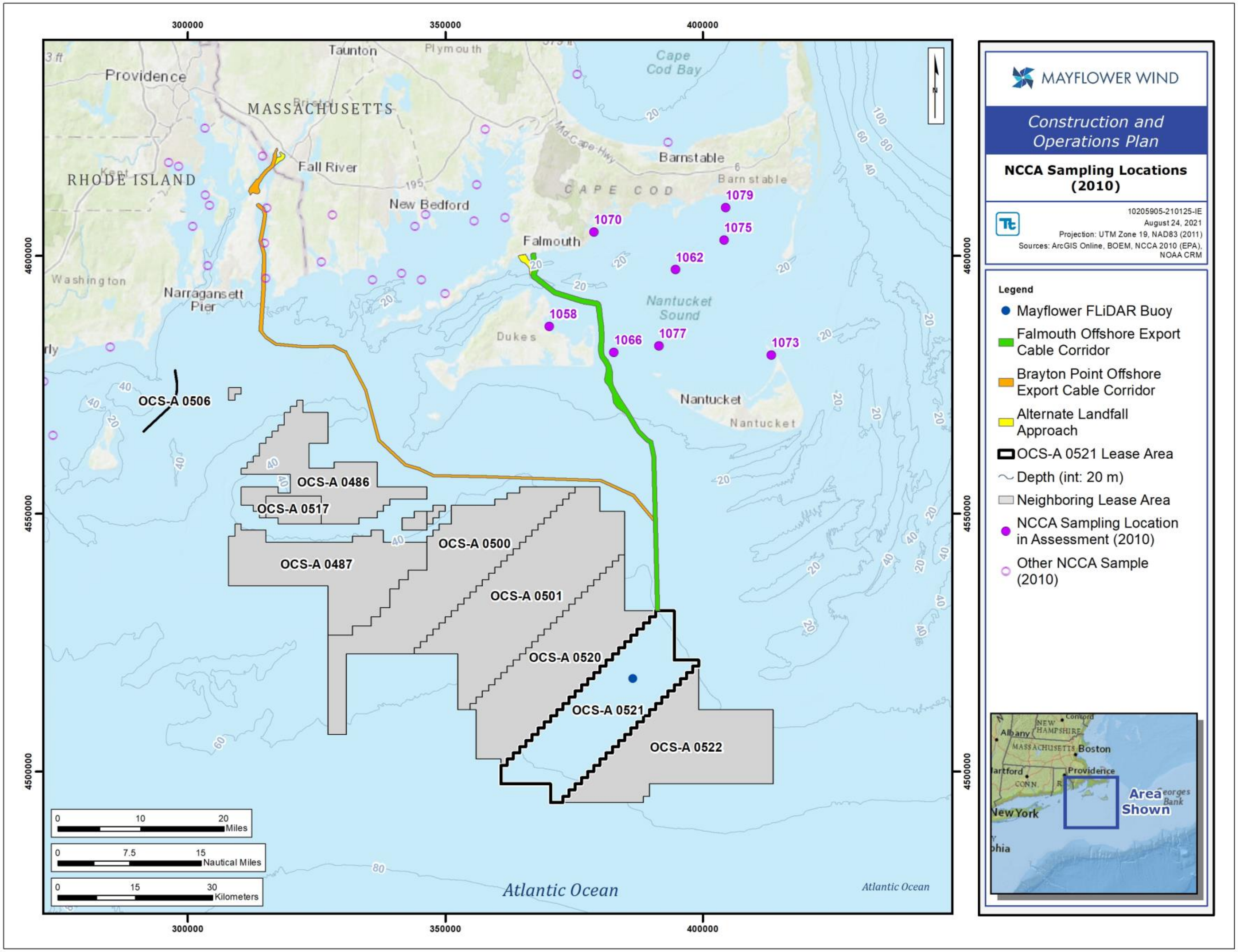


FIGURE 5-6. NCCA SAMPLING LOCATIONS

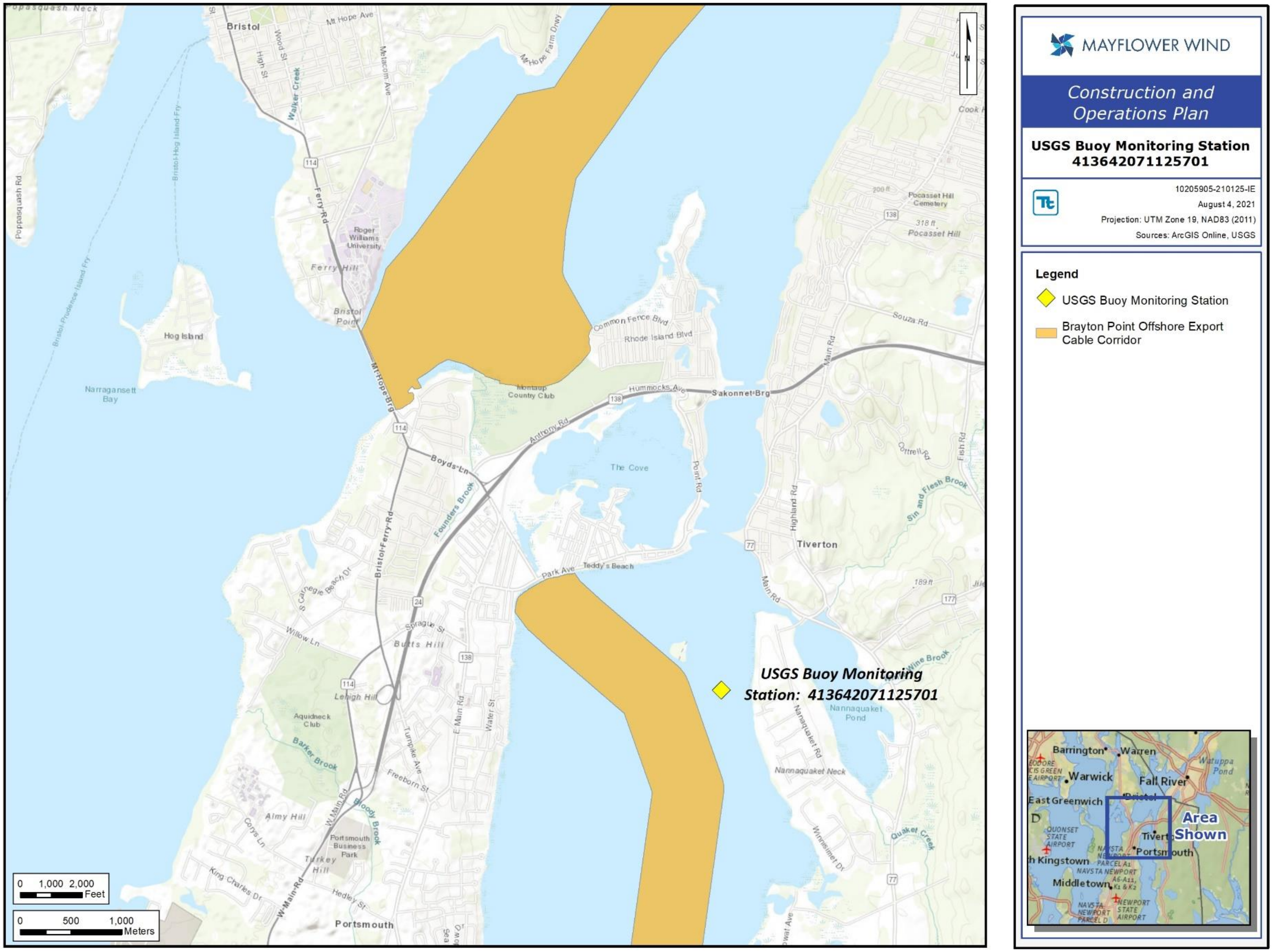


FIGURE 5-7. USGS SAMPLING LOCATIONS

5.2.1.2 Massachusetts Department of Environmental Protection

The MassDEP has two fixed-location buoys in Mount Hope Bay. The Cole River and Taunton River buoys collect data during the summer and early fall between May and November and are part of the Narragansett Bay Fixed-Site Monitoring Network (NBFSMN). Data collected from these stations are available for the 2017 and 2018 seasons (NBFSMN, 2018).

The MassDEP assessment included water temperature, salinity, dissolved oxygen, chlorophyll *a*, and total nitrogen measurements. Water quality results for the Mount Hope Bay data set is provided in **Table 5-14** and sample locations are provided in **Figure 5-8.**

TABLE 5-14. MEAN AND STANDARD DEVIATION FOR WATER QUALITY PARAMETERS MEASURED IN MOUNT HOPE BAY BY NBFSMN (2017-2018)

Year	Site	Water Temp. (°C) a/	Salinity (psu) a/	Dissolved Oxygen (mg/L) a/	Chlorophyll (RFU) a/	Nitrate-N (mg/L) a/
2017	Taunton River	20.3 ± 3.2	27.4 ± 1.2	7.4 ± 1.3	2.5 ± 2.2	0.12 ± 0.06
	Cole River	20.5 ± 3.3	27.9 ± 1.9	7.9 ± 1.3	4.3 ± 3.7	0.13 ± 0.06
2018	Taunton River	21.3 ± 4.3	27.2 ± 2.6	7.1 ± 1.2	2.7 ± 2.2	0.18 ± 0.08
	Cole River	21.4 ± 4.4	27.5 ± 2.1	7.5 ±1.2	2.7 ± 2.0	0.16 ± 0.06

Note:
a/ Results show mean ± 1 standard deviation. psu = Practical Salinity Units; mg/L = milligrams per liter; RFU = relative fluorescence units

5.2.1.3 Onshore Surface Waters and Groundwater

5.2.1.3.1 Onshore Project Area

The Falmouth underground export cable and transmission routes pass several small coastal ponds between the preferred and alternate export cable landfall locations and the onshore substation sites. The onshore export cable and alternate underground transmission routes do not cross any mapped rivers, streams, vernal pools, or waterbodies, but do pass within 0.6 miles (1 km) of Cape Cod Canal, Great Pond, Grews Pond, and Long Pond. The underground onshore export cable routes between the preferred and alternate landfall locations and the onshore substation sites pass through residential areas containing small coastal ponds including Salt Pond, Sols Pond, Jones Pond, Grews Pond, Siders Pond, Shivericks Pond, an unnamed pond north of Shivericks Pond, Nyes Pond, and Morse Pond.

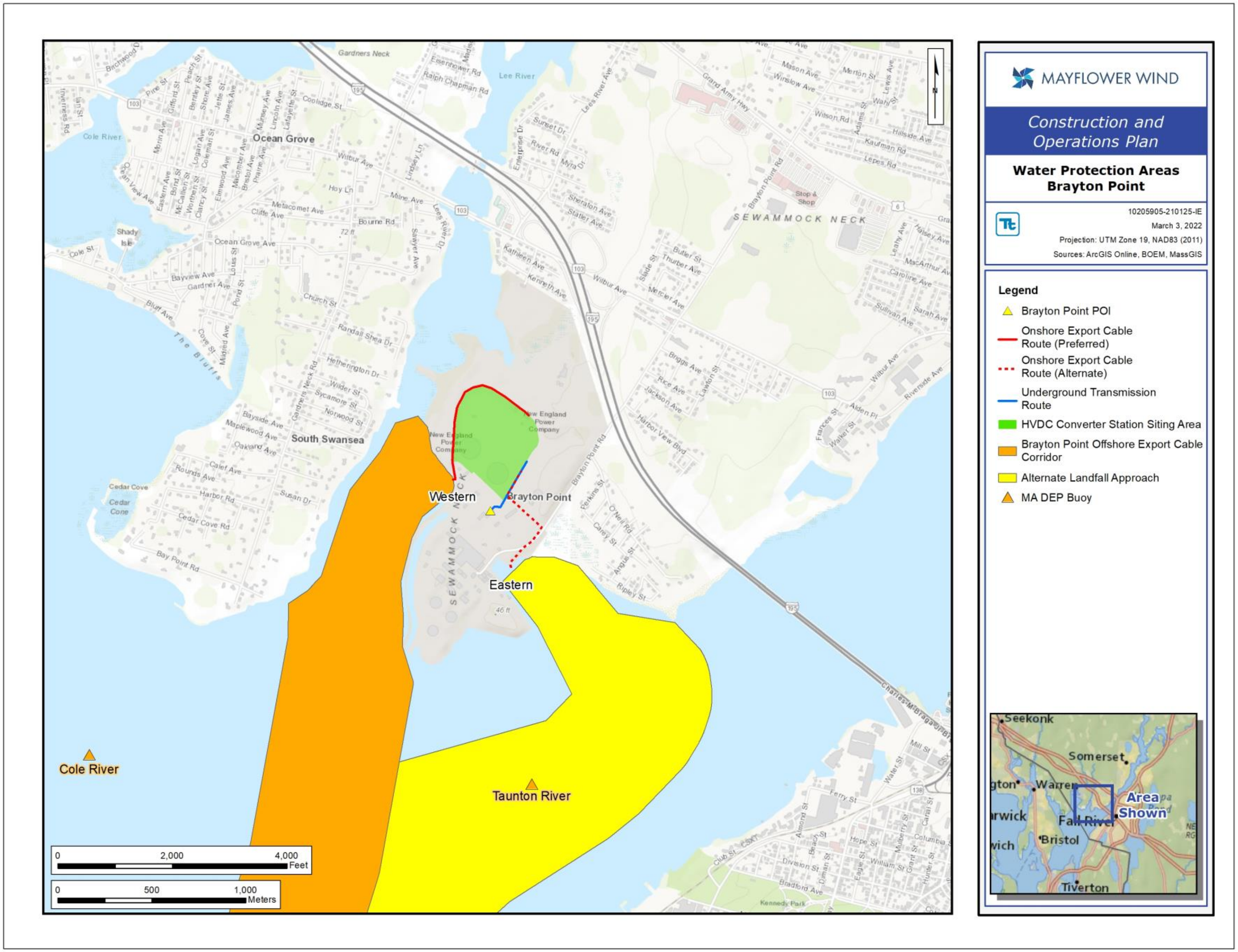


FIGURE 5-8. MASSDEP SAMPLING LOCATIONS

Freshwater Recharge Areas (FWRA) are regulated by the Cape Cod Commission and represent watershed areas where fresh surface or groundwater discharge to various ponds located on Cape Cod. Some of the onshore export cable routes traverse FWRAs and the alternate underground transmission route passes through mapped FWRAs (**Figure 5-9**). Less than 1 acre (ac, 0.25 hectare [ha]) on the northeastern boundary of the Lawrence Lynch site falls within a FWRA. The Cape Cod Aggregates site falls within mapped FWRAs. Water quality data are available from four coastal waterbodies connected to Nantucket Sound located within the vicinity of potential landfall locations including Oyster Pond, Falmouth-Inner Harbor, Little Pond, and Great Pond.

The USGS has investigated groundwater and surface water resources on Cape Cod for over 50 years. Groundwater is the sole source of drinking water and a major source of freshwater for domestic, industrial, and agricultural uses on the Cape. Groundwater discharged from aquifers also supports freshwater pond and stream ecosystems and coastal wetlands. In most areas, groundwater in the sand and gravel aquifers is shallow and susceptible to contamination from anthropogenic sources and saltwater intrusion (Barbaro et al., 2014). No drinking water protection areas occur in the Brayton Point Onshore Project Area in Massachusetts or Rhode Island (see **Figure 5-10** and **Figure 5-11**).

5.2.1.3.2 Brayton Point Onshore Project Area

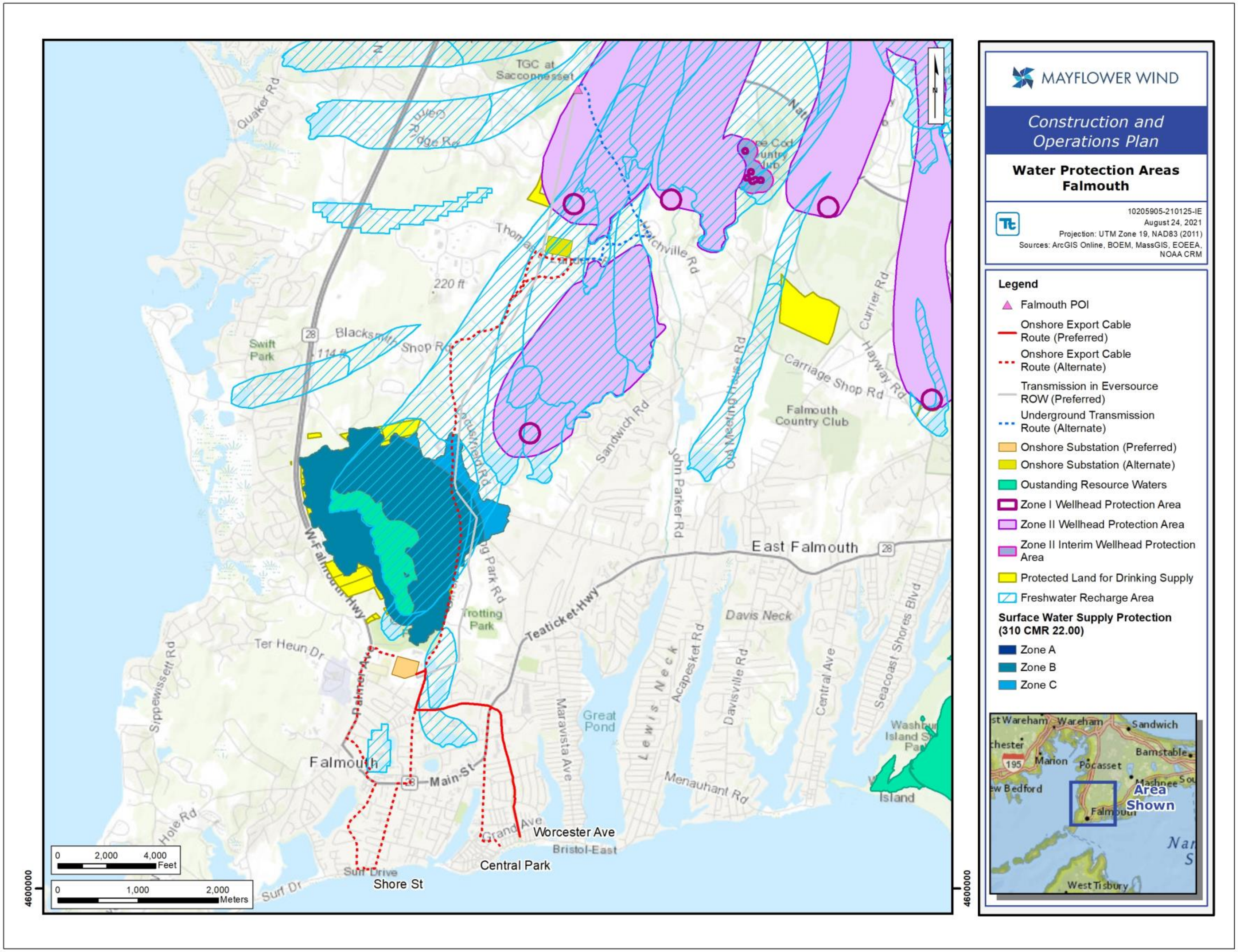
The Brayton Point export cable corridor crosses over Aquidneck Island in route to the Brayton Point landfall locations. As the export cable crosses over Aquidneck Island it passes through residential and recreational areas. There are several freshwater streams and ponds present in the vicinity of the onshore export cable route options. The three proposed routes pass near Founders Brook (**Figure 5-11**), a 1.2 mile (1.9 km)-long stream.

Rhode Island Department of Environmental Management classifies the groundwater quality of the area surrounding the export cable corridors on Aquidneck Island as class GA. Groundwater classified GA is known or presumed to be suitable for drinking water use without treatment. However, this is not considered a priority area and approximately 70 percent of the state of Rhode Island overlies groundwater classified as GA (RIDEM GIS, 2020; RIDEM, 2009). There are no wellhead protection areas along the route (**Figure 5-11**).

The landfall locations of the proposed export cable are situated on a small peninsula in Mount Hope Bay in Massachusetts. While MassDEP does not classify groundwater like Rhode Island, they do identify drinking water protection areas and wellhead recharge areas and the Brayton Point onshore Project area does not contain either (see **Figure 5-10**). The Brayton Point onshore export cable is located near a small detention pond and shallow coastal bay and marsh area, but there are no freshwater recharge areas within the onshore cable route path. The groundwater flow direction is southward toward Mount Hope Bay and the Taunton River from upland areas to the north.

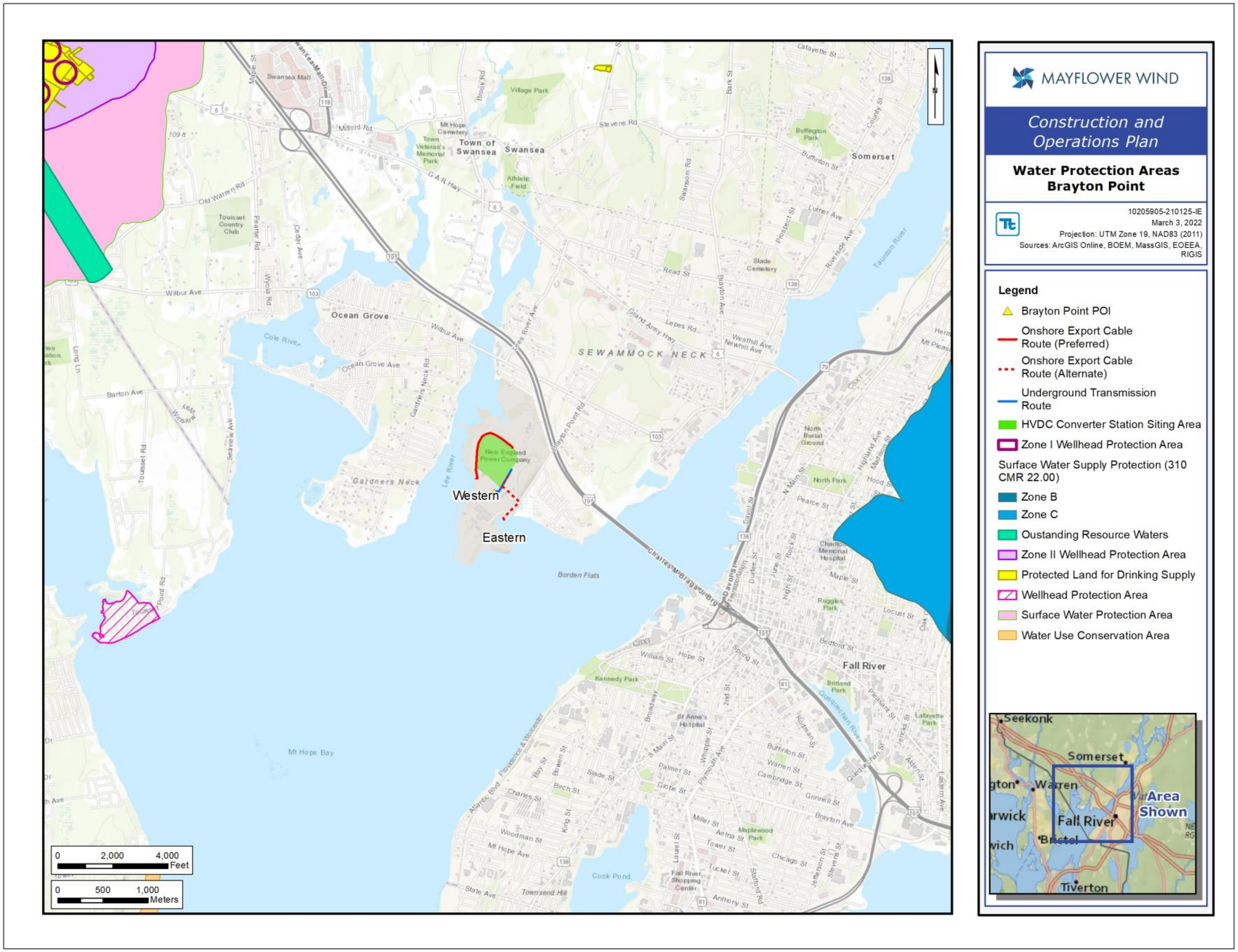
5.2.1.4 Offshore and Coastal Existing Conditions

This section provides a discussion of the water quality data available from the sources identified in Section 5.2.1. The water quality parameters discussed in this section include water temperature, salinity, chlorophyll *a*, nutrients, dissolved oxygen, and turbidity in the offshore locations and coastal ponds. This section discusses available water quality data available for the Lease Area/open ocean, Muskeget Channel/Nantucket Sound, Rhode Island Sound, Sakonnet River, and Mount Hope Bay. Additional details can be found in Appendix H, Water Quality Report.



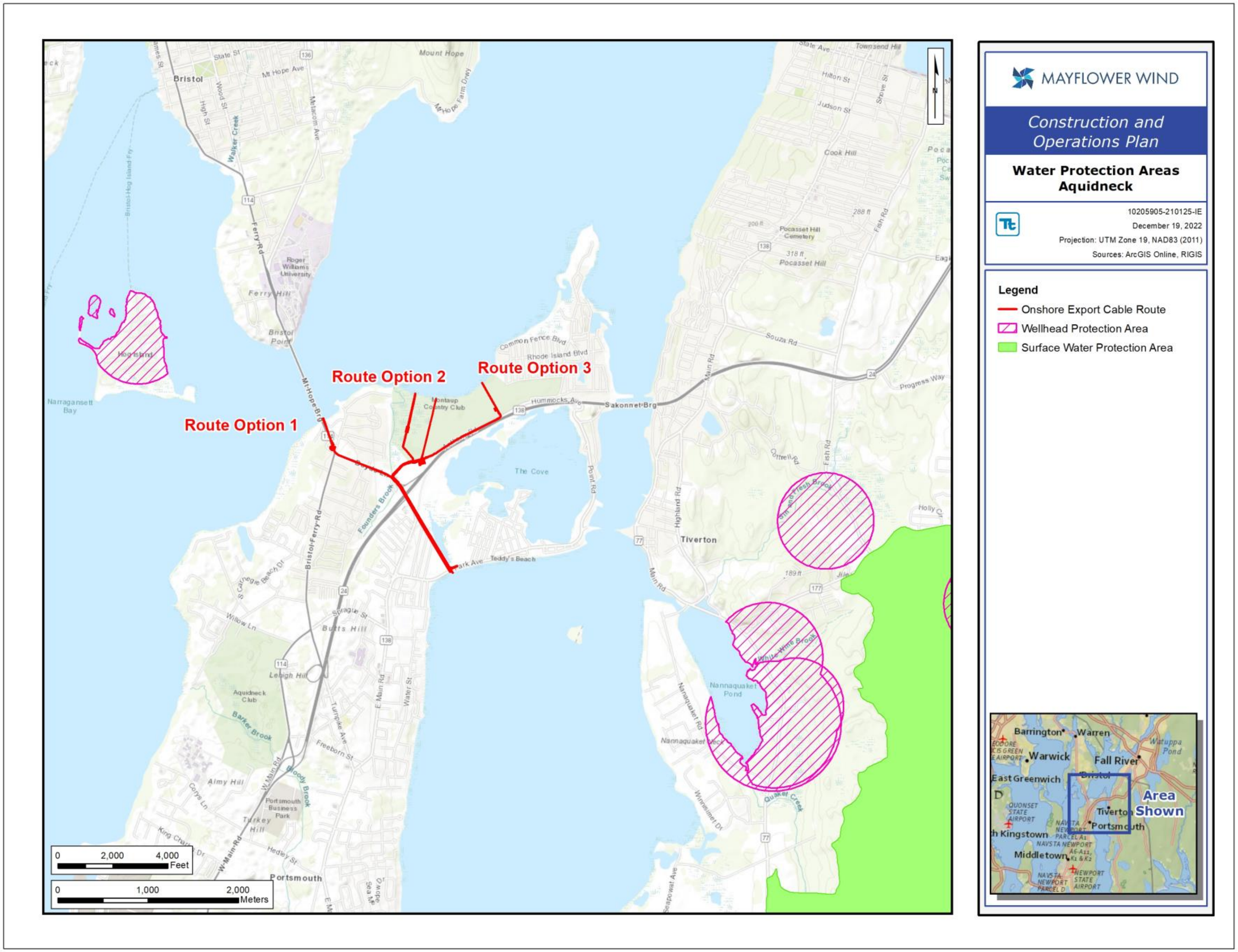
Source: MASSGIS, 2019, 2020; MASSGIS & MASSDEP, 2019; MASSGIS & EOEEA, 2020

FIGURE 5-9. DRINKING WATER PROTECTION AREAS – FALMOUTH ONSHORE PROJECT AREA



Source: MASSGIS, 2019, 2020; MASSGIS & MASSDEP, 2019; MASSGIS & EOEEA, 2020

FIGURE 5-10. DRINKING WATER PROTECTION AREAS – BRAYTON POINT ONSHORE PROJECT AREA



Source: RIGIS, 2016, 2016a; 2019, 2019a

FIGURE 5-11. DRINKING WATER PROTECTION AREAS – AQUIDNECK ISLAND ONSHORE EXPORT CABLE ROUTE OPTIONS

5.2.1.4.1 Temperature

Offshore water temperatures are influenced by seasonal mixing of water masses, estuarine outflows, and air-sea interactions. Water temperatures vary on a seasonal basis, warming in the spring, peaking in late summer, and cooling in the fall and into the winter. These trends are reflected in the seasonal water temperature data presented in **Table 5-6** to **Table 5-12**.

Higher temperatures are consistently recorded in the coastal data set (near export cable landfall locations) (**Table 5-7**) relative to the Nantucket Sound data set (**Table 5-6**). This is not surprising as the coastal samples are collected in smaller, more shallow locations and waterbodies that are not subject to the same current seen in the Sound.

Temperatures in the open ocean, represented by the NEFSC bottom trawl data (**Table 5-8**) and the NOAA NDBC data (**Table 5-9** and **Table 5-10**), are typically lower than observed by CCS in the coastal areas or the Sound, particularly in the spring and fall (CCS data are not collected in winter months).

The NEFSC bottom trawl survey (**Figure 5-4**) collects both surface and bottom water temperatures. These results show that average temperatures at the surface and bottom are similar in spring and winter, with warmer temperatures in the surface horizon in the fall. This suggests some thermal stratification within the water column in the fall. Stratification likely occurs in the summer as well given the more elevated water temperatures recorded by CCS and the NOAA NDBC for the summer months, but bottom temperature data was not available.

Average bottom temperatures are substantially colder in the winter and spring than in the fall. Surface temperatures recorded by the NEFSC were highest and most variable in the fall (summer sampling is not conducted by the NFESC). In the fall, upwelling bottom waters and storm activity mixes the stratified water column that typically occurs by late summer.

The NOAA NDBC data (**Table 5-9** and **Table 5-10**) provide seasonal surface water temperature data over the course of 11 years (2009-2019). The two buoys in the vicinity of the Offshore Project Area (Buoys 44020 and 44097) show generally similar patterns with the highest temperatures in the summer and the lowest in the winter and spring. The lowest average temperatures were recorded in the winter for Buoy 44020 located in Nantucket Sound. The average winter water temperature for Buoy 44097 located in the open ocean off Block Island was twice that of Buoy 44020. The other seasonal averages were generally similar between the two buoys.

The NOAA Buoy FRVM3 located near Brayton Point also shows the highest temperatures occurring in the summer and lowest temperatures occurring in the winter (**Figure 5-5**). Median temperatures were lowest in February and similar to those measured at Buoy 44020. Summer temperatures were higher than those measured at both Buoy 44020 and 44097.

NBFSMN buoy data from its Cole River and Taunton River buoys in Mount Hope Bay show mean temperatures from May to November of 2017 and 2018 (**Table 5-14**). Temperatures at each location were relatively the same each year during the monitoring season, averaging between 68-70ºF (20-21ºC).

5.2.1.4.2 Salinity

Like temperature, salinity may vary based on seasonal changes and currents, but the changes are more minimal than for temperature. In the CCS data, mean salinity in Nantucket Sound data set (**Table 5-6**) was approximately 32 Practical Salinity Units (psu) in spring, summer, and fall and mean salinity in the coastal data set (**Table 5-7**), which is more influenced by freshwater flow and surface runoff, was approximately 21 psu throughout the seasons.

The NEFSC multispecies bottom trawl survey data (**Table 5-8**) showed minimal variation in salinity by season or depth. The seasonal average surface salinities were essentially the same in spring, fall, and winter. The bottom salinities averaged marginally higher than the surface salinities, but the difference were less than 1 psu between the surface and bottom.

The USGS data for the Sakonnet River (**Table 5-13**) shows a mean salinity of approximately 30 psu in the spring, summer and fall. The Sakonnet River is a tidal straight with most influence coming from the Rhode Island Sound and Atlantic Ocean. Further upstream in Mount Hope Bay, mean salinity measured by MassDEP (**Table 5-14**) is slightly lower due to the freshwater influence from the Taunton and Cole rivers as well as the surrounding Narragansett watershed.

5.2.1.4.3 Chlorophyll a

Chlorophyll *a* is a photosynthetic green pigment found in most phytoplankton and plant cells. Measuring chlorophyll *a* in the surface water is an indication of how much primary production is occurring in the surface of the ocean. Chlorophyll *a* is used as an indicator for eutrophication and levels will increase with increased phytoplankton production, which is often related to increased nutrient inputs.

In the CCS data, the highest and most variable chlorophyll *a* levels were recorded in fall samples collected from the coastal sampling locations (average of 13 micrograms per liter [µg/L]; **Table 5-7**) with lower levels recorded in the spring. The levels in the fall reflect nutrient inputs from nearshore sources and the maximum primary production toward the end of the growing season. Chlorophyll *a* levels in Nantucket Sound are lower (seasonal averages ranged from 1.2 to 2.2 µg/L; **Table 5-6**) and show less seasonal variability.

The USGS reported Chlorophyll *a* in the Sakonnet River in 2018 and 2019 and there was some seasonal variability (**Table 5-13**). During the summer, median concentrations of Chlorophyll *a* were 6.5 µg/L while during the fall median concentrations were 2.7 µg/L. Upstream in Mount Hope Bay, the Chlorophyll *a* concentrations were slightly lower (**Table 5-14**).

5.2.1.4.4 Nutrients

Nitrogen and phosphorus are two of the primary nutrients measured in coastal and marine waters. These nutrients are required for the growth of algae and phytoplankton, but excessive levels of these nutrients can lead to eutrophication, reduced water clarity, and lower levels of dissolved oxygen.

Nutrient information is available from the data reported by CCS and in the NCCA (EPA, 2015). Although these two studies report nutrient data differently, they provide useful information relative to nutrient trends in the water. Of the eight Nantucket Sound locations considered in the NCCA, nitrogen levels in all samples were rated in Good condition and phosphorus was rated as Fair in all locations based on the EPA water quality index (EPA, 2015; **Table 5-12**).

The USGS reported total nitrogen and total phosphorus concentrations for the Sakonnet River (**Table 5-13**), and the NBFSMN reported nitrate-N concentrations for Mount Hope Bay were much higher than in the Rhode Island Sound (**Table 5-14**). While both studies reported nutrients differently than the CCS and NCCA studies, they indicated that nutrients were higher in the Sakonnet River and Mount Hope Bay. The Sakonnet River experienced its highest amount of nutrients, both nitrogen and phosphorus, in the fall season. Nutrient inputs are expected to come from the surrounding Narragansett Bay watershed, consisting of mostly developed land.

5.2.1.4.5 Dissolved Oxygen

Dissolved oxygen is essential for maintaining present conditions for aquatic life. Concentrations below 2 mg/L can lead to hypoxia, which is detrimental to most organisms. Dissolved oxygen level can be influenced by physical factors (e.g., water temperature) and biological factors (e.g., respiration, photosynthesis, and bacterial decomposition).

In the CCS data, dissolved oxygen levels were lowest in the summer months for both Nantucket Sound (**Table 5-6**) and coastal locations (**Table 5-7**); however, average dissolved oxygen levels measured by CCS were representative of reasonably well oxygenated conditions.

In the USGS data, the Sakonnet River dissolved oxygen levels were lowest in the summer months. During the summer the mean dissolved oxygen is about 5.9 mg/L (**Table 5-13**). NBFSMN Cole River and Taunton River buoys report healthy mean dissolved oxygen levels for Mount Hope Bay of around 7.5 mg/L (**Table 5-14**).

5.2.1.4.6 Turbidity

Turbidity is a measure of water clarity or how much the material suspended in the water column decreases light penetration. Excessively turbid water can be detrimental to water quality if suspended sediments settle out and bury benthic communities, adversely affect filter feeders, or block sunlight needed by submerged vegetation.

In the CCS data, turbidity levels were highest and most variable in the summer months for Nantucket Sound locations (**Table 5-6**); however, levels were relatively low through the spring, summer, and fall. In the coastal locations, turbidity levels were higher than in the Sound with the highest average recorded in the fall (**Table 5-7**). These coastal turbidity levels are higher than in the Sound due to inputs from onshore sources including suspended sediments from rivers and inlets.

Turbidity in the Sakonnet River reported by USGS (**Table 5-13**) was highest in the summer and fall seasons but overall relatively low (less than 10 Nephelometric Turbidity Units).

Turbidity was not reported by the NBFSMN for Mount Hope Bay.

5.2.1.5 National Coastal Condition Assessment: Present Conditions

NCCA data from the EPA includes Chlorophyll *a*, nutrient, dissolved oxygen, and turbidity collected in two locations to populate the Nantucket Sound set. The Nantucket Sound data percentage distributions can be seen in **Table 5-15**. As stated above, this dataset does not cover the Brayton Point export cable corridor.

TABLE 5-15. NCAA DATA PERCENTAGES IN NANTUCKET SOUND

Area	Condition	Chlorophyll *a* Samples (%) a/	Dissolved Inorganic Nitrogen (%) a/	Dissolved Inorganic Phosphorus (%) a/	Dissolved Oxygen (%) a/	Light Transmissivity (%) a/ b/
Nantucket Sound (n=8) c/	Good	88%	100%	0%	88%	75%
	Fair	12%	0%	100%	12%	0%
	Poor	0%	0%	0%	0%	0%

Notes:
a/ Results show percent of samples within each category for individual parameters and overall water quality index.
b/ Percentages for a parameter do not add up to 100% in cases where results were missing.
c/ n= number of samples (not all samples were analyzed for all parameters)

5.2.1.6 Onshore Surface Water and Groundwater Existing Conditions

As described in Section 5.2.1.3, several coastal and freshwater ponds, wetlands, streams, and groundwater resources are in the vicinity of the onshore export cables. However, specific onshore surface water and groundwater quality data within this corridor were not identified.

Groundwater in the vicinity of the Falmouth onshore export cable routes includes drinking water protection areas and portions of groundwater contamination plumes located approximately ten miles north of the Falmouth Onshore Project Area. Several ponds and surface water supply protection areas are also located in the vicinity of the onshore export cable routes, although few waterbodies are directly adjacent to the routes (one exception is a small pond located to the east of one of the onshore substation sites under consideration). In many cases, there are vegetated areas between the waterbodies and the area likely to be subject to construction activities.

The Brayton Point onshore export cable route crosses an area classified by RIDEM as suitable for drinking water without treatment. However, this is not considered a priority and approximately 70 percent of the state of Rhode Island overlies groundwater classified as GA (suitable for drinking water without treatment). There are no drinking water protection areas (e.g., public wells, well head protection areas, drinking water reservoir watersheds, etc.) along the Brayton Point export cable corridor, including the overland portion on Aquidneck Island. The Brayton Point onshore export cable route passes besides small unnamed ponds and shallow coastal bays.

A review of potential environmentally affected sites along the route was conducted and included a search of various governmental databases by Environmental Data Resources, Inc. This review indicated that all but one reported release had been closed out by the state. One state hazardous waste site associated with a petroleum release at the Falmouth High School remains open. Although most of these sites are closed, there may be institutional controls associated with the properties and residual affected soil and/or groundwater may still be present at concentrations below regulatory standards at closed sites. In addition, incidental spills and/or releases resulting in less than reportable quantities may have occurred and not been reported.

Project-related construction activities will be designed to avoid, minimize, or mitigate potential effects to local groundwater and surface water resources that may occur due to soil erosion or stormwater discharge into waterbodies or contact with groundwater resources. The proposed Project does not anticipate encountering significant areas with contaminated soil and groundwater.

Additional details of the existing conditions for the onshore surface water and groundwater within the Project Area can be found in Appendix H, Water Quality Report.

5.2.2 Sediment Chemistry

Sediment contamination may have a bearing on the potential for water quality effects during construction, associated with sediment disturbing activities. Contaminant data for sediment directly within the proposed Project Area was not identified. The 2010 NCCA (EPA, 2015) included an assessment of sediment chemistry and sediment toxicity information for the eight Nantucket Sound locations identified in **Figure 5-6**. Parameters for sediment chemistry data include sediment contaminants, sediment toxicity, and overall sediment quality index (SQI) and can be found in **Table 5-16**.The available sediment chemistry data for Nantucket Sound document concentrations of sediment contaminants (e.g., metals, polycyclic aromatic hydrocarbons) below levels of concern.

TABLE 5-16. SEDIMENT PARAMETER SCORES AND SQI FOR NANTUCKET SOUND (N=8)

Parameter a/	Good b/	Fair b/	Poor b/
Sediment Contaminants	100%	0%	0%
Sediment Toxicity c/	38%	25%	25%
Overall SQI	50%	25%	25%

Notes:
a/ n = number of samples (not all samples were analyzed for all parameters)
b/ Results show percent of samples within each category for individual parameters and overall SQI
c/ Percentages for a parameter do not add up to 100% in cases where results were missing.

The sediments of Mount Hope Bay showed evidence of contamination by heavy metal and organic pollutants (**Table 5-17**). Data collected from multiple locations approximately 0.62 miles (1 km) southwest of Brayton Point from the top 0.8 inches (in) (2 centimeters, cm) during a single sample event in the bay show that pollutants are present (Calabretta & Oviatt, 2008). Sediment chemistry data for the Sakonnet River was not available; however, based upon the down-bay gradient, the river sediment contaminant concentration should be less than that of Mount Hope Bay.

TABLE 5-17. SEDIMENT CHARACTERISTICS AND CONTAMINANT CONCENTRATIONS FOR MOUNT HOPE BAY

Contaminant	Contaminant Concentration
Heavy metals (mg/kg)	
Arsenic	9.07
Cadmium	0.81
Chromium	111.7
Copper	55.2
Iron	34,500
Lead	86.3
Mercury	0.93
Nickle	23.5
Silver	1.77
Zinc	151.3

Contaminant	Contaminant Concentration
Organic Contaminants (µg/kg)	
Total PAH	1593
Low MW PAH	258
High MW PAH	1336
Total DDT	1.36
Total PCB	14.40

Source: (Calabretta & Oviatt, 2008)

5.2.3 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

IPFs listed in **Table 5-18** may affect water quality due to Project activities in the proposed Project Area. Measures to avoid, minimize, and mitigate potential effects were considered and may be implemented, when necessary.

TABLE 5-18. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON WATER QUALITY

IPF	Potential Effect		Period of Potential Effect		
	Project Component		Project Phase		
	Offshore Project Area	Onshore Project Areas	Construction	O&M	Decomm.
Seabed (or ground) disturbance	Offshore component installation and decommissioning; Routine offshore O&M; Vessel anchoring	HDD	X	X	X
Planned Discharges	Storm water runoff; Routine releases	Storm water runoff; Duct bank installation	X	X	X
Accidental Events	Unplanned releases	Unplanned releases	X	X	X
Natural Hazards	Unplanned releases	Unplanned releases	X	X	X

5.2.3.1 Seabed or Ground Disturbance

Seabed or ground disturbance linked to anchoring, cable placement and maintenance, structure installation, scour protection installation, and HDD activities have the potential to affect the construction, operation, and decommissioning phases of the proposed Project.

5.2.3.1.1 Construction

During the construction phase, vessel anchoring is likely to result in disturbance of bottom sediments during substructure installation, construction of WTGs, and installation of the inter-array and export cables.

The potential effects to water quality via sediment resuspension from repeated hammer blows during pile driving for the installation of substructures (see Section 3.3.1, Substructures) would likely be localized to the work area. Placement of the materials for scour protection may result in an increase in suspended sediments due to resuspension of bottom sediments as the rocks or stones are placed. Installation of rocks or stones for scour protection will be localized.

Inter-array and offshore export cables installation and the repositioning of sediment via sand wave removal within the Lease Area and export cable corridors will have localized effects on water quality, resulting from dredged material being side cast or backfilled, or disturbed and suspended if plowing or jet plowing installation methods are used. These activities as described in Section 3.3.4, Inter-Array Cables, and Section 3.3.5, Offshore Export Cables, may cause an increase in suspended solids in the water column due to sediment remobilization. The volume of suspended solids released will vary based on the speed and type of equipment used.

Mayflower Wind anticipates using HDD for the installation of the export cables at landfall locations. This approach will avoid sediment disturbance that could affect water quality disturbing aquatic life and/or recreational uses of the waters. HDD will eliminate proposed Project-related effects to the beach, intertidal zone, and nearshore areas, as well as ensure that the export cables remain sufficiently buried and permanently out of the human environment at the shoreline. HDD will also avoid disturbing recreational use of the beach. The sea-to-shore transition and HDD process is described further in Section 3.3.6, Sea-to-Shore transition. For HDD trajectories in Falmouth see Appendix P1. Note that HDD trajectory details will be refined (and may change slightly within the PDE) as the Project progresses.

Ground disturbance is anticipated as a result of onshore construction and installation activities including the export cable landfalls, onshore export cables, onshore substation, high-voltage direct-current (HVDC) converter station and underground transmission routes. Best management practices (BMPs), including a Stormwater Pollution Prevention Plan (SWPPP), will be used to control sedimentation and erosion during onshore construction activities. More details regarding the construction and installation of the onshore Project components can be found in Section 3.3, Project Components and Project Stages.

5.2.3.1.2 Operation and Maintenance

In some cases, offshore cable repair may be required that would result in sediment disturbances comparable to those during construction. Vessels used for offshore cable repair may also require anchoring which has the potential to effect water quality from suspended sediments. Any land disturbances greater than one acre would be executed under a NPDES Construction General Permit or under an approved Soil Erosion and Sediment Control Plan for smaller disturbances.

5.2.3.1.3 Decommissioning

Removal of offshore facilities during decommissioning at the end of the proposed Project may affect water quality. The decommissioning of proposed Project facilities would likely include removal of WTGs, OSPs, and associated support structures above the mudline. Offshore export cables and scour protection may be removed or retired in-place. Removal of these materials would result in localized generation of suspended sediments.

5.2.3.2 Planned Discharges

Discharges because of routine vessel releases, onshore construction, and stormwater runoff have the potential to affect the construction, operation, and decommissioning phases of the proposed Project. See Section 3.3.19, Conceptual Decommissioning, for a list of potential, planned discharges.

5.2.3.2.1 Construction

Vessels used during offshore construction activities may routinely release bilge water, engine cooling water, deck drainage and/or ballast water. Such releases would be dispersed, diluted, and cease upon construction completion. Nearshore discharges and discharges in ports are regulated via Massachusetts Office of Coastal Zone Management and CRMC. Vessels and the construction activities offshore will comply with the regulatory requirements related to the prevention and control of discharges, including USCG requirements at 33 CFR 151 and 46 CFR 162, and the prevention and control of accidental spills as documented in the proposed Project's Oil Spill Response Plan (OSRP) in Appendix AA.

During onshore construction activities, dewatering may be required. Such dewatering activities may result in a discharge of groundwater to nearby surface waters or in some cases may be discharged to the ground and re-infiltrated in an upland vegetated area near the construction activities. Groundwater contamination, if it occurs within the area of construction, may reduce the allowable options for discharges to surface water. A dewatering procedure will be developed if groundwater is encountered or expected to be encountered during duct bank installation. A component of the SWPPP for onshore construction will be a Project-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan to prevent inadvertent releases, to the extent practicable, to the environment of oil and/or hazardous materials incidental to the use of heavy construction equipment and vehicles. The SWPPP will also include provisions for stabilization of disturbed soils, equipment refueling, proper handling, storage, and off-site disposal of all solid and/or hazardous wastes generated during construction.

Onshore and offshore ground disturbing activities are subject to the NPDES regulations of stormwater discharges associated with construction activities. One requirement of the construction general permit is the development and implementation of a SWPPP. Sedimentation and erosion during construction activities will be controlled with appropriate BMPs including the development of a SWPPP. The provisions included in the SWPPP will be designed to protect surface water and groundwater for the federal, state, and municipal water quality resources that would be crossed by the Project.

The SWPPP will identify specific erosion and sedimentation controls to be used during the construction phase to control and manage any stormwater runoff originating from the Project site. The SWPPP will also include measures to control fugitive dust that may be generated as a result of soil disturbance and construction vehicle traffic.

5.2.3.2.2 Operations and Maintenance

Routine releases from vessels used during O&M, such as crew transfer vessels, are expected. These releases may include bilge water, engine cooling water, deck drainage, and/or ballast water. In general, where discharges are allowed under the NPDES 2013 Vessel General Permit, it is expected that routine releases from vessels would disperse in offshore areas. Vessels and the O&M activities offshore will comply with the regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills as documented in the proposed Project's OSRP in Appendix AA.

As described in Section 4.3, Physical Oceanography and Meteorology, the use of seawater for the CWIS at the OSP(s) will be discharged at a higher than ambient temperature, which may have localized impacts to the surrounding water quality. The use of sodium hypochlorite (used as an antifouling treatment to maintain proper operation of pumps and other equipment) will fall within safe and previously permitted concentrations for other facilities, similar to ballast water treatment under the Vessel General Permit program administered by the US EPA (78 FR 21938). The volume of water withdrawn from, and discharged to, the source water represents a small volume relative to the surrounding Atlantic Ocean; therefore, impacts to water quality associated with the thermal plume or residual chlorine of the discharge water are expected to be negligible.

5.2.3.2.3 Decommissioning

Vessels used during offshore decommissioning activities may routinely release bilge water, engine cooling water, deck drainage and/or ballast water. Such releases would be dispersed, diluted, and cease upon completion of decommissioning. Nearshore discharges and discharges in ports are regulated via Massachusetts Office of Coastal Zone Management and CRMC. Vessels and the decommissioning activities offshore will comply with the regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills as documented in the proposed Project's OSRP in Appendix AA.

5.2.3.3 Accidental Events

Unplanned events including unplanned releases from vessels, the offshore structures, and port utilization have the potential to affect the construction, operation, and decommissioning phases of the proposed Project.

5.2.3.3.1 Construction

Vessels could experience unplanned releases of oil, solid waste, or other materials during the construction phase of the proposed Project. Increased vessel traffic in the area of construction and at nearby ports may affect the likelihood of unplanned releases. Vessels and the construction activities offshore will comply with the regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills as documented in the proposed Project's OSRP in Appendix AA.

Mayflower Wind will employ effective construction management contingency plan procedures during HDD operations to minimize construction-period disturbances for nearby land uses and minimize the potential for seafloor disturbance through drilling fluid seepage. Mayflower Wind plans to use a drilling fluid composed of bentonite clay or mud that will pose little to no threat to water quality or ecological resources should seepage occur. Mayflower Wind will adhere to operational standards that minimize the potential for drilling fluid seepage. For HDD trajectories in Falmouth see Appendix P1. Note that HDD trajectory details will be refined (and may change slightly within the PDE) as the Project progresses.

Construction and installation of the onshore Project components could result in soil erosion and/or stormwater discharge into adjacent waterbodies along the selected route that could affect local inland water quality.

5.2.3.3.2 Operations and Maintenance

Unplanned events associated with maintenance activities may include unplanned releases from vessels. Damage to the wind turbine structures may result in a release of coolant, oil, or lubricants. The Project will operate under an approved OSRP located in Appendix AA.

Vessels and the operation and maintenance activities offshore will comply with the regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills as documented in the proposed Project's OSRP in Appendix AA.

Unplanned events or releases may also occur in the maintenance and operations of onshore facilities. It is expected that such events would be promptly controlled and cleaned up and will result in no discharge to surface water or groundwater.

5.2.3.3.3 Decommissioning

Vessels and the decommissioning activities offshore will comply with the regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills as documented in the proposed Project's OSRP in Appendix AA.

Removal of transmission cables from onshore areas could result in erosion into local waterways that may affect inland water quality. Sedimentation and erosion during decommissioning will be controlled with appropriate BMPs.

5.2.3.4 Natural Hazards

Natural hazards may create physical hazards to structures and infrastructures or environmental hazards, such as unplanned releases. Additional information regarding natural hazards can be found in Section 3.4, Impact Producing Factors.

5.2.3.4.1 Construction

Accidental releases of non-hazardous or hazardous materials and wastes resulting from potential natural hazards may affect water quality during the construction phase of the proposed Project. Natural hazards include meteorological events (including increased intensity and/or frequency of such events as a result of climate change), seismic and other events causing increased scouring, wave strikes and overtopping, and slope instability. Measures in place to prevent and control accidental events resulting from natural hazards are similar to measures described in Section 5.2.3.3, and are further documented in the proposed Project's SWPPP, SPCC Plan, Appendix Z, Safety Management Plan, and Appendix AA, Oil Spill Response Plan.

5.2.3.4.2 Operations and Maintenance

Natural hazards that could occur during the operation and maintenance phase of the proposed Project may result in indirect effects to water resources by increasing the potential for accidental releases. Due to variability in climate conditions, the potential for natural hazards may change during the lifespan of the proposed Project. Measures in place to prevent and control accidental events resulting from natural hazards are similar to measures described in Section 5.2.3.3, and are further documented in the proposed Project's SWPPP, SPCC Plan, Appendix Z, Safety Management Plan, and Appendix AA, Oil Spill Response Plan.

5.2.3.4.3 Decommissioning

Accidental releases of non-hazardous or hazardous materials and wastes resulting from potential natural hazards may affect water quality during the decommissioning phase of the proposed Project. The potential for natural hazards may have changed over the lifecycle of the proposed Project because of the variability of climate conditions. Measures in place to prevent and control accidental events resulting from natural hazards are similar to measures described in Section 5.2.3.3, and are further documented in the proposed Project's SWPPP, SPCC Plan, Appendix Z, Safety Management Plan, and Appendix AA, Oil Spill Response Plan.

6 BIOLOGICAL RESOURCES

6.1 COASTAL AND MARINE BIRDS

This section describes the coastal and marine bird species with potential to occur in the Project Area and includes an evaluation of potential Project-related effects. For this section, the Project Area is defined as the Offshore Project Area (i.e., the Lease Area, encompassing WTGs and OSPs, and the export cable corridors) and the landfall locations under consideration within the Onshore Project Areas. This evaluation is based on a review of published scientific literature and publicly available reports and data sources, as well as Project-sponsored surveys (e.g., aerial and boat-based surveys) (Mayflower Wind Energy LLC, 2020a-2020d; RPS Group, 2020; 2019). Publicly available sources include aerial and vessel-based avian survey and modeling results for the MA/RI WEA and other regional U.S. federal and state waters. In response to an information request, the Natural Heritage & Endangered Species Program (NHESP; a subdivision of the Massachusetts Division of Wildlife [MassWildlife]) provided data on likely species presence in the Project Area on May 1, 2020 (NHESP, 2020). NHESP also provided data on presence of state-listed rare species in the Brayton Point Project Area on July 23, 2021 (E. Schlüter, personal communication, July 23, 2021). RIDEM provided a list of species for the Brayton Point export cable corridor and onshore Project components in Rhode Island on June 24, 2021. In addition, Mayflower Wind generated an Official Species List from the U.S. Fish and Wildlife Service (USFWS) using the Information for Planning and Consultation (IPaC) tool on June 23, 2021, which is included in Appendix J, Terrestrial Vegetation and Wildlife Assessment Report.

Technical appendices relating to coastal and marine birds include:

- Appendix I1, Avian Exposure Risk Assessment
- Appendix J, Terrestrial Vegetation and Wildlife Assessment Report

6.1.1 Affected Environment

There are approximately 450 species of birds known to occur in Massachusetts; 31 percent of these species occur rarely (e.g., as vagrants) and approximately 216 have been recorded as breeding in the Commonwealth of Massachusetts (Blodget, 2017; Kamm et al., 2013). Rhode Island has approximately 429 documented species of birds, approximately 24 percent of these occur rarely (vagrants) and approximately 231 have been documented as breeding within the state (RIBird.org, 2020). The Project Area is located within the Atlantic Flyway and within the North Atlantic/Shorebird Migratory Route, which are used by various migratory species. The Project Area supports a diverse avifauna, including both resident and migratory species, and encompasses a variety of coastal habitats that are important to the ecology of coastal and marine bird species. Additionally, there are several hotspots of seabird abundance, species richness, and diversity in the offshore waters of Massachusetts (Veit et al., 2016; Veit et al., 2015) including the highly biologically productive Nantucket Shoals (Townsend et al., 2006; Kenney & Wishner, 1995), which can attract large concentrations of seabirds and sea ducks.

Mayflower Wind evaluated the best available literature and government databases, local and regional information evaluating the habitat use, abundance and distribution of coastal and marine birds known to occur in Massachusetts and Rhode Island waters, and site-specific surveys conducted for the proposed Project. The coastal and marine bird species with potential to occur in the Project Area include coastal birds, such as shorebirds, waterfowl, wading birds, raptors, and songbirds, and marine birds such as seabirds and sea ducks. Bird species that are federally or state-listed or are species of conservation concern (i.e., federal Birds of Conservation Concern or state Species of Greatest Conservation Need) are listed in **Table 6-1** and were identified as potentially occurring in the region based on a literature review, review of public databases (e.g., eBird [eBird 2020], Massachusetts Breeding Bird Atlas [Kamm et al. 2013], Christmas Bird Count historic dataset [National Audubon Society, 2020], and the Atlas of Breeding Birds in Rhode Island [RIBird.org, n.d.]), and results of surveys conducted in and around the Project Area, including long-term local or regional survey efforts in the Massachusetts/Rhode Island WEA (e.g., Winship et al., 2018; Curtice et al., 2016; Veit et al., 2016; Enser, 1992).

Project-specific surveys for the Lease Area included aerial high-definition (Aerial HD) surveys that were completed monthly from November 2019 through October 2020 (Mayflower Wind Energy, LLC, 2020a–2020d). Sampling effort was increased during the migratory period (e.g., April, May, and August 2020) for terns and other species of concern in coordination with the MassWildlife NHESP. One survey per month was completed from November 2019 through March 2020, two surveys were flown in April[1] and May 2020, one survey per month was completed from June through July 2020, two surveys were flown in August, and one survey per month was completed from September[2] through October 2020. Survey methods consisted of flying an aircraft over the Lease Area and capturing digital still imagery with a high-resolution camera using a grid-based survey design with a 1.5 centimeter resolution ground sampling distance at an altitude of approximately 1,360 ft (415 m; McGovern et al., 2019). Data collected used a global positioning system (GPS)-linked bespoke flight management system to ensure the survey tracks were flown with a high degree of accuracy. The aerial digital survey captured images along nine lines spaced approximately 1.2 mi (2.0 km) across-track within the Lease Area and one nautical mile buffer surrounding the Lease Area. Images were collected continuously (abutting digital still imagery) each of the survey lines, with a sampling swath width of 1,260 ft (384 m). A minimum of 40 percent coverage of the Lease Area was attained per survey. Third-party experts analyzed the images to enumerate birds and another third-party reviewer provided quality assurance of the data to identify any missed individuals. In general, using the methods employed, a ground sampling distance of 0.59 inch (1.5 cm) resolution is considered sufficiently high to positively identify smaller birds, such as terns, to species. For instance, the third-party experts were able, in most cases, to discern among tern species (e.g., roseate tern versus common tern) based on tail length, wing structure, and plumage.

A series of geophysical and geotechnical vessel surveys completed in the Lease Area between September and November 2019 included an onboard professional avian observer who recorded all birds observed during the surveys. Geophysical and geotechnical surveys were completed between September 9 and 17, 2019 and October 30 and November 7, 2019, during which 33 species were recorded. Most individuals were identified to species.

---

[1] Includes survey on May 2, 2020, in accordance with BOEM guidance.

[2] Mayflower Wind attempted a second survey in September but was unable to complete it due to weather conditions at the end of the month.

TABLE 6-1. BIRD SPECIES WITH POTENTIAL TO OCCUR IN PROJECT AREA

Common Name	Scientific Name	Federal (ESA or BGEPA a/	MA State (MESA) a/	MA State SGCN b/	USFWS BCC c/	RI State d/	RI State SGCN e/	Regional Presence f/
Alcids								
Atlantic puffin	*Fratercula artica*	-	-	Y	-	-	-	Winter
Black guillemot	*Cepphus grille*	-	-	-	-	-	-	Year-round
Common murre	*Uria aalge*	-	-	-	-	-	-	Winter
Dovekie	*Alle alle*	-	-	-	-	-	-	Winter
Razorbill	*Alca torda*	-	-	-	-		Y	Winter
Thick-billed murre	*Uria lomvia*	-	-	-	-	-	-	Winter
Gannets and Cormorants								
Double-crested cormorant	*Phalacrocorax auratus*	-	-	Y	-	-	-	Year-round
Great cormorant	*Phalacrocorax carbo*	-	-	-	-	-	-	Year-round
Northern gannet	*Morus bassanus*	-	-	Y	-	-	-	Winter
Gulls, Skuas, and Jaegers								
Black-legged kittiwake	*Rissa tridactyla*	-	-	-	-	-	-	Winter
Bonaparte’s gull	*Larus philadelphia*	-	-	-	-	-	-	Winter
Glaucous gull	*Larus hyperboreus*	-	-	-	-	-	-	Winter
Great black-backed gull	*Larus marinus*	-	-	Y	-	-	-	Year-round
Great skua	*Stercorarius skua*	-	-	-	-	-	-	Winter
Herring gull	*Larus argentatus*	-	-	Y	-	-	Y	Year-round
Laughing gull	*Larus atricilla*	-	-	Y	-	-	-	Summer
Lesser black-backed gull	*Larus fuscus*	-	-	-	-	-	-	Rare
Little gull	*Hydrocoloeus minutus*	-	-	-	-	-	-	Winter/ Rare
Parasitic jaeger	*Stercorarius parasiticus*	-	-	-	-	-	-	Migration
Pomarine jaeger	*Stercorarius pomarinus*	-	-	-	-	-	-	Migration
Ring-billed gull	*Larus delawarensis*	-	-	-	-	-	-	Year-round
South polar skua	*Stercorarius maccormicki*	-	-	-	-	-	-	Summer/ Rare

Common Name	Scientific Name	Federal (ESA or BGEPA a/	MA State (MESA) a/	MA State SGCN b/	USFWS BCC c/	RI State d/	RI State SGCN e/	Regional Presence f/
Loons and Grebes								
Common loon	*Gavia immer*	-	SC	Y	-	-	Y	Winter
Horned grebe	*Podiceps auratus*	-	-	-	Y	-	Y	Winter
Pied-billed grebe	*Podilymbus podiceps*	-	E	Y	Y	E	Y	Summer
Red-throated loon	*Gavia stellate*	-	-	Y	Y	-	Y	Winter
Sea Ducks and Waterfowl								
American black duck	*Anas rubripes*	-	-	Y	-	-	Y	Year-round
Black scoter	*Melanitta nigra*	-	-	-	-	-	Y	Winter
Brant	*Branta bernicla*	-	-	-	-	-	Y	Winter
Common eider	*Somateria mollissima*	-	-	Y	-	-	Y	Year-round
Common merganser	*Mergus merganser*	-	-	-	-	-	-	Winter
Harlequin duck	*Histrionicus histrionicus*	-	-	Y	-	-	Y	Winter
Hooded merganser	*Lophodytes cucullatus*	-	-	-	-	SC	Y	Year-round
King eider	*Somateria spectabilis*	-	-	-	-	-	-	Winter
Long-tailed duck	*Clangula hyemalis*	-	-	Y	-	-	-	Winter
Red-breasted merganser	*Mergus serrator*	-	-	-	-	-	Y	Winter
Surf scoter	*Melanitta perspicillata*	-	-	-	-	-	Y	Winter
White-winged scoter	*Melanitta fusca*	-	-	-	-	-	Y	Winter
Gadwall	*Anas Strepera*	-	-	-	-	SC	Y	Winter
Shearwaters, Petrels, and Storm-Petrels								
Audubon's shearwater	*Puffinus lherminieri*	-	-	-	Y	-	-	Summer
Band-rumped storm-petrel	*Oceanodroma castro*	-	-	-	-	-	-	Winter/ Rare
Black-capped petrel	*Pterodroma hasitata*	P	-	-	-	-	-	Winter/ Rare
Cory's shearwater	*Calonectris diomedea*	-	-	Y	-	-	Y	Summer
Great shearwater	*Puffinus gravis*	-	-	-	Y	-	Y	Summer
Leach's storm-petrel	*Oceanodroma leucorhoa*	-	E	Y	-	-	-	Summer
Manx shearwater	*Puffinus puffinus*	-	-	Y	-	-	-	Summer
Northern fulmar	*Fulmarus glacialis*	-	-	-	-	-	-	Winter

Common Name	Scientific Name	Federal (ESA or BGEPA a/	MA State (MESA) a/	MA State SGCN b/	USFWS BCC c/	RI State d/	RI State SGCN e/	Regional Presence f/
Sooty shearwater	*Puffinus griseus*	-	-	Y	-	-	-	Summer
Wilson's storm-petrel	*Oceanites oceanicus*	-	-	-	-	-	-	Summer
Shorebirds								
American oystercatcher	*Haematopus palliatus*	-	-	Y	Y	SC	Y	Summer
Dunlin	*Calidris alpine*	-	-	-	Y	-	Y	Winter
Greater yellowlegs	*Tringa melanoleuca*	-	-	-	-	-	Y	Migration
Hudsonian godwit	*Limosa haemastica*	-	-	-	Y	-	-	Migration
Lesser yellowlegs	*Tringa flavipes*	-	-	-	Y	-	-	Migration
Piping plover	*Charadrius melodus*	T	T	Y	-	SE	Y	Summer
Purple sandpiper	*Calidris maritima*	-	-	Y	Y	-	Y	Winter
Red phalarope	*Phalaropus fulicarius*	-	-	Y	-	-	-	Migration
Red-necked phalarope	*Phalaropus lobatus*	-	-	Y	-	-	-	Migration
Ruddy turnstone	*Arenaria interpres*	-	-	Y	Y	-	Y	Winter
Red knot	*Calidris canutus rufa*	T	T	Y	Y	-	Y	Migration
Sanderling	*Calidris alba*	-	-	Y	-	-	Y	Winter
Semipalmated plover	*Charadrius semipalmatus*	-	-	-	-	-	Y	Migration
Semipalmated sandpiper	*Calidris pusilla*	-	-	Y	Y	-	Y	Migration
Short-billed dowitcher	*Limnodromus griseus*	-	-	Y	Y	-	Y	Migration
Upland sandpiper	*Bartramia longicauda*	-	E	Y	Y	SE	-	Summer
Whimbrel	*Numenius phaeopus*	-	-	Y	Y	-		Migration
Willet	*Tringa semipalmata*	-	-	Y	Y	SC	Y	Summer
Wilson's snipe	*Gallinago delicata*	-	-	Y	-	-	-	Migration
Terns and Skimmers								
Arctic tern	*Sterna paradisae*	-	SC	Y	Y	-	-	Migration
Black skimmer	*Rynchops niger*	-	-	-	Y	-	-	Summer
Common tern	*Sterna hirundo*	-	SC	Y	-	-	Y	Summer
Least tern	*Sternula antillarum*	SC	SC	Y	Y	ST	-	Summer
Roseate tern	*Sterna dougalli*	E	E	Y	-	-	Y	Summer
Royal tern	*Sterna maxima*	-	-	-	-	-	-	Summer

Common Name	Scientific Name	Federal (ESA or BGEPA a/	MA State (MESA) a/	MA State SGCN b/	USFWS BCC c/	RI State d/	RI State SGCN e/	Regional Presence f/
Raptors								
American kestrel	*Falco sparverius*	-	-	Y	-	-	Y	Year-round
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	T	Y	Y	-	Y	Year-round
Barn owl	*Tyto alba*	-	SC	-	-	SE	Y	Year-round
Long-eared owl	*Asio otus*	-	SC	Y	Y	SC		Winter
Northern harrier	*Circus hudsonius*	-	T	Y	-	SE	Y	Year-round
Peregrine falcon	*Falco peregrinus*	-	T	Y	Y	SE	Y	Year-round
Short-eared owl	*Asio flammeus*	-	E	Y	Y	-	Y	Summer
Wading Birds								
American bittern	*Botaurus lentiginosus*	-	E	-	Y	E	-	Summer
Black-crowned night-heron	*Nycticorax nycticorax*	-	-	-	Y	SC	Y	Year-round
Little blue heron	*Egretta caerulea*	-	-	-	-	SC	Y	Summer
Common gallinule	*Gallinula galeata*	-	SC	Y	-	-	-	Summer
Glossy ibis	*Plegadis falcinellus*	-	-	Y	-	SC	Y	Summer
Great egret	*Ardea alba*	-	-	Y	-	SC	Y	Year-round
King rail	*Rallus elegans*	-	T	-	Y	SC	Y	Summer
Least bittern	*Ixobrychus exilis*	-	E	Y	Y	ST	Y	Summer
Snowy egret	*Egretta thula*	-	-	Y	Y	SC	Y	Summer
Cattle egret	*Bubulcus ibis*	-	-	-	-	SC	Y	Summer
Songbirds								
Bank swallow	*Riparia riparia*	-	-	Y	-	-	-	Summer
Blackpoll warbler	*Setophaga striata*	-	SC	Y	-	-	Y	Migration
Brown thrasher	*Toxostoma rufum*	-	-	Y	-	-	-	Summer
Eastern towhee	*Pipilo erythrophthalmus*	-	-	Y	-	-	-	Year-round
Field sparrow	*Spizella pusilla*	-	-	Y	-	-	-	Summer
Golden-winged warbler	*Vermivora chrysoptera*	-	E	Y	Y	-	-	Summer
Grasshopper sparrow	*Ammodramus savannarum*	-	T	Y	-	ST	Y	Summer
Marsh wren	*Cistothorus palustris*	-	-	Y	-	SC	-	Year-round
Mourning warbler	*Oporornis philadelphia*	-	SC	Y	-	-	-	Migration

Common Name	Scientific Name	Federal (ESA or BGEPA a/	MA State (MESA) a/	MA State SGCN b/	USFWS BCC c/	RI State d/	RI State SGCN e/	Regional Presence f/
Northern parula	*Parula americana*	-	T	Y	-	ST	Y	Migration
Prairie warbler	*Setophaga discolor*	-	-	Y	Y	-	Y	Summer
Saltmarsh sparrow	*Ammospiza caudacuta*	-	-	Y	Y	-	-	Summer
Seaside sparrow	*Ammospiza maritima*	-	-	Y	Y	SC	Y	Summer
Sedge wren	*Cistothorus platensis*	-	E	Y	Y	-	-	Summer
Vesper sparrow	*Pooecetes gramineus*	-	T	Y	-	-	-	Summer

Notes:

a/ = ESA = Endangered Species Act; BGEPA = Bald and Golden Eagle Protection Act; MESA = Massachusetts Endangered Species Act; E = Endangered; T = Threatened; SC = Special Concern; C = Candidate; P = Petitioned for listing; "-" not listed.

b/ SGCN = Species of Greatest Conservation Need; "-" not an SGCN species; "Y" listed as an SGCN species in the Massachusetts State Wildlife Action Plan (MassWildlife, 2015a). It should be noted that SGCN designation does not represent an equivalent to ESA or MESA species listings; rather, this represents a publicly available data source to identify species which the state considers to be of greatest concern, based on the threat affecting each.

c/ USFWS = U.S. Fish and Wildlife Service; BCC = Bird of Conservation Concern; "-" not a BCC species; "Y" listed as a BCC species (USFWS, 2008). Only BCC species that are identified in Bird Conservation Region 30 (New England/Mid-Atlantic Coast) and in USFWS Region 5 (Northeast) and that occur in Massachusetts are included in this list.

d/ Species regional presence was determined through review of the Bird List for the Commonwealth of Massachusetts (Blodget, 2017) and species ranges on Cornell Lab of Ornithology's Birds of the World (Billerman et al., 2020).

e/ Rare Native Animals of Rhode Island (RIDEM, 2006)

f/ RI Wildlife Action Plan Update & Final SGCN List (RIDEM, 2015). It should be noted that SGCN designation does not represent an equivalent to ESA or MESA species listings; rather, this represents a publicly available data source to identify species which the state considers to be of greatest concern, based on the threat affecting each.

This section identifies and describes the different groups of coastal and marine birds that may be present in and around the Project Area during construction, operations, and decommissioning activities. This section also includes an analysis of if and how coastal and marine birds may be exposed to and affected by Project activities. Existing threats to coastal and marine birds that may occur in the Project Area are identified and evaluated in Section 6.1.2.

Avian occurrence in the Lease Area is contingent on individual species phenology (i.e., life-history patterns including breeding, staging, migration, and overwintering), behavior (e.g., flight height), and horizontal spatial distribution. The AERA identified temporal and horizontal distribution patterns of species with potential to occur in the Lease Area, as described in Appendix I1, Avian Exposure Risk Assessment; and was used to inform occurrence levels. The AERA focused on coastal and marine species that are known to commonly occur offshore, including loons and grebes, sea ducks, shearwaters and storm-petrels, gannets and cormorants, gulls and jaegers, terns, and alcids. AERA focal species also included federally and state-listed shorebirds that are less commonly found in offshore waters.

During the construction phase, coastal and marine birds may co-occur with and be affected by Project activities in the Lease Area, the Falmouth export cable corridor near Muskeget Channel, and the Brayton Point export cable corridor. During the operations phase, coastal and marine birds may co-occur with the WTGs, OSPs, the proposed export cable corridors, and maintenance vessels. Coastal and marine bird likelihood of co-occurrence with Project activities is a function of overall occurrence levels that range from “rare” to “common” and seasonality of occurrence.

Exposure levels for each species evaluated in the AERA helped to inform assessment of occurrence in the Lease Area. The AERA used two primary data sources to evaluate local and regional marine bird use of the Lease Area relative to local and regional waters: the Massachusetts Clean Energy Center (MCEC) seabird surveys (Veit et al., 2016), herein referred to as “MCEC data”, and the Marine-life Data and Analysis Team (MDAT) marine bird abundance and occurrence models (Winship et al., 2018; Curtice et al., 2016), herein referred to as “MDAT data” or “MDAT models”. Exposure levels were further informed by several spatially explicit resources, including data from Aerial HD (Mayflower Wind Energy, LLC, 2020a-2020d) and geophysical and geotechnical surveys (RPS Group, 2020; 2019) completed for the proposed Project, digital very high frequency (VHF) tracking data (Loring et al. 2019), and GPS tracking data (Spiegel et al., 2017).

Spatial data pertaining to *Ammydytes* sp. (e.g., sand lance [*Ammodytes americanus*] and northern sand lance [*A. dubius*]; Northeast Fisheries Science Center [NEFSC] 2020a; 2020b), which are important prey species for multiple avian species including roseate tern (*Sterna dougallii*), Arctic tern (*Sterna paradisae*), Atlantic puffin (*Fratercula arctica*), razorbill (*Alca torda*), common murre (*Uria aalge*), great cormorant (*Phalacrocorax carbo*), great shearwater (*Puffinus gravis*), Cory's shearwater (*Calonectris diomedea*), sooty shearwater (*Puffinus griseus*), northern gannet (*Morus bassanus*), and red-throated loon (*Gavia immer*) (Staudinger et al., 2020) were also consulted. Details on each dataset are available in Appendix I1, Avian Exposure Risk Assessment. For species for which site-specific data were not available, a determination of occurrence was made by synthesizing relevant information from published literature and records (eBird, 2020).

6.1.1.1 Coastal Birds

This section identifies and describes the different bird species that may be present in and around the Project Area during construction, operations, and decommissioning activities, with a focus on coastal habitats, the potential landfall locations, and export cable corridors, with additional evaluation of the likelihood of coastal bird co-occurrence with Project activities in the Lease Area if warranted. Evaluation of coastal bird species occurrence in the export cable corridors focuses on the sections that run from landfall at Brayton Point and Falmouth, Massachusetts, through Muskeget Channel and across Aquidneck Island, in addition to occurrence along the coast through the Sakonnet River, as most coastal birds may traverse waters to and from the mainland and islands (e.g., Nantucket and Martha's Vineyard) or across the river, but are not expected to travel far from shore. Section 6.1.1.2 focuses on potential co-occurrence of marine and some coastal avian species with Project activities in the Lease Area.

The onshore Project components will originate from the landfall location(s) in the Town of Falmouth and the Town of Somerset, Massachusetts. Currently, three landfall locations are under consideration in Falmouth, including Central Park, Shore Street, and Worcester Avenue and two landfall locations within Brayton Point. The Brayton Point onshore Project components also include a landfall and underground export cable route in Portsmouth, Rhode Island, in order to avoid the narrowest point of the Sakonnet River (which begins at the old Stone Bridge) (**Figure 6-1**). Potential effects to coastal habitats at the landfall locations are further discussed in Section 6.5, Coastal Habitats.

Coastal bird species expected to be present at the potential landfall locations and immediately adjacent shoreline or nearshore habitats will vary seasonally. Coastal bird species that are likely to occur in the Project Area are listed in **Table 6-2**. According to the MassWildlife NHESP information request response for the proposed Project, there are no Priority Habitats or Estimated Habitats at the proposed landfall locations in Falmouth for state-listed species. However, there are both Priority and Estimated Habitats adjacent to these areas and the proposed Falmouth export cable corridor (**Figure 6-1**) (NHESP, 2020). An information request to MassWildlife NHESP for the Brayton Point export cable corridor and associated landfalls is pending. The RINHP provided data on likely species presence in the Project Area of the Sakonnet River and Aquidneck Island, on June 24, 2021. In addition, Mayflower Wind generated an Official Species List from the USFWS using the IPaC tool on June 23, 2021. The federally listed piping plover (*Charadrius melodus melodus*) and roseate tern, and two Massachusetts Species of Special Concern, common tern (*Sterna hirundo*) and least tern (*Sternula antillarum*), are discussed in detail in Section 6.1.1.3.

TABLE 6-2. COASTAL BIRD SPECIES WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species a/	Federal (ESA) b/	State (MESA) b/ RIDEM
Shorebirds		
American oystercatcher	-	RI-SC
Dunlin	-	-
Greater yellowlegs	-	-
Hudsonian godwit	-	-
Lesser yellowlegs	-	-
Piping plover	T	MA-T
Purple sandpiper	-	-

Species a/	Federal (ESA) b/	State (MESA) b/ RIDEM
Red phalarope	-	-
Red-necked phalarope	-	-
Ruddy turnstone	-	-
Red knot	T	MA-T
Sanderling	-	-
Semipalmated plover	-	-
Semipalmated sandpiper	-	-
Short-billed dowitcher	-	-
Upland sandpiper	-	MA-E
Whimbrel	-	-
Willet	-	RI-SC
Wilson's snipe	-	-
Gulls and Terns		
Common tern	-	MA-SC
Great black-backed gull	-	-
Herring gull	-	-
Laughing gull	-	-
Least tern	-	MA-SC, RI-T
Ring-billed gull	-	-
Roseate tern	E	MA-E, RI-SH
Waterfowl		
American black duck	-	-
Black scoter	-	-
Brant	-	-
Common eider	-	-
Common merganser	-	-
Gadwall	-	RI-SC
Harlequin duck	-	-
Hooded merganser	-	RI-SC
King eider	-	-
Long-tailed duck	-	-
Red-breasted merganser	-	-
Surf scoter	-	-
White-winged scoter	-	-
Wading Birds		
American bittern	-	MA-E, RI-E
Black-crowned night-heron	-	RI-SC
Cattle egret	-	RI-SC
Common gallinule	-	MA-SC
Glossy ibis	-	RI-SC
Great egret	-	RI-SC
King rail	-	MA-T, RI-C
Least bittern	-	MA-E, RI-T
Little blue heron	-	RI-SC

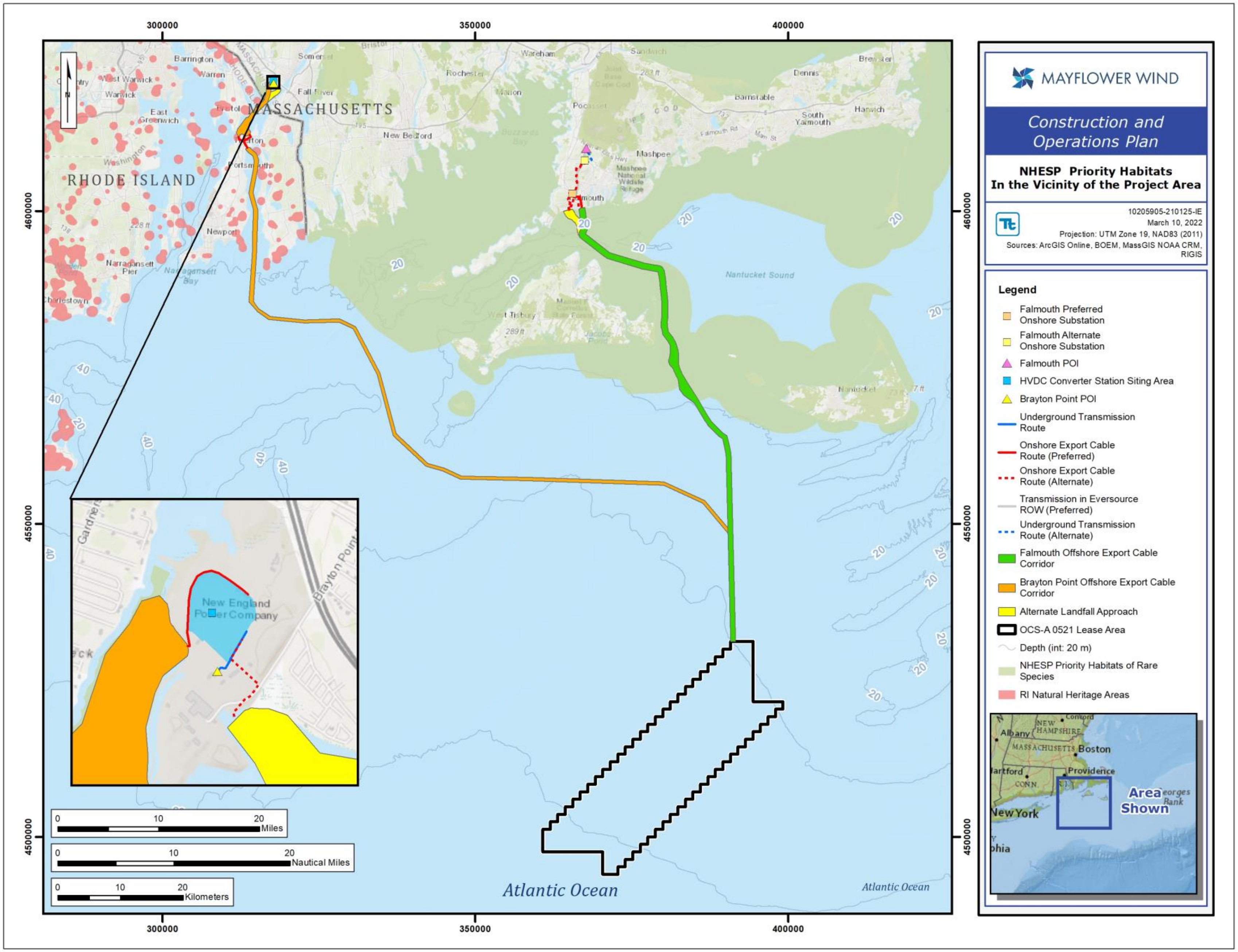
Species a/	Federal (ESA) b/	State (MESA) b/ RIDEM
Snowy egret	-	RI-SC
Raptors		
American kestrel	-	-
Bald eagle	BGEPA	MA-T
Barn owl	-	MA-SC, RI-E
Long-eared owl	-	MA-SC, RI-SC
Northern harrier	-	MA-T, RI-E
Peregrine falcon	-	MA-T, RI-E
Short-eared owl	-	MA-E
Songbirds		
Bank swallow	-	-
Blackpoll warbler	-	MA-SC
Brown thrasher	-	-
Eastern towhee	-	-
Field sparrow	-	-
Golden-winged warbler	-	MA-E
Grasshopper sparrow	-	MA-T, RI-T
Marsh wren	-	RI-SC
Mourning warbler	-	MA-SC
Northern parula	-	MA-T, RI-T
Prairie warbler	-	-
Saltmarsh sparrow	-	-
Seaside sparrow	-	RI-SC
Sedge wren	-	MA-E
Vesper sparrow	-	MA-T, RI-SH

Sources: NHESP 2020; RIDEM 2015 and 2006; Petersen and Meservey, 2003; DeGraaf and Yamasaki, 2001; Veit & Petersen, 1993.

Notes:

a/ Some marine bird species may occur in coastal habitats, particularly waters adjacent to landfall and within Muskeget Channel, but are discussed in further detail in Section 6.1.1.2 and federally and state-listed species are discussed in further detail in Section 6.1.1.3.

b/ ESA = Endangered Species Act; BGEPA = Bald and Golden Eagle Protection Act; MESA = Massachusetts Endangered Species Act; RIDEM = Rhode Island Department of Environmental Management; E = Endangered; T = Threatened; SC = Special Concern; C = Candidate; P = Petitioned for listing; SH = State Historical "-" = not listed.



Source: MassGIS and NHESP, 2018

FIGURE 6-1. NHESP PRIORITY HABITATS IN THE VICINITY OF THE PROJECT AREA

The Lease Area is located approximately 47 mi (76 km) from the mainland (i.e., upper Cape Cod) and 23 mi (37 km) from the nearest island, Nantucket, which is outside of the expected range for most terrestrial and coastal bird species. However, some terrestrial and coastal birds may forage in the Lease Area or may traverse it during spring and/or fall migration periods, including shorebirds (e.g., sandpipers, plovers), waterfowl (e.g., mergansers), wading birds (e.g., herons, egrets), raptors (e.g., falcons, hawks, eagles), and songbirds (e.g., warblers, sparrows).

6.1.1.1.1 Shorebirds

Shorebirds that use coastal and near-coastal environments for nesting, feeding, and resting include sandpipers, avocets, stilts, oystercatchers, plovers, and others. Most shorebird species breed and forage in coastal habitats, including along beaches and in coastal mudflats and marshes. Few shorebirds breed on the U.S. Atlantic Coast; American oystercatcher (*Haematopus palliatus*), piping plover, and willet (*Tringa semipalmata*) breed in Massachusetts and Rhode Island coastal areas, and upland sandpiper (*Bartramia longicauda*) breeds at a limited number of inland sites on Cape Cod. The majority of shorebird species that occur in the Commonwealth of Massachusetts during migration or in the winter are Arctic or Subarctic breeders (O'Connell et al., 2011). Coastal shorebirds with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-3**.

Shorebirds have an extensive distribution in near-coastal waters and are highly migratory with reports of over-ocean flights (Billerman et al., 2020; Hayman et al., 1986). While few studies have examined shorebird use of offshore and marine environments (Burger et al., 2011), shorebirds may traverse the Lease Area as they migrate to and from wintering areas along the U.S. Atlantic Coast. Evidence suggests that many shorebird species migrate at flight heights over 2,000 feet (610 m), which are above the rotor swept zone (RSZ) of most offshore WTGs (approximately 837 ft [255 m]) as described in Senner et al. (2018) and Green (2004). Other studies have tracked and/or visually observed migratory shorebirds flying at heights offshore ranging from 0 to 1,312 ft (0 to 400 m) above the sea surface (Paton et al., 2010; Chamberlin et al., 2006; Gudmundsson et al., 2002; Noer et al., 2000) and Paton et al. (2010) reported shorebirds flying below 33 ft (10 m) in altitude offshore of Rhode Island. A recent study in the Atlantic OCS that tracked 12 shorebird species with digital VHF transmitters during fall and spring migration indicates that shorebird flight heights varied greatly (92 to 9,646 ft [28 to 2,940 m]) and most were estimated to occur above the RSZ (Loring et al., 2020).

A synthesis review of known shorebird occurrence data and movement patterns identified 35 species of shorebirds that regularly occur in coastal and/or offshore areas of the U.S. Atlantic Coast region during spring and/or fall migration (O'Connell et al., 2011). It is therefore expected that shorebird occurrence in the Lease Area for most species is possible, but is expected to be uncommon and limited to spring and fall migration periods. Shorebirds that have greater potential to be present in the marine environment (e.g., phalaropes) are discussed further in Section 6.1.1.2.

Federally listed species: Piping plover and the *rufa* subspecies of the red knot (*Calidris canutus rufa*) are federally listed under the Endangered Species Act (ESA) and state-listed under the Massachusetts Endangered Species Act (MESA) and also in Rhode Island (RIDEM, 2006, 2015) are discussed further in Section 6.1.1.3.

TABLE 6-3. COASTAL SHOREBIRDS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species a/	Occurrence Level	Seasonality in Project Area b/		
		Landfalls	ECCs	Lease Area
American oystercatcher	Uncommon	Uncommon during spring and summer, and during migration	Uncommon during spring and summer, and during migration	Rare during spring/fall migration
Dunlin	Common	Common during winter and migration	Common during winter and migration	Uncommon during migration
Greater yellowlegs	Uncommon	Rare in winter Uncommon during spring and fall migration	Rare in winter Uncommon during spring and fall migration	Rare spring and fall migration
Hudsonian godwit	Rare	Rare during fall migration	Rare during fall migration	Rare during fall migration
Lesser yellowlegs	Uncommon	Rare in winter Uncommon during spring and fall migration	Rare in winter Uncommon during spring and fall migration	Rare during spring and fall migration
Purple sandpiper	Common	Common during winter and migration	Common during winter and migration	Uncommon during migration
Ruddy turnstone	Common	Common in winter and during migration	Common in winter and during migration	Uncommon during migration
Sanderling	Common	Common in winter and during migration	Common in winter and during migration	Uncommon during migration
Semipalmated plover	Uncommon	Uncommon during spring and fall migration	Uncommon during spring and fall migration	Rare during spring/fall migration
Semipalmated sandpiper	Uncommon	Uncommon during spring and fall migration	Uncommon during spring and fall migration	Rare during spring/fall migration
Short-billed dowitcher	Uncommon	Uncommon during spring and fall migration	Uncommon during spring and fall migration	Rare during spring/fall migration
Upland sandpiper	Rare	Rare in summer	Rare in summer	-
Whimbrel	Uncommon	Uncommon during fall migration	Uncommon during fall migration	Rare during spring/fall migration
Willet	Uncommon	Uncommon occurrence in summer	Uncommon in summer	Rare during spring and fall migration

Species a/	Occurrence Level	Seasonality in Project Area b/		
		Landfalls	ECCs	Lease Area
Wilson's snipe	Uncommon	Uncommon during spring and fall migration	Uncommon during spring and fall migration	-

Sources: Billerman et al., 2020; eBird, 2020; National Audubon Society, 2020; Blodget, 2017; Kamm et al., 2013.
Notes:
a/ Marine shorebirds (i.e., phalaropes) are discussed in further detail in Section 6.1.1.2 and federally listed shorebird species are discussed in further detail in Section 6.1.1.3.
b/ Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews for each species. "-" = species is highly unlikely to occur.

State-listed species: In Massachusetts, the state-endangered upland sandpiper is found in large expanses of open grassy fields, hay fields, and grassy strips adjacent to runways (MassWildlife, 2015b), and the species is unlikely to be observed in coastal habitats on upper Cape Cod. However, upland sandpipers have been tracked with satellite tags and GPS making nonstop flights south from western Massachusetts over the Atlantic to wintering grounds in South America (Hill et al., 2019), suggesting the species has the potential to traverse the Lease Area during fall migration. The upland sandpipers that were tracked in Hill et al. (2019) appeared to primarily fly along the U.S. Atlantic Coast during spring migration and did not fly offshore. Occurrence of upland sandpiper in the Lease Area is expected to be rare and limited to migration.

6.1.1.1.2 Waterfowl

Waterfowl in Massachusetts and Rhode Island include duck, geese, and swan species that spend most of the year in terrestrial or coastal wetland habitats, as well as species that are considered to have a stronger affinity for marine environments, termed "sea ducks". Some diving ducks, such as scoters, typically winter on open freshwater. Mergansers, scaups, goldeneyes, buffleheads, and stifftails (e.g., ruddy ducks [*Oxyura jamaicensis*]), generally winter on open freshwater, but may also winter in marine habitats. However, most are usually found within shallow, nearshore waters and do not stray far offshore (Owen & Black, 1990). There are no state-listed waterfowl species in Massachusetts or Rhode Island, and no federally listed species likely to occur in the Project Area. Occurrence of most waterfowl species is expected to be primarily restricted to nearshore waters during the winter; sea ducks are more likely to occur in the Lease Area and are discussed in Section 6.1.1.2. Waterfowl with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-4**.

TABLE 6-4. WATERFOWL WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species a/	Occurrence Level	Seasonality in Project Area b/		
		Landfalls	ECCs	Lease Area
American black duck	Uncommon	Common year-round	Common year-round	-
Barrow's goldeneye	Rare	Rare in winter	Rare in winter	-
Bufflehead	Common	Uncommon in winter	Common in winter	-
Common goldeneye	Common	Uncommon in winter	Common in winter	Rare in winter
Common merganser	Uncommon	Uncommon in winter	Uncommon in winter	-
Harlequin duck	Uncommon	Rare in winter	Uncommon in winter	-
Hooded merganser	Common	Common in winter	Common in winter	-
Red-breasted merganser	Common	Common in winter and spring	Common in winter	Uncommon in spring and winter
Ruddy duck	Rare	Rare in winter	Uncommon in winter	-
Mallard	Common	Common year-round	Common year-round	-

Sources: Billerman et al., 2020; eBird, 2020; National Audubon Society, 2020; Blodget, 2017; Kamm et al., 2013.
Notes:
a/ Occurrence of sea ducks (eiders, scoters, brant, long-tailed duck) in the Lease Area is further described in Marine Birds, Section 6.1.1.2.
b/ Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews for each species.
"-" = species is highly unlikely to occur.

6.1.1.1.3 Wading Birds

Wading birds include long-legged wading species such as herons and egrets, and other aquatic species such as bitterns, coots, moorhens, and rails. Wading birds forage in shallow, freshwater, and brackish habitats, and may breed in coastal wetland habitats in Massachusetts and Rhode Island. Many long-legged and other wading birds that breed in Massachusetts migrate south along the U.S. Atlantic Coast to the Gulf Coast, Caribbean, and Central and South America during the fall; it is possible that these species would traverse the Lease Area during migration. No wading birds were recorded in the Lease Area during offshore surveys (Veit et al., 2016), including during the 2019-2020 Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d). Two great blue herons (*Ardea herodias*) were observed during the October-November 2019 boat-based geophysical and geotechnical surveys (RPS Group, 2020, 2019). There are no federally listed wading bird species that are likely to occur in the Project Area. Overall occurrence of wading birds in the Lease Area is expected to be rare and limited to migration. Wading birds with the potential to occur in the Project Area, along with occurrence levels and seasonality, are listed in **Table 6-5**.

TABLE 6-5. WADING BIRDS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
American bittern	Rare	Rare in summer and during migration	Rare in summer and during migration	-
Black-crowned night-heron	Uncommon	Rare year-round	Uncommon year-round	-
Common gallinule	Rare	Rare in summer and during migration	Rare in summer and during migration	-
Glossy ibis	Uncommon	Uncommon in summer and during migration only	Rare in summer and during migration in Falmouth Uncommon in summer and migration in the Sakonnet River	-
Great blue heron	Common	Common year-round	Common year-round	-
Great egret	Common	Uncommon year-round	Common occurrence year-round	-
King rail	Rare	Rare in summer and during migration	Rare in summer and during migration	-
Least bittern	Rare	Rare in summer and during migration	Rare in summer and during migration	-
Snowy egret	Uncommon	Uncommon in summer and during migration	Uncommon in summer and during migration	-
Yellow-crowned night heron	Rare	Rare in summer	Rare in summer	-

Sources: Billerman et al., 2020; eBird, 2020; National Audubon Society, 2020; Blodget, 2017; Kamm et al., 2013.
Note: a/ Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews for each species. “-“ = species is highly unlikely to occur.

State-listed species: Three state-listed wading birds that occur in Massachusetts and Rhode Island have the potential to occur in the Project Area include state-endangered (Massachusetts and Rhode Island) American bittern (*Botaurus lentiginosus*), Massachusetts state-endangered and Rhode Island state-threatened least bittern (*Ixobrychus exilis*), and Massachusetts state-threatened (Rhode Island Special Concern) king rail (*Rallus elegans*). These species may be present during the breeding season in tidal freshwater marshes adjacent to the potential landfall locations. Although little is known about the migration routes of American and least bittern and king rail, Robinson Willmott et al. (2013) ranked the three species as having relatively low sensitivities (collision and displacement) to offshore wind farms, and having low potential to occur within offshore environments. Based on this information, the occurrence of these three state-listed species in the Lease Area is expected to be rare and limited to migration.

6.1.1.1.4 Raptors

Raptor species may be present in coastal habitats and adjacent upland habitats during the breeding season. State-listed raptor species that are known to occur on Cape Cod and that have the potential to occur in or adjacent to the potential landfall locations include the northern harrier (*Circus hudsonius*; Massachusetts state-threatened and Rhode Island state-endangered) and short-eared owl (*Asio flammeus*; state-endangered). Both species may be affected by Project activities at the landfall locations. Also, both are known to make overwater flights during migration and may pass through the Lease Area in limited numbers (Billerman et al., 2020). Additionally, two owl species that are Special Concern in Massachusetts, the barn owl (*Tyto alba*) and long-eared owl (*Asio otus*), are known to occur on Cape Cod and may occur in the potential landfall locations. However, both are unlikely to occur in the Lease Area. The barn owl is also listed as a state endangered species in Rhode Island and may occur on Aquidneck Island (eBird, 2020; RIDEM, 2015). All raptors with the potential to occur in the Project Area, along with their occurrence levels and seasonality, are listed in **Table 6-6**.

Raptor use of the Lease Area may occur during migration, but occurrence of species is dependent on various factors, including the type of flight patterns a raptor uses to migrate, i.e., a powered or “flapping” flight versus a soaring flight using thermals or topographical features that generate lift. Research indicates that soaring raptors that use thermals during migration (e.g., buteo hawks, such as the red-tailed hawk [*Buteo jamaicensis*], vultures, and eagles) typically do not cross large expanses of water and are rarely observed in offshore environments (DeSorbo et al., 2012; Kerlinger, 1985).

Accipiter hawks use a mix of a powered and soaring flight and may occur on offshore islands but are rarely observed far from shore (DeSorbo et al., 2017). There is also evidence that some owl species (e.g., long-eared owl and northern saw-whet owl [*Aegolius acadicus*]) migrate along the U.S. Atlantic Coast and have been recorded passing over islands in Maine during migration. however, most owls are not known to use the offshore environment. One barn owl was observed during geophysical and geotechnical surveys. However, it was noted that the bird was likely attracted to the vessel (e.g., was in the vicinity of the vessel for more than two minutes) (RPS Group, 2020). American kestrels (*Falco sparverius*) and merlins (*Falco columbarius*) have been observed flying over open water (Ecology and Environment Engineering, P.C., 2017), and merlins and peregrine falcons have been observed on offshore oil platforms (Johnson et al., 2011; McGrady et al., 2006). Peregrine falcons and kestrels have also been observed perching on platform decks of WTGs in Germany (Hill et al., 2014). Additionally, ospreys (*Pandion haliaetus*) have been observed over 93 mi (150 km) offshore (Bierregaard et al., 2020) and a recent analysis of satellite tracking data indicates that juvenile ospreys migrate from fledging sites in New England to the Bahamas (Horton et al., 2014). Raptors that may rarely be exposed to operational activities in the Lease Area are likely limited to falcons and osprey.

Overall occurrence of raptors in the Lease Area is expected to be rare to uncommon, and primarily limited to migration. Peregrine falcon is state-listed under the MESA and the RINHP and is discussed in more detail below (RIDEM, 2006).

State-listed species: The peregrine falcon is listed as state-threatened in Massachusetts and state-endangered in Rhode Island and has been observed offshore, often for days at a time, as the species can fly hundreds of kilometers during migration (DeSorbo et al., 2015; DeSorbo et al., 2012; Cochran, 1985). Peregrine falcon may therefore opportunistically hunt in the Lease Area or may potentially perch on vessels or anchored structures in the Lease Area. A recent satellite-tracking study indicated that two tagged peregrine falcons flew through central Massachusetts toward Narragansett Bay, Rhode Island and did not fly offshore until they reached the mid-Atlantic (DeSorbo et al., 2012).

Additionally, DeSorbo et al. (2015) found that peregrines from a broad geographic range (Block Island, Rhode Island to Cape Hatteras, North Carolina) use the Atlantic flyway during fall migration. Study findings suggest they use offshore habitats regularly, often preying on seabirds such as petrels (Paine et al., 1990). No peregrine falcons were observed in the Lease Area during offshore surveys (Veit et al., 2016) including during the 2019-2020 Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d). One peregrine falcon was observed during the October-November 2019 boat-based geophysical and geotechnical surveys (RPS Group, 2020). Occurrence of peregrine falcon in the Lease Area is expected to be uncommon and limited to fall migration.

Bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are federally protected under the Bald and Golden Eagle Protection Act. Bald eagle is also a state-threatened species in Massachusetts. Bald eagles are found year-round in Massachusetts, primarily in terrestrial environments near water (Buehler, 2020; Katzner et al., 2020), and the statewide breeding population is increasing. Bald eagles inhabit coastal marine environments and overwinter along the coast of Cape Cod and on Martha’s Vineyard and Nantucket (MassWildlife, 2019). However, they do not normally occur in pelagic environments (Buehler, 2020) and the Lease Area is outside of known high-use migration corridors of bald eagles (Mojica et al., 2016). Golden eagles are rarely found in the eastern U.S. and only very rarely on the east coast (Katzner et al., 2020), and are not likely to occur in the Lease Area. Occurrence of bald eagles is expected to be rare and occurrence of golden eagles is not expected in the Lease Area.

TABLE 6-6. RAPTORS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
American kestrel	Uncommon	Uncommon year-round	Uncommon year-round	Uncommon but known to fly over open water and perch on offshore platforms
Bald eagle	Uncommon	Uncommon year-round	Uncommon year-round	-
Barn owl	Rare	Rare year-round on Aquidneck Island RI only	Rare year-round on Aquidneck Island RI only	-
Broad-winged hawk	Uncommon	Uncommon in summer and migration	Uncommon in summer and migration	-
Cooper's hawk	Common	Common year-round	Uncommon year-round	-
Long-eared owl	Rare	Rare in winter	Rare in winter	Rare during migration
Northern harrier	Uncommon	Uncommon year-round	Uncommon year-round	Rare during migration
Northern saw-whet owl	Rare	Rare in winter and migration	Rare in winter and migration	-
Osprey	Common	Common during summer and migration	Common during summer and migration	Rare during migration
Peregrine falcon	Uncommon	Uncommon year-round	Uncommon year-round	Uncommon, potentially attracted to vessels and offshore structures
Red-shouldered hawk	Uncommon	Uncommon year-round	Uncommon year-round	-
Red-tailed hawk	Common	Common year-round	Common year-round	-
Short-eared owl	Rare	Rare in summer and during migration	Rare in summer and during migration	Rare during migration

Sources: Billerman et al., 2020; eBird, 2020; National Audubon Society, 2020; Blodget, 2017; Kamm et al., 2013.

Note:

a/ Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews for each species. "-" = species is highly unlikely to occur.

6.1.1.1.5 Songbirds

Songbirds almost exclusively use terrestrial, coastal, and aquatic habitats (i.e., for breeding, overwintering and stopover), many of which may occur in and adjacent to the landfall locations under consideration. Two Massachusetts state-listed songbird species, grasshopper sparrow (*Ammodramus savannarum*) and vesper sparrow (*Pooecetes gramineus*), are known to breed in coastal habitats on upper Cape Cod, Nantucket, and/or Martha's Vineyard and could potentially be affected by Project activities at the potential landfall locations. The grasshopper sparrow is also a state-threatened species in Rhode Island and may occur in coastal habitats along the Sakonnet River and Aquidneck Island during migration (eBird, 2020; RIDEM, 2006). There are no federally listed songbird species likely to occur in the Project Area. Songbirds with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-7**.

Breeding songbirds that occur in the region are mostly neotropical migrants, flying north to south along the U.S. Atlantic Coast to the tropical regions of Mexico, the Caribbean, and Central and South America. During migration, songbirds mostly travel at night at high altitudes and regularly cross large bodies of water, including the Mediterranean Sea and the Gulf of Mexico (Bruderer & Lietchi, 1999; Gauthreaux & Belser, 1999). The number of individuals passing through the RSZ of offshore wind facilities has been shown to be highly variable and contingent on species and environmental conditions, with most individuals traveling above the rotor swept area of individual turbines (Fijn et al., 2015).

Blackpoll warbler (*Dendroica striata*), which is considered a Massachusetts Species of Special Concern by MassWildlife, is known to migrate nonstop over vast expanses of ocean (DeLuca et al., 2015; Faaborg et al., 2010). While songbirds are known to collide with onshore WTGs (Erickson et al., 2014), species may be able to avoid collisions with offshore WTGs (Petersen et al., 2006) and potential collisions at offshore wind farms could be lower than those observed onshore due to differing behaviors or lower overall exposure (e.g., limited to migration) (NYSERDA, 2015). For example, at the Nysed wind farm in Denmark, 2,400 hours of infrared video camera monitoring was conducted and only one collision of an unidentified small bird, potentially a songbird, was detected (Petersen et al., 2006).

In Europe, migrating songbirds have been detected at or in the vicinity (Kahlert et al., 2004; Krijgsveld et al., 2011; Pettersson & Fågelvind, 2011) of offshore wind farms, and evidence there suggests songbirds may have greater passage rates during the middle of the night (Hüppop & Hilgerloh, 2012). Additionally, songbirds may be most at risk of collision with offshore WTGs during low visibility periods (Hüppop et al., 2006). Songbirds that may traverse the Lease Area during migration may be at risk of collision. During migration, most songbirds fly at altitudes between 295 to 1,969 ft (90 and 600 m) (NYSERDA, 2015), with a large proportion of migratory movements occurring above the RSZ. However, flight heights vary according to species and conditions. For instance, songbirds may be more vulnerable to collision under inclement weather conditions that result in decreased flight heights. Limited information is available regarding the flight heights of individual songbird species. Swainson's thrushes (*Catharus ustulatus*) carrying altimeters during migratory flights demonstrated average flight altitudes of 2,208 ft (673 m) but made numerous altitude adjustments of over greater than 328 ft (100 m) during these flights (Bowlin et al., 2015).

Various songbird species may traverse the Lease Area during migration periods. Common songbirds observed during the geophysical and geotechnical surveys included, mourning dove (*Zenaida macroura*), northern cardinal (*Cardinalis cardinalis*), northern flicker (*Colaptes auratus*), and golden-crowned kinglet (*Regulus satrapa*), among others (RPS Group, 2020, 2019). Additionally, a marsh wren (Massachusetts and Rhode Island State Species of Greatest Conservation Need [SGCN]) was also observed during the October-November 2019 geophysical and geotechnical surveys. It was noted in the survey reports that some songbird species (e.g., golden-crowned kinglet) were likely attracted to the vessel and several songbirds were observed resting on handrails and other structures on the vessel. Overall occurrence of songbirds in the Lease Area is therefore expected to be uncommon to common, highly variable, and limited to migratory periods.

TABLE 6-7. PARTIAL LISTING OF SC AND SGCN DESIGNATED SONGBIRDS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Bank swallow	Uncommon	Potential occurrence in summer and during migration	Rare in summer and during migration	Uncommon during migration
Blackpoll warbler	Uncommon	Uncommon during spring and fall migration	Uncommon during migration	Uncommon during migration
Brown thrasher	Uncommon	Uncommon in summer and during migration	Uncommon in summer and during migration	Rare during migration
Eastern towhee	Uncommon	Common occurrence during the summer and migration	Uncommon in summer and during migration	-
Field sparrow	Uncommon	Potential occurrence in summer and during spring and fall migration	Uncommon in summer and during migration	-
Golden-winged warbler	Rare	Rare in summer and migration	Rare in summer and migration	Rare during migration
Grasshopper sparrow	Rare	Rare in summer and migration	Rare in summer and migration	-
Marsh wren	Uncommon	Uncommon in summer and during migration	Rare in summer and during migration	Rare during migration
Mourning warbler	Rare	Rare during migration	Rare during migration	-
Northern parula	Uncommon	Uncommon during migration	Uncommon during migration	-
Prairie warbler	Uncommon	Uncommon in summer and during migration	Uncommon in summer and during migration	Rare during migration
Saltmarsh sparrow	Rare	Rare in summer and during migration	Rare in summer and during migration	Rare during migration
Seaside sparrow	Rare	Rare in summer and during migration	Rare in summer and during migration	-
Sedge wren	Rare	Rare in summer and during migration	Rare in summer and during migration	Rare during migration

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Vesper sparrow	Rare	No longer breeds in RI, Rare in summer for MA and migration	Rare during migration for both MA and RI	Rare during migration

Sources: Billerman et al., 2020; eBird, 2020; National Audubon Society, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews for each species. "-" = species is highly unlikely to occur.

6.1.1.2 Marine Birds

This section identifies and describes the different marine bird species that may be present in the Lease Area during construction, operations, and decommissioning activities.

A total of 83 marine bird species are known to regularly occur off the coast of the eastern United States. (Nisbet et al., 2013). Marine birds or seabirds are considered to be species that spend most of their time on open ocean waters, come to shore only to breed, and can be categorized by the marine zones in which they tend to forage (e.g., pelagic, nearshore). Pelagic seabirds that forage over the open ocean during both the breeding and non-breeding seasons include shearwaters, petrels, fulmars, phalaropes, and gannets. Nearshore seabirds forage in coastal waters and winter in coastal zones relatively close to shore; these include sea ducks, loons, grebes, terns, and most gulls. **Table 6-8** lists the marine birds that are addressed in Appendix I1, Avian Exposure Risk Assessment, and includes the federal and state status of each species.

The following sections are organized by the species group (e.g., alcids, sea ducks) and each section includes a table that defines the likelihood and seasonality of occurrence of each species in the Project Area. Federally listed species and Massachusetts and Rhode Island state-listed species with potential to occur in the Lease Area are discussed in more detail in Section 6.1.1.3.

TABLE 6-8. MARINE BIRD SPECIES WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species a/	Federal (ESA) b/	State MA (MESA) and RI (RIDEM) b/
Alcids		
Atlantic puffin	-	-
Black guillemot	-	-
Common murre	-	-
Dovekie	-	-
Razorbill	-	-
Thick-billed murre	-	-
Gannets and Cormorants		
Double-crested cormorant	-	-
Northern gannet	-	-
Gulls, Skuas, and Jaegers		
Black-legged kittiwake	-	-
Bonaparte's gull	-	-

Species a/	Federal (ESA) b/	State MA (MESA) and RI (RIDEM) b/
Great black-backed gull	-	-
Great skua	-	-
Herring gull	-	-
Laughing gull	-	-
Parasitic jaeger	-	-
Pomarine jaeger	-	-
Ring-billed gull	-	-
South polar skua	-	-
Loons and Grebes		
Common loon	-	MA - SC
Horned grebe	-	-
Red-throated loon	-	-
Sea Ducks		
Black scoter	-	-
Brant	-	-
Common eider	-	-
Long-tailed duck	-	-
Surf scoter	-	-
White-winged scoter	-	-
Shearwaters, Petrels, and Storm-Petrels		
Audubon's shearwater	-	-
Band-rumped storm-petrel	-	-
Black-capped petrel	-	-
Cory's shearwater	-	-
Great shearwater	-	-
Leach's storm-petrel	-	MA - E
Manx shearwater	-	-
Northern fulmar	-	-
Sooty shearwater	-	-
Wilson's storm-petrel	-	-
Shorebirds		
Red phalarope	-	-
Red-necked phalarope	-	-
Terns		
Arctic tern	-	MA - SC
Common tern	-	MA - SC
Least tern	-	MA - SC, RI - ST
Roseate tern	E	MA – E, RI-E/SH

Notes:

a/ Federally and state-listed species are discussed in further detail in Section 6.1.1.3.

b/ = ESA = Endangered Species Act; BGEPA = Bald and Golden Eagle Protection Act; MESA = Massachusetts Endangered Species Act; E = Endangered; T = Threatened; SC = Special Concern; C = Candidate; P = Petitioned for listing; NL = Not listed, SH = State Historical.

6.1.1.2.1 Alcids

Most alcids that occur in the region breed in northern temperate regions and the Arctic, and are otherwise exclusively marine species during non-breeding seasons (Billerman et al., 2020). Alcids feed on a variety of marine animals, from zooplankton to squid and small fish. Many alcids rank high in sensitivity to displacement due to high habitat specialization and sensitivity to disturbance from boat traffic (Furness et al., 2013). Some studies indicate that alcids are known to avoid offshore wind developments and have a total avoidance rate of 99.2 percent (Cook et al., 2012). A decrease in abundance of some alcid species has also been exhibited at offshore wind farms in Europe; common murres decreased by 71 percent and razorbills have also shown a decrease in abundance by 64 percent (Vanermen et al., 2015). Flight heights recorded for alcid species observed during Aerial HD surveys ranged from an average of 10.8 ft (3.3 m) for razorbills to 132.2 ft (40.3 m) for Atlantic puffin (see Appendix I1, Avian Exposure Risk Assessment for more detail; Mayflower Wind Energy, LLC, 2020a-2020d).

The occurrence of alcids in the Lease Area ranges from rare to common. Generally, alcids may occur in the Lease Area in any season, However, most species are primarily observed during the spring and winter. Alcids with the potential to occur in the Project Area, along with their occurrence levels and seasonality, are listed in **Table 6-9.**

TABLE 6-9. ALCIDS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Atlantic puffin	Common	-	Rare less than three miles from coastal areas	Common in flocks during spring and winter, Rare in summer and fall
Black guillemot	Rare	-	Rare less than three miles from coastal areas	Rare in summer and winter
Common murre	Uncommon	-	Rare less than three miles from coastal areas	Uncommon in spring and winter
Dovekie	Common	-	Rare less than three miles from coastal areas	Common in spring and winter, Rare in summer and fall
Razorbill	Common	-	Rare less than three miles from coastal areas	Common in spring and winter, Rare in summer and fall
Thick-billed murre	Uncommon	-	Rare less than three miles from coastal areas	Uncommon in spring and winter

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.2 Gannets and Cormorants

Northern gannet breeds in southeastern Canada in the Gulf of St. Lawrence, Quebec and off the coast of Newfoundland, and winters along the U.S. Atlantic Coast, with large concentrations often observed near the OCS off Massachusetts (Mowbray, 2020). Northern gannets are opportunistic foragers and plunge-dive after prey from heights ranging from approximately 33 to 131 ft (10 to 40 m) above sea level (Mowbray, 2020). In Europe, the northern gannet has shown displacement from areas with offshore wind facilities and is highly ranked as at risk for colliding with WTGs (Cleasby et al., 2015; Vanermen et al., 2015; Garthe et al., 2014; Johnston et al., 2014; Furness et al., 2013). However, some studies indicate that northern gannets avoid offshore wind farms (Garthe et al., 2017; Hartman et al., 2012; Vanermen et al., 2015), and other studies also indicate that avoidance rates have been estimated to be 64 to 84 percent (macro) and 99.1 percent (total) (Cook et al., 2012; Krijgsveld et al., 2011; Vanermen et al., 2015).

In the mid-Atlantic, GPS-tracked northern gannets mostly used coastal areas during the winter (Spiegel et al., 2017). Northern gannets were observed during fall and spring Aerial HD surveys in the Lease Area (Mayflower Wind Energy, LLC, 2020a-2020d). The average flight height for individual northern gannets observed during Aerial HD surveys was 79.7 feet (24.3 m) (see Appendix I1, Avian Exposure Risk Assessment for more detail) (Mayflower Wind Energy, LLC, 2020a-2020d). Based on the MDAT abundance models (Winship et al. 2018; Curtice et al., 2016), MCEC surveys (Veit et al., 2016), and site-specific surveys, the occurrence of northern gannets in the Lease Area is common during spring, fall, and winter, and rare in summer. Gannets and cormorants with the potential to occur in the Project Area, including their occurrence levels and seasonality, are listed in **Table 6-10**.

Double-crested cormorants (*Phalacrocorax auritus*) are commonly observed on coastlines in Rhode Island and Massachusetts year-round, but are rarely observed offshore (Dorr et al., 2020). The MDAT models and MCEC surveys align with this, indicating that cormorants are concentrated closer to shore. Therefore, the occurrence of double-crested cormorant in the Lease Area is rare across all seasons.

TABLE 6-10. GANNETS AND CORMORANTS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Double-crested cormorant	Common	Common year-round	Common year-round	Rare
Great cormorant	Uncommon	Uncommon in fall and winter, rare in spring	Uncommon in fall and winter, rare in spring	Rare
Northern gannet	Common	Potential occurrence in spring, fall and winter Rare in summer	Rare less than three miles from coastal areas	Common spring, fall and winter, Rare in summer

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.3 Gulls, Skuas, and Jaegers

Gulls are a varied group and many species occur year-round in the region. In general, gulls are primarily coastal species, but may be observed offshore. During MCEC surveys, large gulls, including herring gulls (*Larus argentatus*) and great black-backed gulls, were observed offshore outside of the breeding season and were commonly associated with shearwaters near fishing trawlers (Veit et al., 2016). Overall, the occurrence for gull species in the Lease Area ranges from rare to common, and most species primarily occur in the winter. However, herring gull also occurs in spring and fall and great black-backed gull potentially occur year-round. Gulls, skuas, and jaegers with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-11**.

Jaegers and skuas are large, gull-like seabirds that are exclusively marine outside of the breeding season. The two jaeger species that may occur in the Lease Area (parasitic jaeger [*Stercorarius parasiticus*] and pomarine jaeger [*Stercorarius pomarinus*]) breed in the Arctic and migrate through the North Atlantic region. The occurrence of jaegers and skuas in the Lease Area is rare in spring, summer, and fall.

Generally, jaegers and gulls fly below the RSZ at heights ranging from 0 to 32 ft (0 to 10 m) above the sea surface. However, in collision vulnerability assessments (Furness et al., 2013), gulls are ranked as vulnerable to collisions because they may fly at RSZ heights (Johnston et al., 2014; Cook et al., 2012) and may be attracted to WTGs and OSPs due to an increase in boat traffic, new food sources, or as perching areas (Vanermen et al., 2015; Fox et al., 2006). However, gulls may also avoid wind farms, as exhibited by Cook et al. (2012) in which total avoidance rates for species in the group were estimated at 98 percent. Flight heights recorded for gulls observed during Aerial HD surveys ranged from an average of 130.2 ft (39.7 m) for black-legged kittiwakes (*Rissa tridactyla*) to 404.9 ft (123.4 m) for one individual lesser black-backed gull (*Larus fuscus*) (see Appendix I1, Avian Exposure Risk Assessmentfor more detail) (Mayflower Wind Energy, LLC, 2020a-2020d).

No flight heights were recorded for jaegers or skuas. However, regional data for the Atlantic OCS indicates that jaegers and skuas have primarily been recorded at flight heights below 820 ft (250 m) (see Appendix I1, Avian Exposure Risk Assessment for more detail) (Metheny & Davis, 2017; Palka et al., 2017; NOAA, 2004; Winiarski, et al. 2011). Resident gull populations in the region and in Massachusetts are not considered of conservation concern (Burger, 2020; Good, 2020; Pollet et al., 2020b; Weseloh et al., 2020) and jaegers are also not considered of conservation concern (Billerman et al., 2020).

TABLE 6-11. GULLS, SKUAS, AND JAEGERS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Black-legged kittiwake	Common	-	Rare in winter	Common in winter, Rare in spring and fall
Bonaparte's gull	Common	Common in winter	Potential occurrence in winter	Common in winter and spring, Rare in fall
Great black-backed gull	Common	Common year-round	Common year-round	Common year-round
Great skua	Rare	-	Very rare in fall	Very rare in fall

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Herring gull	Common	Common year-round	Common year-round	Common spring, fall and winter, Rare in summer
Laughing gull	Common	Common in summer and during fall/spring migration	Common in summer and during fall/spring migration	Rare in summer and fall
Parasitic jaeger	Rare	-	Rare during migration and winter	Very rare in spring, summer, and fall
Pomarine jaeger	Rare	-	Rare during migration and winter	Very rare in spring, summer, and fall
Ring-billed gull	Common	Common year-round but rare in winter	Common year-round but rare in winter	Rare in winter, Very rare in spring, summer, and fall
South polar skua	Rare	-	Very rare in fall	Very rare in summer and fall

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1, and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.4 Loons and Grebes

Loons that occur in Massachusetts and Rhode Island are Arctic and subarctic breeders that winter on the Atlantic OCS (Billerman et al., 2020). Satellite-tracked red-throated loons were primarily distributed in nearshore waters of the mid-Atlantic, and the species is known to use the Nantucket Shoals located northeast of the Lease Area (Gray et al., 2017). Evidence shows that common loons (*Gavia stellate*) have a more dispersed distribution offshore than red-throated loons (Johnson et al., 2015). Loons are among the species identified as most vulnerable to displacement (Heinänen et al., 2020; Furness et al., 2013; Garthe & Hüppop, 2004). Red-throated loons are likely to occur in the Lease Area in the spring and the species is known to avoid wind farms (Heinänen et al., 2020; Lindeboom et al. 2011; Percival, 2010) and may be permanently displaced. Loons and grebes with the potential to occur in the Project Area, including their occurrence levels and seasonality, are listed in **Table 6-12**.

The MDAT abundance models and MCEC surveys indicate that red-throated loons are generally concentrated closer to shore and in the Nantucket Shoals during fall and winter. Red-throated loon was observed in the Lease Area during the 2019-2020 Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d), and common loon was observed during the October-November 2019 boat-based geophysical and geotechnical surveys (RPS Group, 2020).

No flight heights were recorded for loon species during the Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d). However, regional data for the Atlantic OCS indicates that red-throated and common loons have primarily been recorded at flight heights below 820 ft (250 m) (see Appendix I1, Avian Exposure Risk Assessment for more detail) (Metheny & Davis, 2017; Palka et al., 2017; NOAA, 2004; Winiarski, et al. 2011). Occurrence of red-throated loons in the Lease Area is expected to be common in spring, with the potential to occur in winter and is expected to be very rare in fall. Occurrence of common loons is expected to be uncommon in spring and winter and very rare in summer and fall.

Grebes in Massachusetts spend most of the year in freshwater lakes and marshes, and occur in nearshore marine environments during the winter (Billerman et al., 2020). The state-endangered pied-billed grebe (*Podilymbus podiceps*) winters in Central and South America and typically migrates over-land (Muller & Storer, 2020; MassWildlife, 2015c). No flight heights were recorded for grebe species during the Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d) and there is no regional flight height data in the Atlantic OCS for grebes (see Appendix I1, Avian Exposure Risk Assessment for more detail) (Metheny & Davis, 2017; Palka et al., 2017; NOAA, 2004; Winiarski, et al. 2011). Based on MDAT models, MCEC surveys, and site-specific surveys, the occurrence of horned grebe (*Podiceps auratus*) is expected to be rare and limited to winter.

TABLE 6-12. LOONS AND GREBES WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Common loon	Common	-	Common in winter and during spring/fall migration, Very rare in summer	Potential occurrence in spring and winter; Very rare in summer and fall
Horned grebe	Rare	-	Rare in winter	Very rare in winter
Pied-billed grebe	Uncommon	-	Uncommon in Summer, Rare in winter – mostly found in freshwater	-
Red-necked grebe	Uncommon	-	Rare occurrence in winter	Uncommon occurrence in winter
Red-throated loon	Common	-	Common in winter and during spring/fall migration, Very rare in summer	Uncommon in spring, Rare in winter, Very rare in fall and summer

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.5 Sea Ducks

Waterfowl taxa, commonly termed "sea ducks", regularly use the marine environment outside of their breeding seasons, with most species tending to feed and rest within coastal (nearshore and inshore) waters and others using offshore waters. They typically form large flocks and are often observed in large rafts on the sea surface during this period. Sea ducks that may occur within the Lease Area include eiders, scoters, mergansers, long-tailed ducks, and harlequin ducks (*Histrionicus histrionicus*). Most sea ducks forage on waters over rocky substrate, where they forage on shellfish and other benthic invertebrates. Sea ducks with the potential to occur in the Project Area, including their occurrence levels and seasonality, are listed in **Table 6-13**.

The western edge of the Nantucket Shoals is recognized as an important wintering area for sea ducks and other marine birds (Veit et al., 2016; Silverman et al., 2013). Long-tailed ducks and white-winged scoters winter on the Nantucket Shoals in large aggregations. Other sea ducks winter on the Nantucket Shoals in large aggregations from mid-November to mid-April as well (White & Veit, 2020; Silverman et al., 2012; White et al., 2009).

Radar and GPS tracking studies indicate that some waterfowl species (i.e., geese and swans) avoid offshore wind farms (Plonczkier & Simms, 2012; Griffin et al., 2011), and it is generally believed that waterfowl may be less likely than other avian taxa to suffer direct mortality from WTG operations during both the breeding and migratory periods. For example, only one collision event was recorded during observations of 1.5 million migrating waterfowl, primarily common eider, at a wind facility in the Kalmar Sound, Sweden (Pettersson, 2005).

Radar and collision observation studies indicate that migrating waterbirds (including waterfowl) may be able to detect WTGs and divert their flight paths away from WTGs from up to 1.9 mi (3.0 km) in daytime and 0.6 mi (1.0 km) at night (Drewitt & Langston, 2006; Kahlert et al., 2004,). In Nysted, Denmark, there is evidence that migrating common scoters (*Melanitta nigra*) avoided a wind farm and its immediate vicinity and that common eiders were able to travel between rows of turbines placed 1,575 ft (480 m) apart (Drewitt & Langston, 2006).

Another study conducted off the east coast of England demonstrated that migrating geese can adjust their flight paths both horizontally and vertically to avoid wind farms, leading the authors to conclude that the facilities studied added no additional risk of mortality to these waterfowl (Plonczkier & Simms, 2012). In general, waterfowl mortalities at wind facilities tend to be low, relative to higher strike-risk species that do not exhibit avoidance behaviors at the micro- or macro- spatial scale (review in Marques et al., 2014). Flight heights recorded for sea ducks observed during Aerial HD surveys ranged from an average of 20.7 ft (6.3 m) for common eiders to 107.6 ft (32.8 m) for white-winged scoter (see Appendix I1, Avian Exposure Risk Assessment for more detail; Mayflower Wind Energy, LLC, 2020a-2020d).

Sea ducks are also vulnerable to displacement. Avoidance behavior has been documented for several species, including black scoter and common eider (Desholm & Kahlert, 2005, Larsen & Guillemette, 2007) and studies have also documented sea ducks increasing their altitude to avoid WTGs at night (Desholm & Kahlert, 2005).

The regional MDAT abundance models and MCEC surveys indicate that most sea ducks are concentrated close to shore and in the Nantucket Shoals. Overall, occurrence of sea ducks in the Lease Area ranges from rare to common, with most species occurring in winter and early spring.

TABLE 6-13. SEA DUCKS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfalls	ECCs	Lease Area
Black scoter	Uncommon	Rare in winter only	Uncommon in winter and during fall migration only	Uncommon in spring and winter; Very rare in fall
Brant	Uncommon	Uncommon in winter and migration, Rare in summer	Uncommon in winter and during migration only, Rare in summer	Very rare in fall only
Common eider	Common	Common in winter and migration, Rare in summer	Common in the winter and migration, Rare in summer	Uncommon in winter and spring; Rare in summer and fall
King eider	Rare	Very rare in winter only	Rare in winter only	Very rare in winter only
Long-tailed duck	Common	Rare in winter only	Common in winter and migration, Rare in summer	Occurs in spring and winter Rare in fall
Red-breasted merganser	Uncommon	Uncommon in winter and migration only	Uncommon in winter and migration, Rare in summer	Rare in year-round
Surf scoter	Uncommon	Rare in winter only	Potential occurrence in winter	Uncommon in winter, Rare in spring and fall
White-winged scoter	Common	Rare in winter only	Potential occurrence in winter	Common in spring and winter, Rare in fall and summer

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.6 Shearwaters, Petrels, and Storm-Petrels

Petrels, shearwaters, and storm-petrels are pelagic seabirds that only make landfall during the breeding season. Most of the species that occur regionally breed in the Arctic, subarctic, and subantarctic. Leach's storm-petrel (*Oceanodroma leucorhoa*) is state-listed under the MESA and is discussed in Section 6.1.1.3. Two species, manx shearwater (*Puffinus puffinus*) and Audubon's shearwater (*Puffinus lherminieri*), breed in temperate and temperate-tropical regions, respectively. Most pelagic species may be observed in high densities in the broader U.S. Atlantic Coast region, including within the Massachusetts/Rhode Island WEA, in the summer (austral winter; Veit et al., 2016; Veit et al., 2015; Nisbet et al., 2013).

Conversely, northern fulmar (*Fulmarus glacialis*) is primarily observed in the region in the winter (austral summer), and both the band-rumped storm-petrel (*Oceanodroma castro*) and black-capped petrel (*Pterodroma hasitata*) are considered rare visitors during the winter. Northern fulmar and shearwater species feed primarily on fish and invertebrates (e.g., squids, crustaceans), typically snapping them up from the surface, but occasionally diving in pursuit. Storm-petrels feed on a variety of zooplankton, small fish, squid, and crustaceans that they catch from the water's surface as they flutter above (Billerman et al., 2020).

Black-capped petrel was proposed for federal-listing under ESA as threatened in 2018 and is currently under review by the USFWS (USFWS, 2018). The average flight height for individual northern fulmars observed during Aerial HD surveys was 124.7 ft (38.0 m; see Appendix I1, Avian Exposure Risk Assessment for more detail; Mayflower Wind Energy, LLC, 2020a-2020d). No flight heights were recorded for shearwaters, petrels, or storm-petrels. However, regional data for the Atlantic OCS indicates that shearwaters, petrels, or storm-petrels have primarily been recorded at flight heights below 820 feet (250 m; see Appendix I1, Avian Exposure Risk Assessment for more detail; Metheny & Davis, 2017; Palka et al., 2017; NOAA, 2004; Winiarski, et al. 2004).

The regional MDAT models and MCEC surveys indicate that the occurrence in the Lease Area for shearwaters, petrels, and storm-petrels ranges from rare to common. Cory's shearwater, great shearwater, and northern fulmar occurrence is common; Cory's shearwater and great shearwater primarily occurring in summer with potential occurrence in fall and winter and northern fulmar primarily occurring in fall and winter with potential occurrence in spring. Shearwaters, petrels, and storm-petrels with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-14**.

TABLE 6-14. SHEARWATERS, PETRELS, AND STORM-PETRELS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species a/	Occurrence Level	Seasonality in Project Area b/		
		Landfalls	ECCs	Lease Area
Audubon's shearwater	Rare	-	Very rare in spring, summer, and fall only	Very rare in spring, summer, and fall only
Band-rumped storm-petrel	Rare	-	Very rare in summer	Very rare in summer
Black-capped petrel	Rare	-	Very rare year-round	Very rare year-round
Cory's shearwater	Common	Very rare during summer and fall only	Common in summer, Uncommon in spring and fall, Very rare in winter	Common in summer, Potential occurrence in spring and fall, Very rare in winter
Great shearwater	Common	-	Common in summer, Uncommon in spring and fall	Common in summer Uncommon in spring and fall
Manx shearwater	Rare	-	Rare in spring, summer, and fall	Rare in spring, summer, and fall
Northern fulmar	Common	-	Common in fall and winter, Rare in spring, Very rare in summer	Common in fall and winter, Rare in spring, Very rare in summer
Sooty	Uncommon	-	Rare in spring and	Uncommon in spring

Species a/	Occurrence Level	Seasonality in Project Area b/		
		Landfalls	ECCs	Lease Area
shearwater			summer, Very rare in fall	and summer, Very rare in fall
Wilson's storm-petrel	Common	-	Common in summer, Rare in spring and fall	Common in summer Rare in spring and fall

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Notes:
a/ The state-listed Leach's storm-petrel is discussed in further detail in Section 6.1.1.3.
b/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.7 Marine Shorebirds

Red phalarope (*Phalaropus fulicarius*) and red-necked phalarope (*Phalaropus lobatus*) are the only two species that are considered to be more marine than coastal (e.g., forage/rest on open waters offshore) (Tracy et al., 2020; Rubega et al., 2020) and have the potential to occur in the Lease Area during multiple seasons. Little is known about the migratory movements of these two phalarope species; however, they are known to travel over open waters during migration (O'Connell et al., 2011). Flight heights recorded for both phalarope species observed during Aerial HD surveys ranged from an average of 87.6 ft (26.7 m) to 288.0 ft (87.8 m) (see Appendix I1, Avian Exposure Risk Assessment for more detail) (Mayflower Wind Energy, LLC, 2020a-2020d).

The MDAT abundance models and MCEC surveys indicate that red phalarope occurrence in the Lease Area is uncommon in spring and red-necked phalarope occurrence in the Lease Area is rare in spring. Marine shorebirds with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-15**.

TABLE 6-15. MARINE SHOREBIRDS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area a/		
		Landfall	Export Cable Corridors	Lease Area
Red phalarope	Uncommon	-	Rare during migration	Uncommon in spring; Rare in summer and fall migration
Red-necked phalarope	Rare	-	Rare in summer and during migration	Rare in spring; Very rare in summer and fall migration

Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013
Note: a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.2.8 Terns

Common terns, least terns, and roseate terns breed in coastal habitats in Massachusetts, whereas Arctic terns are Arctic breeders and are only observed regionally during the spring and fall migration periods. Roseate tern is federally listed under the ESA and is discussed in Section 6.1.1.3. The common tern, Arctic tern, and least tern are also considered Massachusetts Species of Special Concern by MassWildlife and common tern and least tern are discussed in detail in Section 6.1.1.3. A discussion of Arctic tern is not included because occurrence of the species in the Project Area is anticipated to be very rare and the species was not observed during Project-sponsored surveys in the Lease Area (Mayflower Wind Energy, LLC, 2020a-2020d; RPS Group, 2020; 2019).

The Lease Area is located outside of high use areas for terns (e.g., western side of Nantucket Shoals, Muskeget Channel, and Sakonnet River) (Veit et al., 2016). Terns have also exhibited avoidance behaviors at wind farms in Europe (Krijgsveld et al., 2011) suggesting that terns may be able to detect turbine blades and adjust flight paths and heights to avoid spinning rotors (MMS, 2008; Vlietstra, 2007). In addition, terns rarely fly at heights of the RSZ (Furness et al., 2013; Garthe & Hüppop, 2004). No flight heights were recorded for grebe species during the Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d); however, regional data for the Atlantic OCS indicate that terns have primarily been recorded at flight heights below 820 ft (250 m) (see Appendix I1, Avian Exposure Risk Assessment for more detail) (Metheny & Davis, 2017; Palka et al., 2017; NOAA, 2004; Winiarski, et al. 2011). Generally, during the breeding season, risk of collision declines the further WTGs are from breeding colonies (Cranmer et al., 2017; Everaert & Stienen, 2007). Most tern fatalities recorded at offshore wind farms in Europe have occurred at WTGs that were less than 98 ft (30 m) from nests (Burger et al., 2011). The Lease Area is not located within 20 mi (32 km) of any known tern nesting colony.

The MDAT abundance models and MCEC surveys indicate that terns are primarily concentrated close to shore. Overall, the likelihood of occurrence in the Lease Area for terns ranges from rare to uncommon. Terns with the potential to occur in the Project Area, including occurrence levels and seasonality, are listed in **Table 6-16**.

TABLE 6-16. TERNS WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Species a/	Occurrence Level	Seasonality in Project Area b/		
		Landfalls	ECCs	Lease Area
Arctic tern	Rare	Very rare in summer	Very rare in summer	Very rare in summer
Bridled tern	Rare	-	Very rare in summer and fall	Very rare in summer and fall
Royal tern	Rare	Very rare in summer	Very rare in fall	Very rare in fall
Sooty tern	Rare	Very rare in summer	Very rare in summer	Very rare in summer

Sources: Billerman et al., 2020; eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Notes:
a/ Federally and state-listed tern species are discussed in further detail in Section 6.1.1.3.
b/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for each species. Only seasons in which species were observed or are likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.3 Federally and State-Listed Coastal and Marine Birds

There are six species of marine and coastal birds that are listed as threatened or endangered under the ESA, MESA (including Special Concern species) and/or RINHP that may be present within the Project Area. These include piping plover, red knot, roseate tern, Leach's storm-petrel, common tern, and least tern, with the exception of the state-threatened peregrine falcon which is discussed in Section 6.1.1.1.4.

6.1.1.3.1 Roseate Tern

The roseate tern is a medium-sized tern that is primarily pelagic along seacoasts, bays, and estuaries, using land only for nesting and roosting (Gochfeld & Burger, 2020; Sibley, 2000). The Atlantic subspecies of roseate tern (*S. dougallii dougallii*) breeds in two discrete areas in the western hemisphere (USFWS, 2010a, 1998). The northeastern population, which is listed as endangered under the ESA, breeds along the coast from New York north to Maine and into adjacent areas of Canada and winters along the northeastern coast of South America, primarily Brazil (USFWS, 2010a). Much of the population (over 90 percent) has become concentrated into three breeding colonies located on islands off Massachusetts (Bird, Ram, and Penikese Islands in Buzzards Bay) and at one location in New York (Great Gull Island) (Gochfeld & Burger, 2020; Loring et al., 2017; USFWS, 2010a). The last roseate tern breeding colony in Rhode Island disappeared in 1979. However, the species will likely forage and migrate through coastal areas of Rhode Island, including the Sakonnet River. The northeastern population of roseate tern was estimated to be 3,200 pairs in 2013 (Gochfeld & Burger, 2020). The roseate tern is also state-listed as endangered under the MESA and state-endangered historical under the RINHP (RIDEM, 2006). Currently there are no breeding colonies in the state of Rhode Island.

Roseate terns forage offshore and roost in flocks typically near tidal inlets in late July to mid-September. Roseate terns forage mainly by plunge-diving and contact-dipping. They are adapted for fast flight and relatively deep diving and often submerge completely when diving for fish (USFWS, 2011). Roseate terns arrive to northwestern Atlantic breeding colonies in late April to early May (Nisbet, 1984). Breeding records for roseate terns indicate that the Lease Area is approximately 31 mi (50 km) and 56 mi (90 km) from the nearest breeding colonies (Loring et al., 2019, 2017; Kamm et al., 2013). During the nesting period (mid-May through July), adults are believed to remain close (less than 19 mi [30 km]) to the nesting colony during foraging and in mid-September, the terns begin their migration south (Normandeau Associates Inc., 2011).

Cape Cod and its nearby islands (Martha's Vineyard and Nantucket) are important post-breeding staging areas prior to migration (Normandeau Associates Inc., 2011). Aerial surveys conducted by Veit et al. (2016) identified hotspots of roseate tern abundance on the western side of the Nantucket Shoals and in the Muskeget Channel between Martha's Vineyard and Muskeget during the spring. The Nantucket Shoals location also hosts large numbers of long-tailed ducks and white-winged scoters during winter, and common and roseate terns during spring. The Muskeget Channel area was also identified as potentially important for scoters, eiders, loons, and terns (Veit et al., 2016). Previous aerial surveys in the region indicated that roseate tern activity occurred almost exclusively near the Muskeget Channel from August to September, with little to no activity farther offshore (Veit & Perkins, 2014).

Migration routes of roseate terns are not well known, but are believed to be largely or exclusively pelagic in both spring and fall (USFWS, 2010a; Nisbet, 1984); therefore, roseate terns may pass through the Lease Area during this period (Veit et al., 2016; Normandeau Associates Inc., 2011). Roseate terns may be present in the Lease Area during nesting, post-breeding staging, and during spring and fall migrations. According to the NHESP, there are no Priority Habitats and Estimated Habitats at the proposed Falmouth landfall locations for state-listed species. However, there are both Priority and Estimated Habitats adjacent to these areas and the proposed Falmouth export cable corridor (NHESP, 2020). These habitats may include those defined for state-listed tern species, including roseate tern, but species-specific information is not public. The species is a historical breeder (last known colony was in 1979) in Rhode island with no known breeding colonies in the state (RIDEM, 2015).

Common terns have exhibited avoidance behaviors around spinning WTG blades (Vlietstra, 2007) and local breeding terns are likely to stay close to shore and nesting colonies when foraging offshore. Additionally, data suggest that roseate terns and related tern species in Europe infrequently fly between 66 to 492 ft (20 to 150 m) (Jongbloed, 2016; Cook et al., 2012). This is also supported by pre-construction surveys in the Nantucket Sound area for Cape Wind, which indicates that 95 percent of estimates of flight heights for common/roseate terns were below the Project's proposed RSZ of 75.5 to 439.6 ft (23 to 134 m) (MMS, 2008). Altitudes at which roseate terns migrate offshore is not well known. However, it is thought to be in the hundreds or thousands of meters (MMS, 2008; Perkins et al., 2004). Recent tracking surveys (with immersion sensors) also showed that the species may drop latitudes during migration, and roseate terns were recorded resting on the water's surface during migration and wintering periods (Gochfeld & Burger, 2020). Generally, the flight heights of roseate terns during migration vary by weather. Tern species have been recorded flying at lower altitudes in headwinds (Jongbloed, 2016; MMS, 2008; Alerstam, 1985).

The predicted abundance of roseate tern in the Lease Area is very low in fall and summer, and the MDAT abundance models suggest that predicted abundance of the species is low relative to levels of abundance observed in Nantucket Sound (Winship et al., 2018; Curtice et al., 2016). Roseate terns were observed in the Lease Area during Aerial HD surveys in spring only (Mayflower Wind Energy, LLC, 2020a-2020d) (**Figure 6-2**). No roseate terns were observed during the September or October-November 2019 geophysical and geotechnical surveys (RPS Group, 2020, 2019).

Recent tracking data indicate that most post-breeding movements of tagged roseate terns to staging areas occurred close to shore. However, detection ranges were limited to within approximately 12 mi (20 km) of onshore tracking stations (Loring et al., 2019). Potential movements over the Lease Area may have occurred, as a limited number of movement tracks indicated southward movement from Muskeget Island before individuals moved beyond the detection range. Based on the MDAT abundance models, MCEC surveys, tracking surveys, and Aerial HD surveys, roseate tern occurrence in the Lease Area is expected to be rare in spring and fall. Potential occurrence of roseate tern in the Project Area, including species occurrence level and seasonality, is defined in **Table 6-17**.

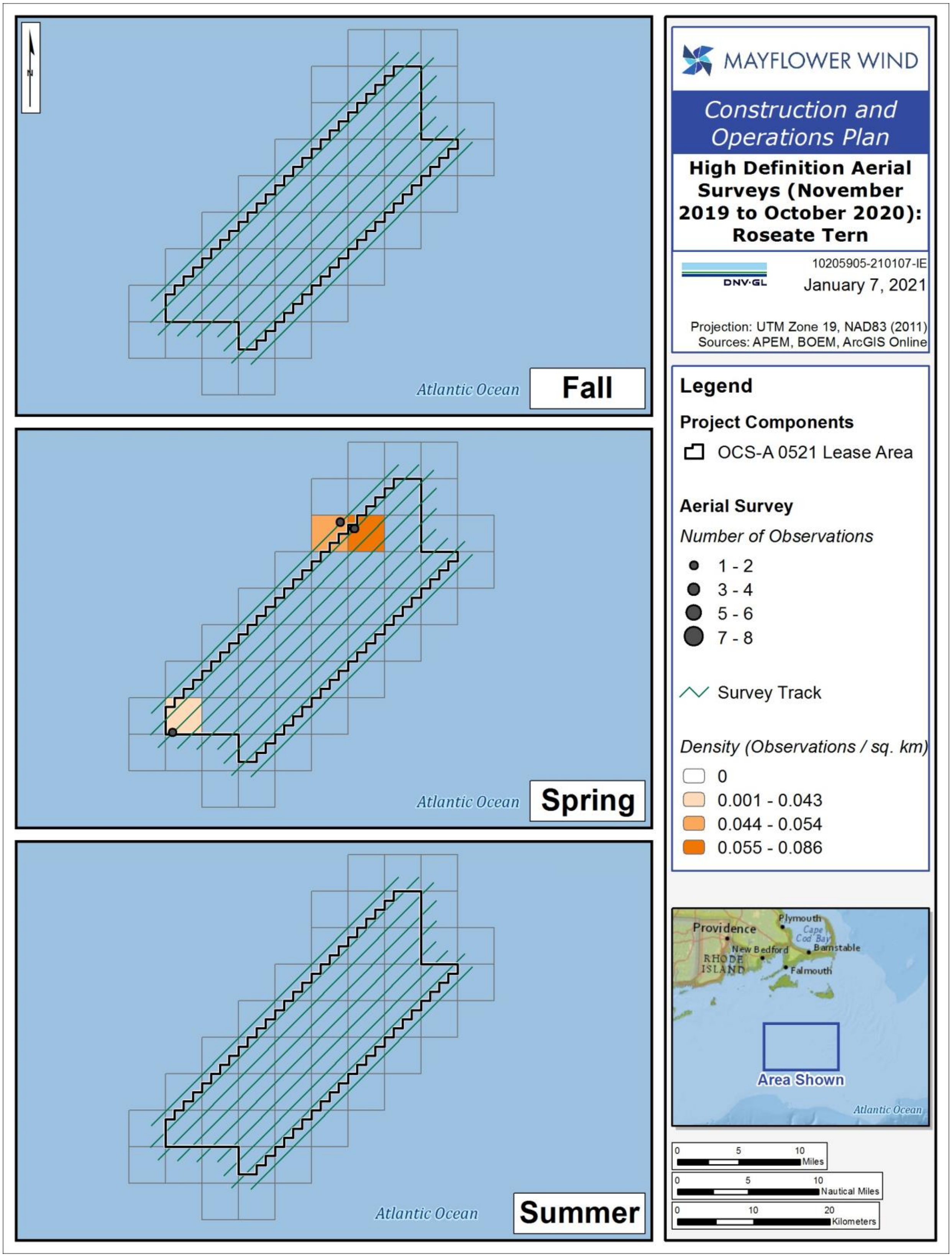


FIGURE 6-2. RAW OBSERVATIONS AND EFFORT-ADJUSTED SEASONAL DENSITY ESTIMATES FOR ROSEATE TERN (SEE AERA [APPENDIX I1] FOR DETAILED METHODOLOGY)

TABLE 6-17. POTENTIAL OCCURRENCE OF ROSEATE TERN IN THE PROJECT AREA

Occurrence Level	Seasonality in Project Area a/		
	Landfalls	ECCs	Lease Area
Rare	Rare in summer for MA only; Rare spring and fall migrant for both states	Rare in summer for MA only; Very rare spring and fall migrant for both states	Very rare in spring and fall migration only

Sources: eBird, 2020; Gochfeld & Burger, 2020; National Audubon, 2020; Loring et al., 2019; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews. Only seasons in which the species was observed or is likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.3.2 Piping Plover

The piping plover is a small, migratory shorebird that breeds on sandy beaches from Newfoundland to North Carolina (and occasionally in South Carolina) and winters along the U.S. Atlantic Coast from North Carolina south, along the Gulf Coast, and in the Caribbean (Elliot-Smith & Haig, 2020, 2009). Piping plovers inhabit coastal sandy beaches and mudflats. They use open, sandy beaches close to the primary dune of the barrier islands for breeding and nesting and spend most of their time foraging along the wrack zone where organic material (e.g., kelp, seagrass, shells) and other debris is deposited at high tide (Elliot-Smith & Haig, 2020).

According to the USFWS (2009), piping plovers that breed on the Atlantic Coast belong to the *melodus* subspecies and this population is classified as threatened under the ESA, whereas the *circumcinctus* subspecies of piping plover (*C. m. circumcinctus*) inhabit the Northern Great Plains and Great Lakes watershed and are classified as endangered under the ESA. The Northern Great Plains and Great Lakes piping plover populations winter along the Atlantic and Gulf of Mexico coastlines (Stucker and Cuthbert, 2006) but are not expected to commonly occur along the New England coast. A key threat to the Atlantic Coast population is habitat loss resulting from shoreline development (USFWS, 1996). Predation is also an issue and is associated with human-related disturbance in the Commonwealth of Massachusetts (BOEM, 2014; USFWS, 2009; Elliott-Smith & Haig, 2004). The Massachusetts population of Atlantic Coast piping plover was estimated to be 649 pairs in 2016 (USFWS, 2017). The piping plover is also state-listed in Massachusetts as threatened under the MESA and state endangered in Rhode Island (RIDEM, 2015).

Piping plovers may occur in Massachusetts throughout their breeding season as well as their spring and fall migratory seasons from late March through mid-October (Robinson Willmott et al., 2013; Normandeau Associates, Inc., 2011). During nesting, egg-laying, and the rearing of fledglings (late April through mid-September) this species is unlikely to occur in the Lease Area (Normandeau Associates Inc., 2011). Migratory pathways of this species are not well known (Normandeau Associates Inc., 2011; USFWS, 2009). However, during their migratory periods, April and May (spring) and August and September (fall), some individuals of this species will likely traverse the Lease Area, as Normandeau Associates Inc. (2011) found that the bulk of migratory activity of the Atlantic coastal breeding population of piping plover may be noncoastal. According to the NHESP, there are no Priority Habitats and Estimated Habitats at the proposed landfall locations for state-listed species, but there are both Priority and Estimated Habitats adjacent to these areas and the proposed Falmouth export cable corridor (NHESP, 2020). These habitats may include those defined for state-listed shorebird species, including piping plover, but species-specific information is not public. Flight heights of migratory piping plovers are unknown (Burger et al., 2011); however, a recent tracking study indicates that some individuals may migrate at high altitudes (Paton, 2016). Piping plovers are known to use beaches near the Brayton Point export cable corridor along Aquidneck Island (Sachuest National Wildlife Refuge [NWR]) and Sakonnet Lighthouse in Rhode Island (eBird, 2020).

The MDAT did not model predicted abundance of piping plover and the species was not observed during MCEC or during the 2019-2020 Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d) or geophysical and geotechnical surveys (RPS Group, 2020, 2019) conducted in the Lease Area. A recent VHF-tracking study indicated that some piping plover individuals from Monomoy Island, Muskeget Island, and Nantucket Island moved southward and the individuals may have traversed over the Lease Area before they moved beyond the detection range of trackers (Loring et al., 2019). Potential occurrence of piping plover in the Project Area, including species occurrence level and seasonality, is defined in **Table 6-18**.

TABLE 6-18. POTENTIAL OCCURRENCE OF PIPING PLOVER IN THE PROJECT AREA

Occurrence Level	Seasonality in Project Area a/		
	Landfalls	ECCs	Lease Area
Rare	Rare in spring and summer; Very rare in fall	Rare in spring and summer along coastal MA (Falmouth Beach) and RI (Aquidneck Island – Sachuest NWR)	Not modeled; Based on literature, very rare in spring and fall migration

Sources: eBird, 2020; Elliot-Smith & Haig, 2020; National Audubon, 2020; Loring et al., 2019; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews. Only seasons in which the species was observed or is likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.3.3 Red Knot

The red knot is a medium-sized shorebird that migrates in large flocks. The species migrates long distances, undertaking nonstop flights up to 4,970 mi (8,000 km) (Baker et al., 2020), between breeding grounds in the mid- and high-arctic areas and wintering grounds in southern South America (Normandeau Associates, Inc., 2011; USFWS, 2010b; Harrington, 2001). Red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks (USFWS, 2010b). The North American breeding population of red knots was listed as threatened by the USFWS in December 2014 (79 Fed. Reg. 73706). Threat factors contributing to the decline of the species include habitat destruction resulting from beach erosion and various shoreline protection and stabilization projects, human disturbance, reduction in important food resources (e.g., horseshoe crabs in the Delaware Bay), potential limiting factors in overwintering areas, and competition with other species for limited food resources. The red knot is also state listed as threatened under the MESA in Massachusetts. The species is not state listed in Rhode Island.

Red knot is present in Massachusetts during spring and fall migratory periods (BOEM, 2014) and is known to stop over on Monomoy Island during fall migration (Baker et al., 2020), which is located over 50 mi (80 km) from the Lease Area. Red knot migration northward through the contiguous United States occurs in April to June and southward migration occurs in July to October. Delaware Bay is the most important spring migration stopover in the eastern United States because it is the final stop at which the birds can refuel in preparation for their nonstop leg to the Arctic (USFWS, 2010b).

These studies have revealed that migratory pathways of red knots through the Atlantic OCS are fairly diverse, as some individuals traverse northern sections of the region as they travel directly between northeastern U.S. migratory stopover sites and wintering areas or stopover sites in South America and the Caribbean, while others follow the U.S. Atlantic Coast or traverse the Atlantic OCS farther to the south moving between U.S. Atlantic coastal stopover sites and wintering areas in the southern United States, Caribbean, or northern South America (Loring et al., 2018; Normandeau Associates Inc., 2011; Niles et al., 2010). Additionally, these studies indicate that in the spring, red knots tend to be more concentrated in the mid-Atlantic or southward, whereas in the fall, there is more of a northerly concentration, especially in Massachusetts (Loring et al., 2018; Normandeau Associates Inc., 2011; Niles et al., 2010). There are few sightings of red knots along the Brayton Point export cable corridor within the Sakonnet River, with most sightings occurring irregularly at Sachuest NWR in the spring (eBird, 2020).

Approximately 2,000-5,000 individual red knots may stage on Cape Cod during southbound migration (L. Niles, personal communication, July 1, 2020), with most southbound flight paths appearing to occur closer to shore (and well west and north of the Lease Area) according to data from tagged individuals (Loring et al., 2018). Red knot flight heights during migration (excluding takeoff and landing) are estimated to be approximately 3,281 to 9,843 ft (1,000 to 3,000 m; Burger et al., 2011). Shorebird and seabird migration heights are known to be influenced by environmental conditions (Finn et al., 2012; Newton, 2010) and red knots are believed to travel at lower altitudes during headwinds, high winds, or poor weather that reduces visibility (Baker et al., 2020; Gordon & Nations, 2016; Burger et al., 2011).

Red knot was not modeled in the MDAT abundance models and no red knots were observed during MCEC surveys or during the 2019-2020 Aerial HD (Mayflower Wind Energy, LLC, 2020a-2020d) or 2019 geophysical and geotechnical surveys (RPS Group, 2020; 2019) conducted in the Lease Area. The likelihood of occurrence of red knot in the Lease Area is rare in spring and fall. Potential occurrence of red knot in the Project Area, including species occurrence level and seasonality, is defined in **Table 6-19**.

TABLE 6-19. POTENTIAL OCCURRENCE OF RED KNOT IN THE PROJECT AREA

Occurrence Level	Seasonality in Project Area a/		
	Landfalls	ECCs	Lease Area
Rare	Rare during migration at Falmouth Beach (MA) and Sachuest NWR (RI)	Rare during migration at Falmouth Beach (MA) and Sachuest NWR (RI)	Not modeled Based on literature, very rare in spring and fall

Sources: Baker et al., 2020; eBird, 2020; National Audubon, 2020; Loring et al., 2018; Blodget, 2017; Kamm et al., 2013)
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in the Project Area is qualitatively based on literature and available data reviews. Only seasons in which the species was observed or is likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.3.4 Leach's Storm-Petrel

The Leach's storm-petrel is a medium-sized storm-petrel that breeds on islands in the Atlantic Ocean from Norway to Massachusetts, and disperse widely across the Atlantic and mainly in the tropics, with overwintering areas along Brazil and southwestern Africa (Pollet et al., 2020a; 2014). Leach's storm-petrels forage at sea and feed on plankton, fishes, crustaceans, cephalopods, and jellyfish while hovering over the surface. Leach's storm-petrel breed in Massachusetts on two tiny, low-lying offshore islands, Penikese and Noman's Land Island, which are the southernmost breeding locales for the species in the Atlantic Ocean (MassWildlife, 2015d; French, 2002). The Leach's storm-petrel is listed as endangered under the MESA due to its limited and declining breeding population in the Commonwealth of Massachusetts. There were an estimated 80-90 pairs when the species was first discovered nesting in Massachusetts in 1941, and numbers have steadily declined since, with fewer than 15 pairs suspected to be left (MassWildlife, 2015d; Peterson & Meservey, 2003). Threats to Leach's storm-petrel include increase in nesting predators, habitat changes, human disturbance at nest sites, and ingestions of plastics (Pollet et al., 2020a). The species is also vulnerable to pollution from organochlorine compounds such as pesticides and heavy metals.

A GPS tracking study found that some Leach's storm-petrels will remain in the North Atlantic after the breeding season (Pollet et al., 2014). Little is known about the migration patterns of small seabirds, including the Leach's storm-petrel. However, recent tracking studies of Leach's storm-petrels from breeding colonies in Nova Scotia, Canada (Pollet et al., 2019) suggests that the species migrate in a general clockwise pattern around the North Atlantic Gyre, as observed with Arctic terns and sooty shearwaters (Hedd et al., 2012; Egevang et al., 2010). None of the tracks of the tagged birds from either Pollet et al. study (2019; 2014) appeared to traverse the Lease Area. Leach's storm-petrel is ranked in the medium range of vulnerability to displacement from WTGs and highly ranked as at risk for colliding with WTGs (Robinson Willmott et al., 2013). These rankings were assigned for the Atlantic OCS (from Florida to Maine) based on several metrics, including observations from existing wind facility studies in Europe, species global population estimates, and estimated population size in the Atlantic OCS. There is little evidence or research of the average flight heights of the species or the potential for the species to avoid offshore wind developments.

The MDAT models and MCEC surveys indicate that the likelihood of occurrence of Leach's storm-petrel in the Lease Area is rare in spring, summer, and fall, as the species is predicted to primarily occur further offshore than the Lease Area. Leach's storm-petrel was not observed during the 2019-2020 Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d) or geophysical and geotechnical surveys (RPS Group, 2020, 2019) conducted in the Lease Area. Potential occurrence of Leach's storm-petrel in the Project Area, including species occurrence level and seasonality, is defined in **Table 6-20**.

TABLE 6-20. POTENTIAL OCCURRENCE OF LEACH'S STORM-PETREL IN THE PROJECT AREA

Occurrence Level	Seasonality in Project Area a/		
	Landfall	Falmouth Export Cable Corridor	Lease Area
Rare	Very rare in summer and fall for Falmouth ECC only	Very rare in summer and fall for Falmouth ECC only	Rare in spring, summer, and fall

Sources: eBird, 2020; National Audubon, 2020; Pollet et al., 2020a, 2019, 2014; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews. Only seasons in which the species was observed or is likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.3.5 Least Tern

The Lease Tern is a Massachusetts Species of Special Concern in Massachusetts and a Rhode Island state-threatened species. The least tern is the smallest North American tern. In North America, it breeds on the U.S. Atlantic Coast from Maine to Florida, along the Gulf Coast, and on the Pacific Coast from California to Mexico, and inland along major tributaries of the Missouri, Ohio, and Mississippi Rivers. In Massachusetts, the species arrives in early May to nest at coastal locations and departs to wintering grounds by early September. In Massachusetts, the largest populations occur on Cape Cod and the surrounding islands. Historically the species was common, but populations declined rapidly in the early 20th century due to egg collecting and the millenary trade, reducing populations at the time to approximately 250 breeding pairs in Massachusetts.

Aggressive legal protections have resulted in an increase to a record high of 3,420 breeding pairs in 2001. Currently, 54 breeding sites occur in the state (MassWildlife, 2015e). The greatest threats to least terns are known to be an increased number of human-subsidized predators (e.g., mammals, corvids, gulls), beach driving, disturbance (e.g., pedestrian, dogs) and vegetative succession of the limited remaining breeding habitat.

Least tern forages along estuaries, bays, rivers, lagoons, and lakes along the coast, typically within 1.9 mi (3 km) from colonies. Least tern nesting colonies are commonly associated with piping plovers, which use the same nesting habitat that consists of bare sandy areas or areas with limited vegetation found primarily along mainland beach strands or along barrier island beaches beyond the reach of normal spring tides. Nesting colonies have also been found on sandy dredge disposal sites with sparse vegetation and near sand and gravel pits related to mining operations. According to the NHESP, there are no Priority Habitats and Estimated Habitats at the proposed Falmouth landfall locations and Brayton Point for Massachusetts state-listed species. However, there are both Priority and Estimated Habitats adjacent to these areas and the proposed Falmouth export cable corridor (NHESP, 2020). These habitats may include those defined for state-listed tern species, including least tern, but species-specific information is not public. In Rhode Island, most observations of least terns occur in the spring (May) along coastal areas (eBird, 2020; RIDEM, 2015). Observations of least tern near the Brayton Point export cable corridor in the Sakonnet River occur along Aquidneck Island (Sachuest NWR) and Sakonnet Lighthouse in Rhode Island (eBird, 2020).

The MDAT abundance models and MCEC surveys indicate that least tern likelihood of occurrence in the Lease Area is rare in spring and fall. Least tern was not observed during the 2019-2020 Aerial HD surveys (Mayflower Wind Energy, LLC, 2020a-2020d) or geophysical and geotechnical surveys (RPS Group, 2020; 2019) conducted in the Lease Area. Potential occurrence of least tern in the Project Area, including species occurrence level and seasonality, is defined in **Table 6-21**.

TABLE 6-21. POTENTIAL OCCURRENCE OF LEAST TERN IN THE PROJECT AREA

Occurrence Level	Seasonality in Lease Area a/		
	Landfalls	ECCs	Lease Area
Uncommon	Very rare at Brayton Point, Uncommon at Falmouth landfalls for spring and summer only, Very rare in fall	Uncommon at entrance to Sakonnet River (Sachuest NWR and Sakonnet Lighthouse), Uncommon at Falmouth landfalls, spring and summer, Very rare in fall	Very rare in spring and fall migration

Sources: eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews. Only seasons in which the species was observed or is likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.1.3.6 Common Tern

The common tern, a Massachusetts Species of Special Concern, is a medium-sized tern. In North America, it breeds along the Atlantic Coast from Labrador to South Carolina and along inland lakes and rivers. The species arrives in Massachusetts in April and remains until August to nest at coastal locations, with the largest populations occurring on Cape Cod (MassWildlife, 2015f). Common tern populations in Massachusetts significantly decreased in the late 19^{th} century due to the millinery (hat-making) trade. Regulatory protections aided in population increases in the 1920s, but they declined again in the 1970s due to displacement from nesting colonies by gull species and predation. Gull control, and other predator and habitat management efforts are underway to support tern restoration (MassWildlife, 2015f). Common tern is not state listed in Rhode Island.

Common terns breed in large colonies and are commonly associated with other tern species including roseate tern. Preferred nesting habitat for the common tern consists of sandy beaches, gravelly or sparsely vegetated shores of small coastal islands, back bays, and both freshwater and high salt marshes. Common terns consume a wide variety of small fish, crustaceans, insects, and occasionally squid, tadpoles, marine worms, mollusks, and lizards. In coastal areas, common terns may feed up to approximately 14 mi (22 km) from nesting colonies and up to approximately 0.6 mi (1 km) from shore in bays, tidal inlets, or between islands (e.g., Nantucket and Martha's Vineyard) (MassWildlife, 2015f; USFWS, 2001). According to the NHESP, there are no Priority Habitats and Estimated Habitats in the proposed Falmouth landfall locations for Massachusetts state-listed species. However, there are both Priority and Estimated Habitats adjacent to these areas and the proposed Falmouth export cable corridor (NHESP, 2020). These habitats may include those defined for state-listed tern species, including common tern, but species-specific information is not public.

The MDAT abundance models and MCEC surveys indicate that common tern likelihood of occurrence in the Lease Area is uncommon in spring and rare in summer and fall. Common terns were observed in the Lease Area during Aerial HD surveys in spring only (Mayflower Wind Energy, LLC, 2020a-2020d; **Figure 6-3**). No common terns were observed during the September or October-November 2019 geophysical and geotechnical surveys (RPS Group, 2020, 2019). Potential occurrence of common tern in the Project Area, including species occurrence level and seasonality, is defined in **Table 6-22**.

TABLE 6-22. POTENTIAL OCCURRENCE OF COMMON TERN IN THE PROJECT AREA

Occurrence Level	Seasonality in Lease Area a/		
	Landfalls	ECCs	Lease Area
Uncommon	Rare at Brayton Point, Uncommon at Falmouth landfalls for spring and summer only, Rare in fall	Uncommon at entrance to Sakonnet River (Sachuest NWR and Sakonnet Lighthouse); Uncommon at Falmouth landfalls, spring and summer; Very rare in fall	Very rare in spring and fall migration

Sources: eBird, 2020; National Audubon, 2020; Blodget, 2017; Kamm et al., 2013.
Note:
a/ Seasonality of occurrence in landfall and the export cable corridors is qualitatively based on literature and available data reviews for the species. Seasonality of occurrence in the Lease Area is based on the AERA included in Appendix I1 and seasonality in landfall and the export cable corridors is qualitatively based on literature and available data reviews. Only seasons in which the species was observed or is likely to occur are included in the determination of the seasonality of the species occurrence in the Lease Area. "-" = species is highly unlikely to occur.

6.1.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects. IPFs relating to coastal and marine birds during each phase of the proposed Project can be found in **Table 6-23**.

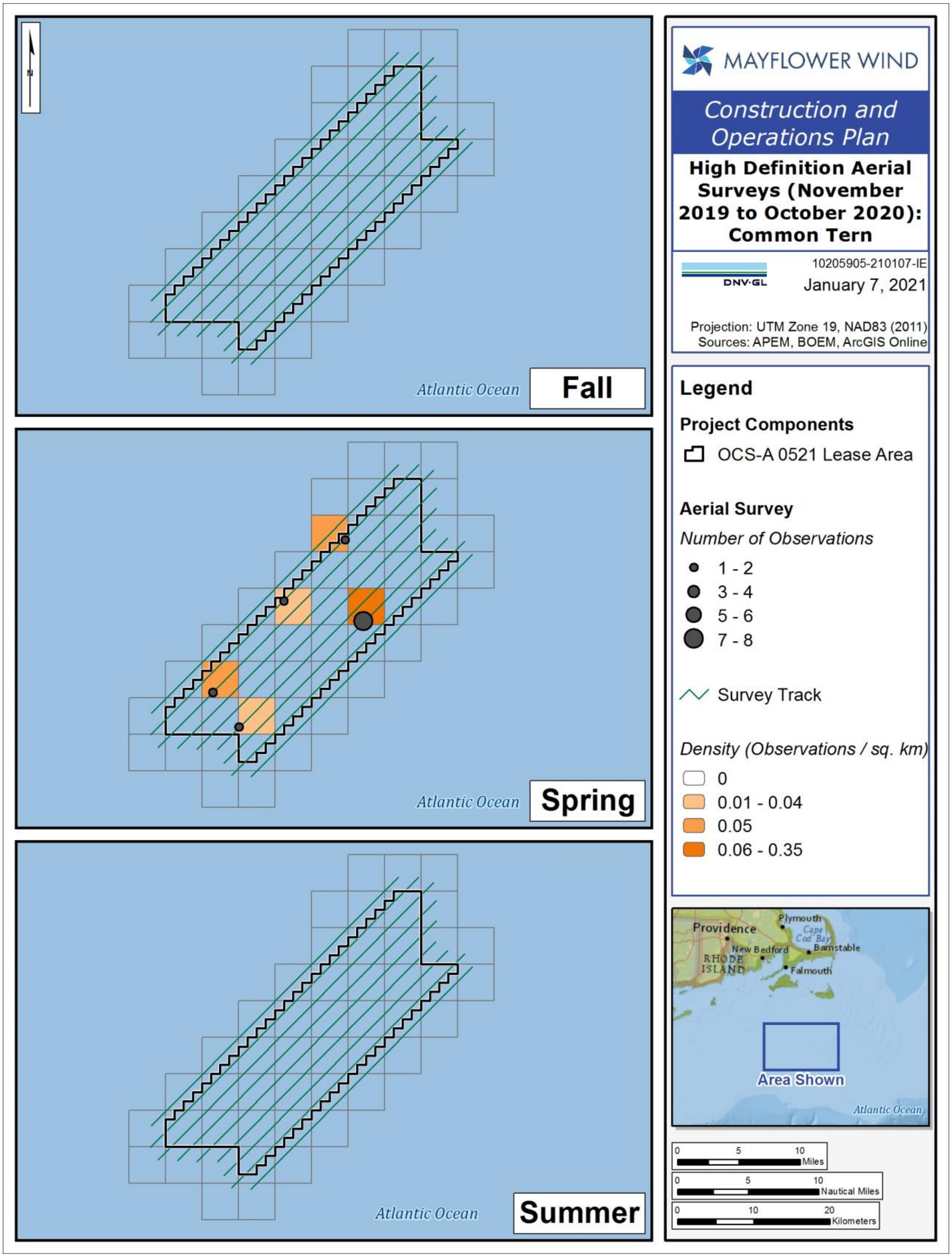


FIGURE 6-3. RAW OBSERVATIONS AND EFFORT-ADJUSTED SEASONAL DENSITY ESTIMATES FOR COMMON TERN (SEE AERA [APPENDIX I1] FOR DETAILED METHODOLOGY)

TABLE 6-23. IPFS AND POTENTIAL EFFECTS ON COASTAL AND MARINE BIRDS IN THE PROPOSED PROJECT AREA

IPF	Potential Effects			Period of Effect		
	Project Components			Project Phase		
	Offshore Project Area		Onshore Project Areas			
	Lease Area	ECCs	Landfalls	Construction	O&M	Decomm.
Seabed (or Ground) Disturbance	Habitat loss/fragmentation	Habitat loss/fragmentation	Habitat loss/ fragmentation	X	-	X
Introduced Sound	Avoidance/displacement	Avoidance/displacement	Avoidance/ displacement	X	-	X
Changes in Ambient Lighting	Displacement/attraction Collision with WTGs	Displacement/attraction	-	X	X	X
Actions that may cause displacement of or direct injury or death of biological resources - Presence of Structures	Collision with WTGs Avoidance/displacement and barrier effects Habitat loss/modification	-	-	-	X	-
Actions that may cause displacement of or direct injury or death of biological resources - Vessel Operations	Collision with vessels Avoidance/displacement	Collision with vessels Avoidance/displacement	-	X	-	X
Planned Discharges	Disturbance or fatality	Disturbance or fatality	-	X	-	X
Accidental Events	Oiling or fatality from accidental spills Ingestion of marine debris	Oiling or fatality from accidental spills Ingestion of marine debris	-	X	X	X

6.1.2.1 Seabed (or Ground) Disturbance

Potential effects to coastal and marine bird species associated with ground disturbance at the landfall location and seabed disturbance in the Offshore Project Area are limited to construction and decommissioning. Maintenance activities during operations are not anticipated to cause ground or seabed disturbance that would affect avian species. Any unplanned maintenance or repairs are expected to be short-term and temporary, and therefore will have insignificant effects on coastal and marine birds. Mayflower Wind will coordinate with MassWildlife, RIDEM, and USFWS to identify appropriate measures in order to mitigate any potential effects of seabed disturbance.

6.1.2.1.1 Construction and Decommissioning

Potential effects to bird species associated with the construction activities at the landfall locations will largely be dependent on the time of year, e.g., breeding periods for species that are within or adjacent to the landfall locations.

The landfall locations at Brayton Point and Falmouth are unlikely to have any nesting activity for piping plover. Brayton Point was once the site of a coal-burning electrical power plant with coastal waterline beaches reinforced with rock placements to reduce coastal erosion, which is unsuitable habitat for piping plovers. The sandy beaches at Falmouth could possibly be used by piping plover. However, the beaches are narrow and publicly used extensively for recreation and unlikely to be used by piping plovers. Neither site was identified as priority habitat by NHESP.

The export cable landfalls will be installed using HDD technology and no open cutting or excavation for trenches in the nearshore marine waters or coastal habitats, including on beaches, will occur. Additionally, construction equipment will be located within existing paved or gravel parking areas for adjacent public beaches, and no ground clearance is anticipated for laydown yards or other vehicles required for construction at the landfall location. HDD activities for cable installation at the landfall location will primarily be conducted under beaches and parking lots or lawns adjacent to parking lots in disturbed and developed areas. Due to the very small area needed for HDD operations, compared to the amount of suitable habitat available on upper Cape Cod and in the vicinity of Brayton Point, species in the area are not expected to be affected by the short-term and temporary construction activity. For HDD trajectories in Falmouth see Appendix P1. Note that HDD trajectory details will be refined (and may change slightly within the PDE) as the Project progresses.

During construction in the Lease Area, the installation of WTGs, OSPs, inter-array cables, and offshore export cables will temporarily disturb the seafloor, which will temporarily disturb or disperse fish and other prey species within the Lease Area. This may temporarily affect foraging, particularly on such prey items like sand lance (*Ammodytes* sp.; Staudinger et al., 2020), within the Lease Area for some marine birds, such as alcids, loons, grebes, sea ducks, and phalaropes. The Lease Area does not contain important foraging habitat for marine birds as long-term datasets of the Lease Area indicate density estimates for marine birds were low (see Appendix I1 Avian Exposure Risk Assessment). Due to the homogeneous sandy habitat observed in the Lease Area and much of the southern portion of the export cable corridors, recolonization rates in these areas are expected to be reversed in a relatively short period of time. Similarly, the deeper sandy habitats of portions of the export cable corridors may have habitat prey items like sand lance however, any disturbances to the sea floor will have similar or faster recolonization due to amplified tidal currents mobilizing the sandy seabed sediments as described in

Appendix E, MSIR. The conditions in areas outside the export cable corridors are anticipated to be similar to those within the export cable corridors, and therefore have not been described separately. Since the cables are to be buried and habitat returned to the original form, any impacts to habitat and prey species would be temporary and limited to the narrow width of the export cable corridors compared to the amount of suitable habitat available. Dernie et al. (2003) reports that sandy sediments recover rapidly. Since the Lease Area primarily consists of sand, the loss of soft-sediment habitat is expected to be relatively insignificant. Alternatively, development activities could have neutral or positive effects on foraging fish such as sand lance attributed to increased or neutral effects on sediment quality, increases in juvenile abundance, associations of midwater feeding schools with structure and/or reductions in predators during construction, and reductions in fishing activities during construction and operation of wind farms (Staudinger et al., 2020). Because the effects will be short-term, temporary, and localized (see Section 6.7, Finfish and Invertebrates and Section 5.2.2 of Appendix M, Benthic Resources), it is expected that seafloor disturbance will have insignificant effects on marine birds.

During the decommissioning phase of the proposed Project, disturbance effects are expected to be similar to those exhibited during the construction phase. The proposed Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there will be no effects from decommissioning. If cable removal is required, the cable trench in the seabed will be jet-plowed to fluidize the sediment covering the cables, and the cables will then be reeled up onto barges. Effects from removing the cables will be localized to the export cable corridors and similar to those experienced during cable installation. Consequently, seabed disturbance effects on benthic and shellfish resources and to coastal and marine birds that prey on benthos and shellfish during decommissioning are anticipated to be similar to those during construction.

6.1.2.2 Introduced Sound

6.1.2.2.1 Construction and Decommissioning

Construction activities at the landfall locations may introduce sound into coastal habitats that could displace coastal bird species that are in the vicinity of the activities, including shorebirds, waterfowl, waterbirds, wading birds, falcons, and songbirds. However, potential effects are expected to be minimal as the noise from activities will be limited to areas where work is directly being performed (e.g., local), and will be temporary and short-term.

Marine birds, including sea ducks and loons may be disturbed by introduced sound in the Lease Area and export cable corridors that results from increased vessel traffic and construction activities, including some potential helicopter use (MMS, 2007; Fox et al., 2006; Petersen et al., 2006) and piling driving as described in Section 3, Description of Proposed Activities. However, helicopter use will be short-term and minimal.

Offshore acoustical noise from pile driving is expected to have minimal or no impact on avian species. As stated in Section 3.3.1.5.2; typical pile installation procedures utilize a low energy soft start method with a gradual increase in hammering energy levels. The soft start method effectively provides a warning to marine and avian animals allowing them time to distance themselves from the construction activity before the full-energy hammering commences. Species that commonly forage in open ocean, such as sea ducks, loons, and alcids, would be temporarily displaced by the presence of construction vessels and would be unlikely to be foraging underwater in the vicinity of the pile driving construction activities. Additionally, prey species for marine birds would likely be temporarily displaced from the active construction noise and will likely cause avian species to forage elsewhere. Potential disturbances from pile driving noise are expected to be short term, temporary, and limited to the areas where the activity occurs. Additionally, the increase in vessel traffic during construction activities is not expected to significantly increase the current level of normal boat traffic, including vessel-related noise, in the area (see Section 13, Navigation and Vessel Traffic). Studies also indicate that most birds that are disturbed by offshore wind farm construction return to the area after the completion of the construction activities that initially disturbed the birds (Adams et al., 2016).

Federally listed species: Roseate terns have a highly specialized diet and construction-related disturbance to prey populations, particularly American sand lance, could affect foraging in roseate terns. No sand lance were captured in the Lease Area or vicinity during NEFSC fall and summer bottom trawl surveys or ichthyoplankton surveys and capture rates in the Lease Area during spring were very low relative to adjacent waters in the region (NEFSC, 2020a; 2020b). Additionally, there are no roseate tern colonies within 31 mi (50 km) of the Lease Area (Loring et al., 2019, 2017; Kamm et al., 2013).

Piping plover and red knot are not expected to be affected by introduced sound in the Lease Area because construction activities will not occur near breeding areas and the species do not use the marine environment for foraging or staging.

Decommissioning activities are expected to be similar to construction activities. However, there will not be any pile driving noise during decommissioning. Therefore, potential effects from introduced sound during decommissioning are expected to be minimal.

6.1.2.3 Changes to Ambient Lighting

6.1.2.3.1 Construction and Decommissioning

Coastal and marine birds have the potential to be displaced or attracted to lit structures and vessels during construction in the Lease Area and the proposed export cable corridors; however, as stated in the Vineyard Wind Draft Environmental Impact Study, although the temporary displacement of birds and/or temporary collision hazard may occur as a result of maintenance vessels and associated activities, adverse effects are not expected to occur as a result (BOEM, 2018).

Birds typically use natural sources of light for navigation while migrating, whether they migrate by day or night (Pollet et al., 2020a; Kerlinger et al., 2010; Rubega et al., 2000). Many birds are nocturnal migrants, and it is well documented that artificial lighting can attract and disorient nocturnal migrating birds. Additionally, “fall out” events may occur as nocturnal migrants are drawn to artificial sources of light in adverse weather (Rebke et al., 2019).

Evidence generally suggests birds, including some songbirds and marine birds, may be attracted to structures, including offshore oil platforms and vessels when lighted (Pollet et al., 2020a; Rebke et al., 2019; Hüppop et al., 2006; Montevecchi, 2006; Wiese et al., 2001), particularly during adverse weather and fog (Rebke et al., 2019). Shearwaters and petrels forage on bioluminescent prey at night (Imber, 1975) and along with other species that forage at night (black-legged kittiwakes [Hatch et al., 2020]) or during low light conditions (common eider and white-winged scoter [Brown & Fredrickson, 2020; Goudie et al., 2020]), may be more likely to be attracted to artificial light sources. Vessels travelling from shore to the Lease Area during construction may attract birds if travelling at night with lights on. Additionally, safety lights on OSPs as they are being installed, may attract birds. However, lighting will be minimized during offshore construction activities to reduce potential effects related to birds, where practicable (see Section 16), as discussed in Section 3.4.

6.1.2.3.2 Operations and Maintenance

Migrating birds may be at risk of collision with WTGs at night if they become disoriented by changes in ambient lighting (overcast vs. clear conditions) in the Lease Area, particularly during adverse weather conditions (e.g., rain, fog). No light variant was constantly avoided by all nocturnally migrating passerines crossing the open sea (Rebke et al., 2019). However, studies indicate that short-wavelength lighting (blue and green lights) caused the strongest attractant response, while birds were less attracted to longer-wavelength lighting (red and yellow lights; Zhao et al., 2020; Rebke et al., 2019). Thus, a white light (i.e., lighting that is a mixture of all color wavelengths) will also be more of an attractant for birds than red lights (Hill et al., 2014).

Furthermore, steady burning lights can pose more of a risk than pulsing strobe lights (Rebke et al., 2019; Patterson, 2012; Kerlinger et al., 2010; Kerlinger, 2000). While lighting intensity did not influence the number attracted, birds were drawn more towards continuous lighting than towards blinking illumination, especially during overcast conditions when stars were not visible (Rebke et al., 2019). Therefore, lighting schemes for offshore wind farms should employ the least amount of long-wavelength (reds and/or yellows) pulsing strobe lighting as needed to illuminate the dangers of the wind farm to passing aircraft and sea-going vessels. As discussed in Section 3, Description of Project Activities, lighting schemes that are consistent with BOEM's final lighting and marking guidelines (BOEM, 2021), Federal Aviation Administration (FAA) requirements, and U.S. Coast Guard (USCG) navigation lighting guidelines, will be utilized, as appropriate.

6.1.2.4 Vessel Operations

6.1.2.4.1 Construction and Decommissioning

Of the marine bird species, sea ducks, loons, and alcids are considered to be vulnerable to displacement from vessel operations (Furness et al., 2013; MMS, 2007; Fox et al., 2006; Petersen et al., 2006). Generally, potential effects are related to disturbance from sound (see Section 3.4, Summary of Impact Producing Factors), but species may also be displaced by the presence of vessels (Burger et al., 2019). However, vessels travel regularly through the Muskeget Channel and at reduced levels near the Lease Area as noted in Appendix X, Navigation Safety Risk Assessment. It is expected that the increase in vessel traffic during construction and decommissioning activities will not significantly increase the current level of normal boat traffic in the area (see Section 13, Navigation and Vessel Traffic, for further details).

Studies also indicate that most birds who are disturbed or displaced by offshore wind farm construction return to the area after the completion of the construction activities that initially disturbed the birds (Adams et al., 2016). Potential exposure of marine birds to displacement from the presence of vessels during construction and decommissioning is expected to be minor to low, short-term, and temporary.

6.1.2.5 Presence of Structures

6.1.2.5.1 Operations and Maintenance

Collision Risk: Several factors influence risk of collision with WTGs for birds, including behavior, season, weather, and lighting. In general, species using marine habitats have exhibited lower collision rates than those documented at terrestrial wind facilities, although data from offshore operational sites are very limited (Adams et al., 2016; Thaxter et al., 2017). A fully detailed collision and avoidance risk assessment is in Appendix I1, Avian Exposure Risk Assessment.

The primary groups of coastal birds that may be exposed to Project activities are shorebirds, waterfowl, wading birds, raptors, and songbirds. The Lease Area is located over 23 mi (37 km) from the nearest shoreline on Nantucket and, therefore, potential risk of collision for most coastal species that do not regularly use the offshore environment will be limited to spring and fall migration periods. Overall, exposure to operational WTGs in the Lease Area for shorebirds, waterfowl, wading birds, and raptors is expected to be insignificant and limited to migration.

While songbirds are known to collide with onshore WTGs (Erickson et al., 2014), species may be able to avoid collisions with offshore WTGs (Petersen et al., 2006) and potential collisions at offshore wind farms could be lower than observed onshore due to differing behaviors or lower overall exposure (e.g., limited to migration) (NYSERDA, 2015). Overall, songbird exposure to operational WTGs in the Lease Area is likely low and limited to migration periods.

As noted in Section 6.1.2.2.1 above, loons and sea ducks exhibit avoidance of offshore wind farms (Furness et al., 2013), and it is generally believed that waterfowl may be less likely than other avian taxa to suffer direct mortality from WTG operations during both the breeding and migratory periods.

Based on the information presented in Section 6.1.1.2.3, potential exposure to operational activities in the Lease Area for gulls is likely. However, population level effects are not expected. Potential exposure to operational activities in the Lease Area for jaegers is insignificant due to the rare occurrence of parasitic and pomarine jaegers in the Lease Area.

Terns may be exposed to operational activities in the Lease Area. However, the species rarely fly at heights of the RSZ (Furness et al., 2013; Garthe & Hüppop, 2004) and have exhibited avoidance of rotating WTG blades (Vlietstra, 2007). Overall, tern exposure to operational WTGs in the Lease Area is likely low and limited to non-breeding seasons.

Most shearwaters, storm-petrels, and alcids rank extremely low for collision risk (Furness et al., 2013), possibly due to observed avoidance rates (99.2 percent total avoidance for alcids [Cook et al., 2012]) and most species in these groups tend to fly close to the surface of the sea (Cook et al., 2012). As a result, exposure to operational WTGs in the Lease Area for shearwaters, storm-petrels, and alcids are likely very low.

Mayflower Wind will develop and implement a Post-construction Monitoring Plan to evaluate and mitigate for potential collision risk for bird species (see Section 16, Summary of Avoidance, Minimization, and Mitigation Measures).

Displacement Risk: Flying is the most energetically costly of all avian activities, so if the deflection in migration routes caused by avoidance of an existing wind farm is significant, such a response could affect the energy budgets of migratory birds (Petersen et al., 2006). Additionally, birds may be displaced by offshore wind farms as a result of behavioral avoidance responses (Krijgsveld et al., 2011; Lindeboom et al., 2011; Fox et al., 2006) or as a result of barrier effects (i.e., impede movement of birds; Masden, et al. 2009 and 2012).

Desholm and Kahlert (2005) found that the percentage of diurnal flocks of migrating common eider and other migratory geese entering the Nysted offshore wind farm area decreased significantly from pre-construction to initial operation. Radar observations at the Nysted and Horns Rev offshore wind farm in Denmark suggest that birds more closely approached WTGs on the outer edge of the wind farm and were more likely to traverse through the wind farm at night than during the day, likely because it is more difficult for night migrating birds to detect WTGs at night (Petersen et al., 2006).

At night, migrating flocks were more prone to enter the wind farm, but counteracted the higher risk of collision in the dark by increasing their distance from individual WTGs and flying within the corridors between WTGs spaced 2,790 ft (850 m) between rows and 1,575 ft (480 m) between WTGs with less than 1 percent of the ducks and geese migrating close enough to the WTGs to be considered at any risk of collision (Desholm and Kahlert 2005). Observations also indicated nighttime migrants avoided WTGs at night; birds exhibited avoidance responses at distances of 1,640 ft (500 m) from WTGs at night and at distances of 10,000 ft (3,000 m) during the day (Petersen et al., 2006).

This evidence suggests migrating birds may have decreased visibility at night but are eventually able to detect the WTGs and avoid collision. In the situation where migrating birds show large scale avoidance of WTGs, the risk of collision is clearly diminished. Mayflower Wind proposes to space each WTG 1 nm or 6,100 ft (1,850 m) in a north-south and east-west grid pattern which should allow sufficient space for most migrant birds to pass through the Lease Area without barrier effect impacts. To date, there have been no reported instances of barrier effects so severe as to completely divert a migratory route along another course (Fox and Petersen 2019).

Coastal birds such as waterfowl and songbirds may avoid offshore wind farms, as observed with geese and swans (Plonczkier & Simms, 2012; Griffin et al., 2011). However, because most coastal birds do not use the offshore environment for critical breeding, foraging, staging, or wintering area and use of the Lease Area is likely limited to migration. Displacement of coastal birds is expected to be unlikely and limited to migration for most species.

Of the marine birds, species groups considered most at risk of the effects of displacement include sea ducks, loons, and some alcids. Overall, the potential effect of displacement on loons, sea ducks, and alcids is likely to be low because the Lease Area does not appear to contain important foraging habitat for marine bird species, and because surrounding areas provide more favorable foraging habitat, e.g., Nantucket Shoals.

Studies indicate that northern gannets avoid offshore wind farms (Garthe et al., 2017; Hartman et al., 2012; Vanermen et al., 2015). However, because northern gannets have a diverse, and highly mobile prey source (Mowbray, 2002), avoidance of the Lease Area is unlikely to lead to habitat loss.

As noted in Section 6.1.2.3, gulls have exhibited an attraction to wind farm developments (Krijgsveld et al., 2011; Lindeboom et al., 2011), and gulls and jaegers rank low in vulnerability in displacement assessments (Furness et al., 2013). Research suggests tern distribution and abundance are not affected by the presence of wind farms (Krijgsveld et al., 2011; Lindeboom et al., 2011), potentially due to local breeding tern populations remaining close to shore or within shallow areas (e.g., shoals) when foraging (Burger et al., 2011). Overall, potential risk of displacement from operational activities in the Lease Area for gulls, jaegers, and terns is expected to be low, and in the case of gulls, potentially positive.

Shearwaters and storm-petrels are the lowest ranked in displacement vulnerability assessments (Furness et al., 2013), and therefore, are not expected to be exposed to displacement effects from operational activities in the Lease Area.

Federally listed species: *Roseate tern:* As noted above, as a group, terns are ranked low in vulnerability in displacement assessments and research suggests that the distribution and abundance of terns is not affected by the presence of wind farms (Vlietstra, 2007). This may be due to a preference for shallow waters, such as shoals. As a result of rare occurrence of roseate tern in the Lease Area and the information presented in Section 6.1.1.3.1, potential risk of displacement to roseate terns is expected to be low. Overall, roseate tern exposure to operational WTGs and activities in the Lease Area is expected to be low and likely limited to post-breeding seasons.

Piping plover and red knot: Potential piping plover exposure to operational WTGs in the Lease Area is expected to be insignificant to low and limited to spring and fall migratory periods.

Recent predictive modeling for a proposed wind energy project in Nantucket Sound indicated that approximately one red knot collision would be expected every six years (Gordon & Nations, 2016). Therefore, predicted collision rates in the Lease Area, which is much further from shore, would expectedly be much lower. Red knot exposure to operational WTGs in the Lease Area is expected to be insignificant to low and limited to spring and fall migratory periods.

Shorebird avoidance of offshore wind developments is not well understood. No breeding or important migratory staging areas for piping plover and/or red knot occur in the Lease Area (Burger et al., 2011). The nearest breeding and/or staging areas for piping plovers and staging areas for migrating red knots would be the beaches along southern Nantucket, approximately 23 mi (approximately 37 km) north of the Lease Area. There is not much evidence that suggests the two species may traverse the Lease Area during migration, and therefore, potential exposure to operational activities in the Lease Area are expected to be insignificant and limited to spring and fall migratory periods.

State-listed species: Due to the rarity of the occurrence of Leach's storm-petrel in the Lease Area, exposure to operational WTGs in the Lease Area is expected to be insignificant.

Least tern: As noted above, as a group, terns are ranked low in vulnerability in displacement assessments and research suggests that the distribution and abundance of terns is not affected by the presence of wind farms (Vlietstra, 2007). This may be due to a preference for shallow waters, such as shoals. As a result of very rare occurrence of least tern in the Lease Area, potential risk of displacement to least terns is expected to be low. Overall, least tern exposure to operational WTGs and activities in the Lease Area is expected to be low and likely limited to spring and fall migration.

6.1.2.6 Planned Discharges

6.1.2.6.1 Construction and Decommissioning

Vessels used during offshore construction and decommissioning activities may routinely release bilge water, engine cooling water, deck drainage, and/or ballast water under a vessel discharge plan. Such releases will quickly be dispersed and diluted and will cease when construction is complete. Due to the expected and controlled dispersion and dilution of planned discharges as described in Section 3.4, Summary of Impact Producing Factors, potential effects to coastal and marine birds from planned discharges are expected to be insignificant.

6.1.2.7 Accidental Events

6.1.2.7.1 All Project Phases

Accidental spills in and contamination of marine environments can affect coastal and marine birds due to their diverse foraging strategies, susceptibility to bioaccumulation of environmental contaminants, and risk of contaminants, especially oil, to adhere to their plumage (Stenhouse et al., 2018; Haney et al., 2017; Copping et al., 2015; Goodale et al., 2008; Jarvis, 2005). As described in Section 3.4, Summary of Impact Producing Factors, accidental spills and contamination are not expected to be produced by the proposed Project during the construction, O&M, or decommissioning phases. In the event a spill does occur in the proposed Project Area, the proposed Project will implement the OSRP, (see Appendix AA, Oil Spill Response Plan).

The ingestion of marine debris has been shown to be a significant cause of mortality in seabird species, with Procellariiformes species (i.e., albatrosses, shearwaters, petrels, storm-petrels) exhibiting the highest incidence of marine debris ingestion (Roman et al., 2019). The EPA and other relevant federal organizations implement oceanic protections to prevent further marine debris and other anthropogenic contaminants from entering the U.S. marine environment (see Section 3.4, Summary of Impact Producing Factors). Marine debris is not expected to be produced by the proposed Project. Any marine debris produced will be removed from the Project Area in accordance with all regulations under the Clean Water Act, as well as the Bureau of Safety and Environmental Enforcement's (BSEE) Notice to Lessees and Operators No. 2015-G03 (BSEE, 2015).

6.1.3 Conclusion

Coastal and marine birds have the potential to be exposed to IPFs in the proposed Project Area during all Project phases.

Generally, coastal birds include shorebirds, raptors, waterfowl, water birds, and songbirds are the species that are expected to be exposed to Project activities in the Lease Area and export cable corridors during migration. Marine birds may be exposed to Project activities in the Lease Area and export cable corridors during all seasons. For shorebirds, songbirds, and falcons including peregrine falcons, potential exposure to Project components and activities is likely to be low and limited to migration, primarily in the fall. Vulnerability to collision and displacement for marine birds depends on the species and other factors, including season, flight height, and behavior.

Generally, sea ducks, loons, and some alcids are vulnerable to displacement from offshore wind developments. Decreases in abundance of species from these groups has been observed at offshore wind farms. However, the Lease Area does not appear to contain important foraging or staging areas for these species, and therefore, potential exposure to the effects of displacement from construction and operational activities in the Lease Area is likely low.

Gulls have the highest potential for exposure to collision with WTGs. Other species groups that are considered vulnerable to collision include loons, sea ducks, and northern gannets. However, evidence suggests these species may avoid wind farms. Implementation of avoidance, minimization, and/or mitigation measures and best management practices will minimize potential effects to coastal and marine birds (see Section 16, Summary of Avoidance, Minimization, and Mitigation Measures).

Protected ESA-, MESA-, and/or RIDEM-listed species, including roseate tern, least tern, piping plover, red knot, and Leach's storm-petrel, have the potential to be exposed to IPFs during construction, operations, and decommissioning. Roseate and least terns do not occur in the Lease Area during the breeding season, as the species typically forages closer to shore. As a result, roseate and least tern exposure to IPFs in the Lease Area are expected to be low and likely limited to spring and fall when migrating.

Piping plover and red knot also do not occur in the Lease Area during the breeding season, and piping plover and red knot exposure to IPFs in the Lease Area are expected to be insignificant to low and limited to spring and fall migration. The Leach's storm-petrel breeds in Massachusetts and the species occurs rarely in the Lease Area during the spring, summer, and fall and exposure to IPFs in the Lease Area is expected to be insignificant due to the rarity of the species in Massachusetts.

6.2 Bats

This section describes the bat species that may occur in the Project Area and includes an evaluation of potential Project-related effects. For this section, Project Area is defined as the Offshore Project Areas (i.e., the Lease Area, including WTGs and OSPs, as well as the offshore export cable corridor) and the Onshore Project Areas (i.e., landfall locations, onshore export cables, onshore substation, converter station, and alternate underground transmission route). This evaluation is based on a review of published scientific literature and publicly available technological reports, including bat-specific monitoring and vessel-based acoustic monitoring surveys conducted for other offshore wind facilities in the northern Atlantic OCS, and supplemented by consultation with state wildlife agencies and anecdotal records. In response to a request, the NHESP; a subdivision of the Massachusetts Division of Fish and Wildlife [MassWildlife]) provided data on likely species presence in the Falmouth Project Area on May 1, 2020 (K. Freeman, personal communication, May 1, 2020). NHESP provided data on presence of state-listed rare species in the Brayton Point Project Area on July 23, 2021 (E. Schlüter, personal communication, July 23, 2021). In addition, the Rhode Island Natural Heritage Program responded to a data request on June 24, 2021 regarding threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat within the Rhode Island portions of the Brayton Point export cable corridor (USFWS, personal communication [two separate letters: one regarding Sakonnet River and Mount Hope Bay, the other Lower Narragansett], June 23, 2021). Rhode Island does not currently list any bat species on its endangered and threatened species list but does list all of its bat species on its 2015 State Wildlife Action Plan as Species of Greatest Conservation Need.

Technical appendices related to bats include:

- Appendix I2, Bat Risk Assessment
- Appendix L2, Onshore Protected Lands

6.2.1 Affected Environment

Of the nine species of bats that occur in Massachusetts and Rhode Island, there are eight species which may potentially be present in the Project Area, including several that are federally listed, state-listed in Massachusetts, or petitioned for listing (**Table 6-24**). There are seven bat species that occur in Rhode Island of which six species may occur in the Project Area, including one federally listed species. The federally endangered Indiana bat (*Myotis sodalis*) is not found in coastal Rhode Island or the eastern part of Massachusetts (BCI, 2021) and the species is not expected to occur in the Project Area, thus risk to this species is not discussed further in this analysis. Bat species that may be present in the Project Area include cave-hibernating bats and migratory tree-roosting bats; tree-roosting bats are generally solitary and migrate long distances to warm climates, whereas cave-hibernating bats hibernate during the winter. Generally, mating takes place during the fall “swarming period” prior to migration or hibernation typically in late August to October (BCI, 2021). Females give birth to 1 to 3 young, depending on the species, typically in June/July in “maternity colonies” made up of breeding females (BCI, 2021). Males often roost solitarily or in small bachelor groups separate from the females but often nearby to maternity colonies (BCI, 2021). Young often take their first flight at about four weeks, which usually signals the breakup of the maternity colony prior to the swarming period, followed by migration or hibernation period in the life cycle (BCI, 2021).

TABLE 6-24. BAT SPECIES WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Common Name	Scientific Name	Federal (ESA) a/	Massachusetts State a/ (MESA) b/	Rhode Island State (RINH) c/	Cave-Hibernating	Migratory Tree-Roosting	Migratory Pattern
Big brown bat	*Eptesicus fuscus*	—	—	SGCN	Yes	No	None
Eastern small-footed bat	*Myotis leibii*	—	E	SGCN	Yes	No	None
Little brown bat	*Myotis lucifugus*	d/	E	SGCN	Yes	No	Some latitudinal migration
Northern long-eared bat	*Myotis septentrionalis*	T	E	SGCN	Yes	No	Unknown but believed to be philopatric
Silver-haired bat	*Lasionycteris noctivagans*	—	—	SGCN	No	Yes	Continental
Eastern red bat	*Lasiurus borealis*	—	—	SGCN	No	Yes	Continental
Hoary bat	*Lasiurus cinereus*	—	—	SGCN	No	Yes	Continental
Tri-colored bat	*Perimyotis subflavus*	P	E	SGCN	Yes	No	Some latitudinal migration

Notes:

a/Species is currently under USFWS discretionary review and is likely to be petitioned for listing. T = Threatened; P = Petitioned for Listing; "—"= Not listed.

b/Massachusetts Endangered Species Act; E = Endangered; "—"= Not listed.

c/No threatened or endangered species are listed by the State of Rhode Island as having the potential to occur in the Project Area. Rhode Island Wildlife Action Plan 2015; SGCN = Species of Greatest Conservation Need. SGCN species are identified by RIDEM and the Rhode Island Chapter of The Nature Conservancy in the Rhode Island Wildlife Action Plan. It should be noted that SGCN designation does not represent an equivalent to ESA or MESA species listings; rather, this represents a publicly available data source to identify species which Rhode Island considers to be of greatest concern, based on the threat affecting each (RIDEM, 2015).

d/Species under review (USFWS, 2021).

6.2.1.1 Bat Occurrence: Offshore Project Area

This section identifies and describes the different bat species that may be present in the Offshore Project Area during construction, operations, and decommissioning activities. Offshore is defined as waters beyond a 3.5-mi (5.6-km) distance from land (e.g., mainland, islands) and nearshore is defined as waters within the 3.5-mi (5.6-km) distance from land (i.e., approximately three nautical miles (nm), or waters within state jurisdiction). Mayflower Wind also includes in Section 6.2.2 Potential Effects an analysis of whether and to what extent bats may be exposed to Project activities in the Offshore Project Area and whether these species may be affected.

Although little is known about bat migration and movements over marine habitats, both historical and contemporary records have documented bat offshore activity in North America. Several bat species have been observed roosting on ships and offshore installations at sea (Stantec, 2018; Thompson et al., 2015; Ahlén et al., 2009) or at remote islands (Johnson et al., 2011; Cryan & Brown, 2007), suggesting some level of movements over water. Bats have also been observed roosting on structures (e.g., lighthouses) on nearshore islands (Dowling et al., 2017). A bat acoustic study conducted in 2009 and 2010 in the mid-Atlantic recorded bats at a maximum distance of 13.6 mi (21.9 km) from shore (Sjollema et al., 2014). Additionally, bats were detected migrating offshore in the Gulf of Maine on islands more than 25.0 mi (40.2 km) from the mainland suggesting these islands are used as temporary roosts or stopover sites during seasonal movements (Peterson et al., 2014).

Cave-hibernating bats are observed offshore less frequently than migratory tree-roosting bats (Sjollema et al., 2014; Pelletier et al., 2013). During bat acoustic studies in the mid-Atlantic, the maximum distance *Myotis* species of bats were detected from shore was 7.2 mi (11.5 km) and the average distance for all bats detected was 5.2 mi (8.4 km) (Sjollema et al., 2014). Little brown bat (*Myotis lucifugus*) and big brown bat (*Eptesicus fuscus*) migratory movements from Martha's Vineyard to Cape Cod were recorded during a nano-tracking study in 2016; however, offshore movements beyond the island were not detected for either species (Dowling et al., 2017). Big brown bats and tri-colored bats (*Perimyotis subflavus*) were recorded on a barrier island less than one mile (1.6 km) off the coast of Maryland (Johnson et al., 2011). An acoustic study conducted on islands and buoys in the Gulf of Maine indicated that offshore migration activity for cave-hibernating bats took place between July and October (Peterson et al., 2014). During passive acoustic surveys conducted for the Block Island Wind Farm (BIWF) located 3.8 mi (6.1 km) from the shore of Block Island, Rhode Island, several calls were identified as Myotis species and approximately 29 percent as high frequency species that could not be identified to genus; the unidentified calls may have been from Myotis species, tri-colored bat, and/or eastern red bat (*Lasiurus borealis*) (Tetra Tech & DeTect, 2012). Use of the offshore environment by cave-hibernating species is expected to be mostly limited to the fall migration period, based on acoustic studies conducted regionally and at nearby facilities (Stantec, 2018; Thompson et al., 2015; Tetra Tech & DeTect, 2012; Ahlén et al., 2009).

Migratory tree-roosting bats are known to migrate long distances in the winter months and have been documented using coastlines and islands offshore during migration (Normandeau Associates, 2014; Hatch et al., 2013; Johnson et al., 2011). Some migratory tree-roosting species are known to occur on remote islands, indicating offshore movements during migration. For instance, eastern red bats and other species have historically and seasonally been documented on the island of Bermuda, indicating that they are capable of travelling over 621 mi (1,000 km) over open water (Grady & Olson, 2006; Van

Gelder & Wingate, 1961; Allen, 1923). Eastern red bats, hoary bats (*Lasiurus cinereus*) and silver-haired bats (*Lasionycteris noctivagans*) were also recorded on a barrier island located less than one mile (approximately 0.5-1 km) off the coast of Maryland, suggesting these species use the island during migration (Johnson et al., 2011). Eastern red bats migrating along the U.S. Atlantic Coast were observed approximately 27.0 mi (43.4 km) offshore during an aerial survey using high-definition video (Hatch et al., 2013), and hoary bats are regularly observed on Southeast Farallon Island during fall migration, approximately 21.0 mi (33.8 km) from the California coast (Cryan & Brown, 2007). Eastern red bats are known to migrate from Martha's Vineyard in the late fall (October-November); one nano-tagged bat was tracked as far south as Maryland (Dowling et al., 2017). Eastern red bats were also recorded during acoustic surveys conducted in the mid-Atlantic between 2009 and 2010, in which the species comprised 78 percent of all bat detections recorded offshore (Sjollema et al., 2014). A long-term study of bat movements in the coastal, nearshore and offshore environments in the northeast, mid-Atlantic and Great Lakes regions from 2012-2014 found that bat activity was highly seasonal, with peak activity occurring during the spring and fall migration periods (Stantec, 2016a; Pelletier et al., 2014). During this study, bat calls were detected from 3 to 80 mi (4.8 to 130 km) offshore, including several detections approximately 9 to 30 mi (14 to 49 km) southeast of Montauk and Block Island. These detections were located west of the Lease Area and Montauk and Block Island are located approximately 72 mi (115 km) and 59 mi (95 km) from the Lease Area, respectively.

Hoary bat, silver-haired bat, and eastern red bat were detected during passive acoustic surveys conducted for the BIWF in the summer to fall periods in 2009 and spring period in 2010 at four locations on Block Island and two offshore buoys (Tetra Tech & DeTect, 2012). Only one offshore buoy located approximately 3.4 mi (5.5 km) from shore was deployed in 2010 from April to October. Bat activity was detected at all survey locations except the furthest buoy which was located approximately 17 mi (27 km) east of Block Island. Vessel-based surveys conducted during construction of the BIWF also detected eastern red bats and silver-haired bats (Stantec, 2016b, as cited in Stantec, 2018), and the majority of bat passes recorded during post-construction acoustic surveys at BIWF were eastern red bats (Stantec, 2018).

Although most migratory tree-roosting bats are not currently protected under ESA/MESA, they represent the most commonly observed species as fatalities at operational land-based wind energy facilities (hoary bat, silver-haired bat, eastern red bat; Peters et al., 2020). There is therefore concern among agencies and conservation organizations regarding potential effects to these species from onshore wind energy. While migratory tree-roosting bats are detected more often in the offshore environment than cave-hibernating bats, use is expected to be primarily limited to the migration period.

<u>*Federally listed species*</u>: In Massachusetts, northern long-eared bats (*Myotis septentrionalis*; Threatened) are known to primarily occur in the eastern part of the state during hibernation and to occur on Cape Cod during the maternity roosting period. Northern long-eared bats were also documented on Nantucket and Martha's Vineyard in a 2016 tracking study (Dowling et al., 2017), but no offshore movements of the species were recorded during the study. It is possible that northern long-eared bats migrate over offshore waters; however, based on movements of the related little brown bat, it is likely that movements of northern long-eared bat are limited between Nantucket and Martha's Vineyard and the mainland. Based on studies conducted regionally, northern long-eared bats may infrequently be present in the Offshore Project Area. If they were to migrate over water, movements would likely be

from Martha's Vineyard to the nearest known hibernacula on the mainland in central Massachusetts (Normandeau, 2014; Tetra Tech & DeTect, 2012; Stantec, 2016b; Dowling et al., 2017).

State-listed species: As previously discussed, nano-tagged little brown bats were recorded migrating from Martha's Vineyard to the mainland during tracking studies in 2016 (Dowling et al., 2017). *Myotis* bats, possibly little brown bats, were observed flying aboard a fishing vessel and roosting overnight approximately 68 mi (110 km) from the mainland in the Gulf of Maine in 2003 (Thompson et al., 2015). This anecdotal account noted that the bats were seen after "high-fliers," large buoys with a bottom weight and a high 6 to 20 ft (2 to 6 m) pole fitted with a metal radar reflector, were collected and the bats emerged from roosting in the radar reflectors. The account suggests *Myotis* bats may roost in these structures and on other buoys in open water offshore; however, no additional evidence or other recent accounts supporting this information have been reported. Tri-colored bats were recorded using a barrier island off the coast of Maryland during migration (Johnson et al., 2011), and both tri-colored bats and eastern small-footed bats (*Myotis leibii*) were recorded on Block Island NWR off the coast of Rhode Island (Smith & McWilliams, 2016; 2012). The research on Block Island NWR and other coastal Rhode Island locations indicated that tri-colored bat and other *Myotis* species migrated short distances between the islands and the mainland primarily from July to September (Smith & McWilliams, 2016). No other records of the occurrence of tri-colored bats and eastern small-footed bats offshore have been reported.

Based on the anecdotal information and scientific literature reviewed, it is possible for the three Massachusetts state-listed species to occur offshore; however, movements of these species are likely limited to nearshore (less than 10 mi [16 km]) and between islands (e.g., Martha's Vineyard and Nantucket) and the mainland.

TABLE 6-25. BAT SPECIES SEASONALITY IN THE OFFSHORE PROJECT AREA

Species	Seasonality in Offshore Project Area
Eastern red bat **Hoary bat** **Silver-haired bat**	Limited mostly to fall migration period.
Northern long-eared bat	Offshore movements of these species may be limited between offshore islands and mainland.
Big brown bat **Eastern small-footed bat** **Little brown bat** **Tri-colored bat**	Likely limited to nearshore and between islands and the mainland during migration periods.

6.2.1.1.1 Risk Factors

Although the potential effects of offshore wind energy facilities on bats are poorly understood, fatalities observed from collision with land-based wind energy facilities (Martin et al., 2017; Pettit & O'Keefe, 2017; Hayes, 2013; Smallwood, 2013; Cryan & Barclay, 2009) indicate that bats may be vulnerable to collisions with operational offshore WTGs if they are present in the offshore environment. Collisions are defined as turbine strikes and barotrauma caused by rapid pressure changes at the tips or trailing edges of blades (Cryan & Barclay, 2009); however, recent studies indicate that barotrauma may not be a significant cause of bat fatalities as previously considered (Rollins et al., 2012).

Research on the interactions of bats with wind turbines and other tall, anthropogenic structures has demonstrated an overall pattern of attraction (Smallwood & Bell, 2020; Cryan et al., 2014; Jameson & Willis, 2014; Cryan & Barclay, 2009; Kunz, et al., 2007). Bats could be attracted to WTGs and other tall structures for a variety of reasons, including attempting to roost or forage near them if they are mistaken for trees (Bennett et al., 2017; Cryan & Barclay, 2009), foraging for insects (Bennet et al., 2017; Foo et al., 2017; Rydell et al., 2016; Horn et al., 2008) or using them as social hubs during spring and fall migration periods (Jameson & Willis 2014). A recent study by Smallwood and Bell (2020) also suggests that bats may be more likely to interact with operational WTGs than inoperable or curtailed turbines.

Additionally, light of different wavelengths may affect bats differently, and those effects may vary by species or season. For example, some studies have suggested that migratory tree-roosting bats were attracted to red light emitting diode lights on WTGs (Voigt et al., 2018; Bennet & Hale, 2014; Arnett et al., 2008; Horn et al., 2008) and green light emitting diode lights (Voigt et al., 2017), but not to warm white lights (Voigt et al., 2018). However, Spoelstra et al. (2017) found that bat behavior was affected by white and green lights (i.e., *Plecotus* and *Myotis* species avoided white and green lights), but not red lights. Evidence from a number of studies at land-based wind energy facilities have demonstrated that aviation safety lights are not associated with a greater risk of mortality at onshore WTG locations (Arnett et al., 2008).

Vessel lighting may attract insects that attract bats or act as a deterrent to bats. During the installation of WTGs at BIWF, construction vessel crews observed multiple instances of bats roosting on the vessels during daytime hours (Stantec, 2016b as cited by Stantec, 2018).

6.2.1.2 Bat Occurrence: Onshore Project Areas

This section identifies and describes the different bat species that may be present in the Onshore Project Areas during construction, operations, and decommissioning activities. Many bats are philopatric (Perry, 2011; Lewis, 1995) and potential habitat loss or disturbance may affect bats that use the Onshore Project Areas for foraging and/or roosting. Above-ground construction of onshore facilities for the Falmouth Onshore Project Area will include the onshore substation, which will be in Falmouth, Massachusetts, and the Project will connect this onshore substation to a point of interconnection (POI) located in Falmouth, Massachusetts. An alternate underground transmission route is under consideration (refer to Sections 2.2.3 and 3.2.10). Construction of onshore facilities for the Brayton Point Onshore Project Area will include a new converter station, and the Project will connect this to the existing POI, all located at Brayton Point in the Somerset, Massachusetts as well as an underground onshore export cable route through Portsmouth, Rhode Island.

Two sites for the onshore substation in Falmouth are being considered with buildable areas comprising between 25.0 and 27.3 ac (10.1 and 11.1 ha). The two sites primarily consist of developed lands (e.g., former quarry). Based on preliminary information, up to 26.0 ac (10.5 ha) of land will be required for the onshore substation (see Section 3.3.8) and the Falmouth POI will be located at an existing facility (see Section 3.3.10). It is likely that some tree clearing will be required for the onshore Project components in Falmouth.

The site for the onshore converter station at Brayton Point will be located where cooling towers once existed when Brayton Point Power Station was operational. Based on preliminary information, up to 7.5 ac (3.0 ha) of land will be required for the converter station (see Section 3, Description of Proposed

Activities). It is possible that some limited tree clearing may be necessary to support construction of the converter station in Somerset, Massachusetts or the underground onshore export cables through Portsmouth, Rhode Island. The Brayton Point POI will also be located at an existing facility (see Section 3.3.10).

Cave-hibernating and migratory tree-roosting bats are nocturnal insectivores that use a variety of forested and open habitats (e.g., agricultural fields, waterways, lakes and other waterbodies) for foraging during the summer. Some bat species primarily forage in the understory of clustered forests and in forest gaps, whereas others tend to forage over the forest canopy (Taylor, 2006). Several species regularly forage over water sources (e.g., wetlands, ponds, lakes) and waterways as well as along roads and other linear travel corridors (e.g., paths, transmission lines). Forested habitats provide foraging and roosting habitat for both migratory and non-migratory bats in Massachusetts. Roost selection varies by species, with some species generally roosting in the foliage of trees and others typically selecting dead or dying trees, where they roost under bark or inside crevices. The fragmentary nature of the nearby forest also lowers the likelihood of bat presence. The proposed locations for the onshore substation in the Falmouth Onshore Project Area are located in previously disturbed areas that are not expected to be important summer foraging or roosting habitat. However, the existing transmission line corridor is adjacent to extensive contiguous forest that contains known maternity colonies of the northern long-eared bat.

Important habitats for cave-hibernating bats are caves and mines that are used as winter hibernacula, swarm locations in the fall months (e.g., when bats forage and mate prior to entering hibernation), and summer roosting locations for some species. For a hibernacula to be occupied, suitable conditions such as minimal disturbance and suitable temperature, humidity, and airflow in the cave or mine hibernacula are required for bats to survive the winter [Tuttle & Taylor, 1998]). Based on the information reviewed, the onshore substation and converter station locations are not expected to contain winter hibernacula for any bat species, including caves and mines.

Federally listed species: The northern long-eared bat is found across most of the eastern U.S. and eastern Canada and in portions of the mid-western U.S., Alberta and British Columbia (Naughton, 2012; Caceres & Barclay, 2000). The species was listed as Threatened under the ESA in 2015 due to impacts from white-nose syndrome (WNS) and population declines are expected to continue with the ongoing spread of the disease throughout the species' range (USFWS, 2016). In January 2020, the U.S. District Court for the District of Columbia remanded the decision regarding ESA designation back to USFWS. The USFWS has appealed this decision; however, no additional information regarding whether the appeal was successful or whether the USFWS will be required to undertake a new listing decision for the species has been made publicly available since January 2020. Under the current Threatened listing, a 4(d) Rule for northern long-eared bat was issued by USFWS in January 2016 (USFWS, 2016). The rule allows incidental take of the species that results from otherwise lawful activities, including wind energy operations. Under the 4(d) rule, no Incidental Take Permit would be required for northern long-eared bat; however, incidental take resulting from tree removal is prohibited if it: occurs within a 0.25-mi (0.4-km) radius of known northern long-eared bat hibernacula; or cuts or destroys known occupied maternity roost trees, or any other trees within a 150-ft (45-m) radius from a known maternity roost tree during the pup season (June 1 through July 31). The species is also listed as endangered under the MESA and WNS has been confirmed in Massachusetts (MassWildlife, 2020).

The northern long-eared bat hibernates in caves and mines in the winter and is found in forested habitats during the remainder of the year (i.e., from March to November, Brooks & Ford, 2005; Menzel et al., 2002). Northern long-eared bats also occasionally roost in human-made structures (e.g., barns). During the summer, the species prefers clustered stands of large trees and will roost in large cavities and bark crevices in living and dead hardwoods (MassWildlife, 2012; Naughton, 2012). The northern long-eared bat forages under the forest canopy, above small ponds and streams, and along roads and forest edges (MassWildlife, 2012). Maternity colonies are formed at summer roosting locations and female roost-site selection with respect to tree species, height and canopy cover appears to change with reproductive stage (USFWS, 2016). Females give birth to and rear single young from mid-May to mid-July (MassWildlife, 2012). Maternity colonies begin to break up in mid-August as bats begin migrating to hibernation sites (Menzel et al., 2002) and are seen around the hibernation sites in what is known as the fall swarm period (Brooks & Ford, 2005; Broders & Forbes, 2004). Northern long-eared bats have small home ranges of less than 25 ac (10 ha; Silvis et al., 2016 as cited in Dowling et al., 2017); however, their migratory movements may range between 5.0 and 170.0 mi (8.0 and 275.0 km; BCI, 2021).

Several mist-netting, acoustic and telemetry surveys at Camp Edwards Joint Base Cape Cod (JBCC), located 8.1 mi (13.1 km) from the Falmouth POI and the proposed onshore substation site in Falmouth, have confirmed the presence of northern long-eared bats on Cape Cod (Tetra Tech, 2017, 2015; WEST, 2017; Tetra Tech et al., 2015) (**Figure 6-4**).[3]

Portions of the proposed onshore Project components in Falmouth overlap Massachusetts Priority Habitat (Priority Habitat 213) for state-listed species. Mayflower Wind submitted an information request to NHESP for the Falmouth Onshore Project Area and received a response on May 1, 2020 (NHESP, 2020). At that time, no Priority Habitats for state-listed bat species, including the northern long-eared bat (**Figure 6-5**), were identified in the information request response. However, the crossing of Priority Habitat 213 was not included in this consultation which has since received updated Priority Habitat designations (14th edition to 15th edition confirmed in OLIVER) by NHESP. Mayflower Wind will update the correspondence with NHESP to confirm that the Project will not intersect with the known geographical extent of Priority and Estimated Habitat for state listed bat species/northern long-eared bat.

The Brayton Point Onshore Project Area is located in an existing industrial area that is unlikely to have presence of northern long-eared bat. In addition, the fragmentary and isolated nature of the nearby forest also lowers the likelihood of northern long-eared bat presence. The nearest hibernaculum is located 40.4 mi (65.0 km) north in Wellesley, Massachusetts and the nearest maternity colonies are located 34.8 mi (56.0 km) east near Sandwich, Massachusetts (MassWildlife, 2019). The information request response from NHESP dated July 23, 2021 for the Brayton Onshore Project Area in Somerset, Massachusetts did not note any Priority and Estimated Habitat associated with bat species (**Figure 6-6**). Rhode Island does not provide a designation of Priority and/or Estimated Habitat associated with bat species. The information request response dated June 24, 2021 from RIDEM did not identify any presence of northern long-eared bat in the Rhode Island portions of the Brayton Point export cable corridor (P. Jordan, personal communication, June 24, 2021).

[3] There is no corresponding figure for the Brayton Point Onshore Project Area as review of MassWildlife 2019 does not indicate any known locations of winter hibernacula and maternity roost trees for northern long-eared bat.

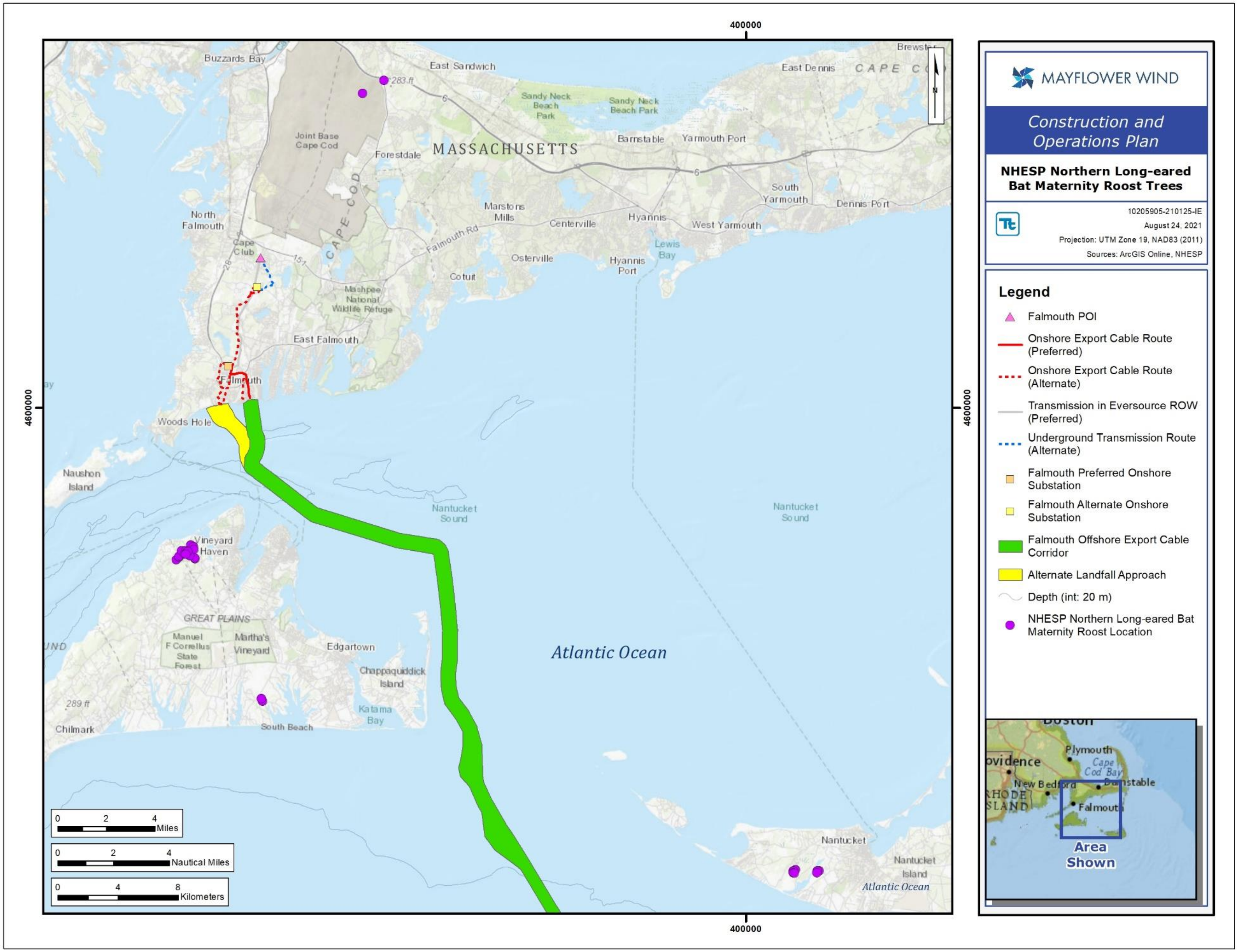


FIGURE 6-4. NHESP NORTHERN LONG-EARED BAT MATERNITY ROOST LOCATIONS

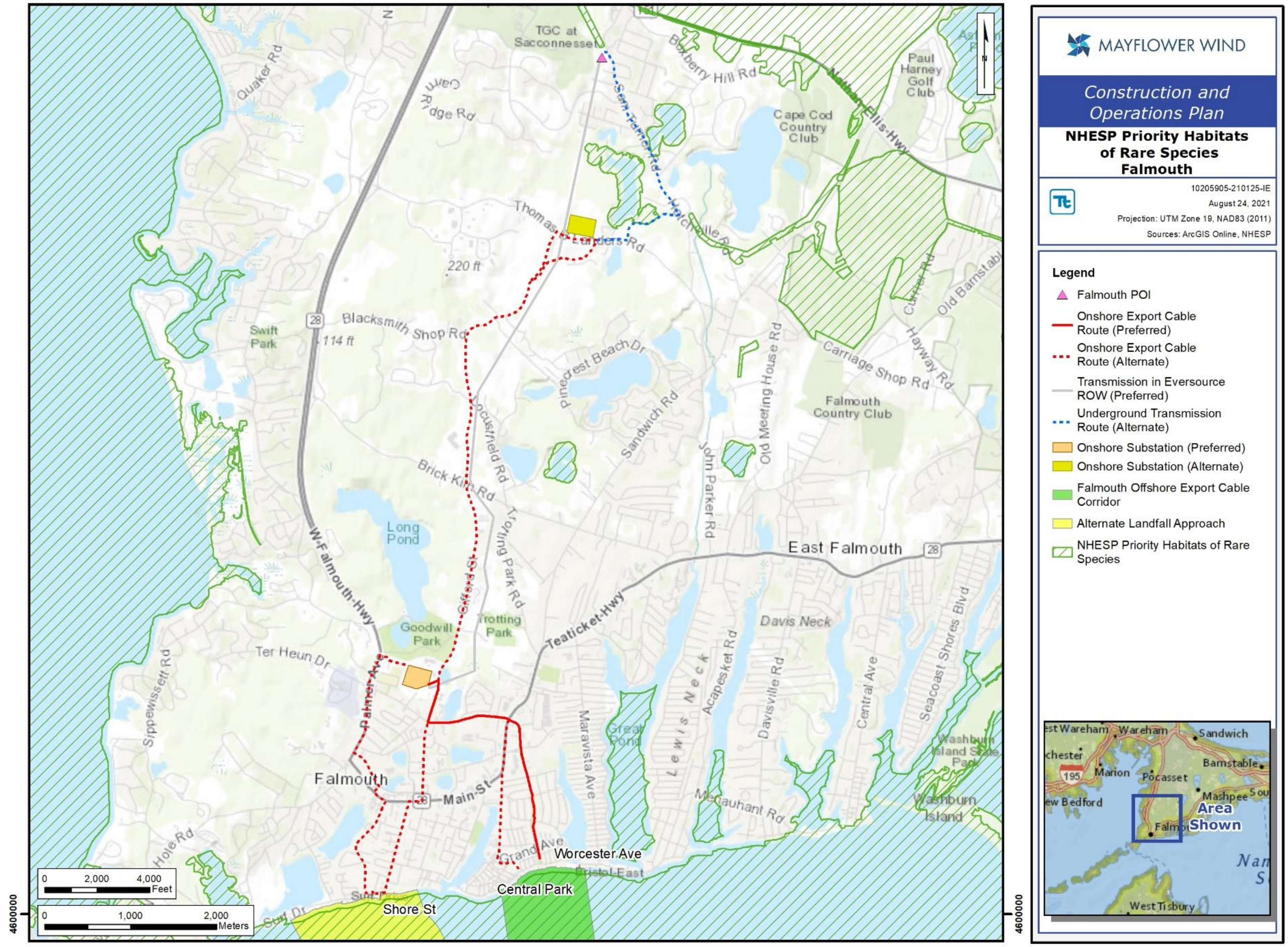


FIGURE 6-5. FALMOUTH ONSHORE PROJECT AREA NHESP PRIORITY HABITATS OF RARE SPECIES

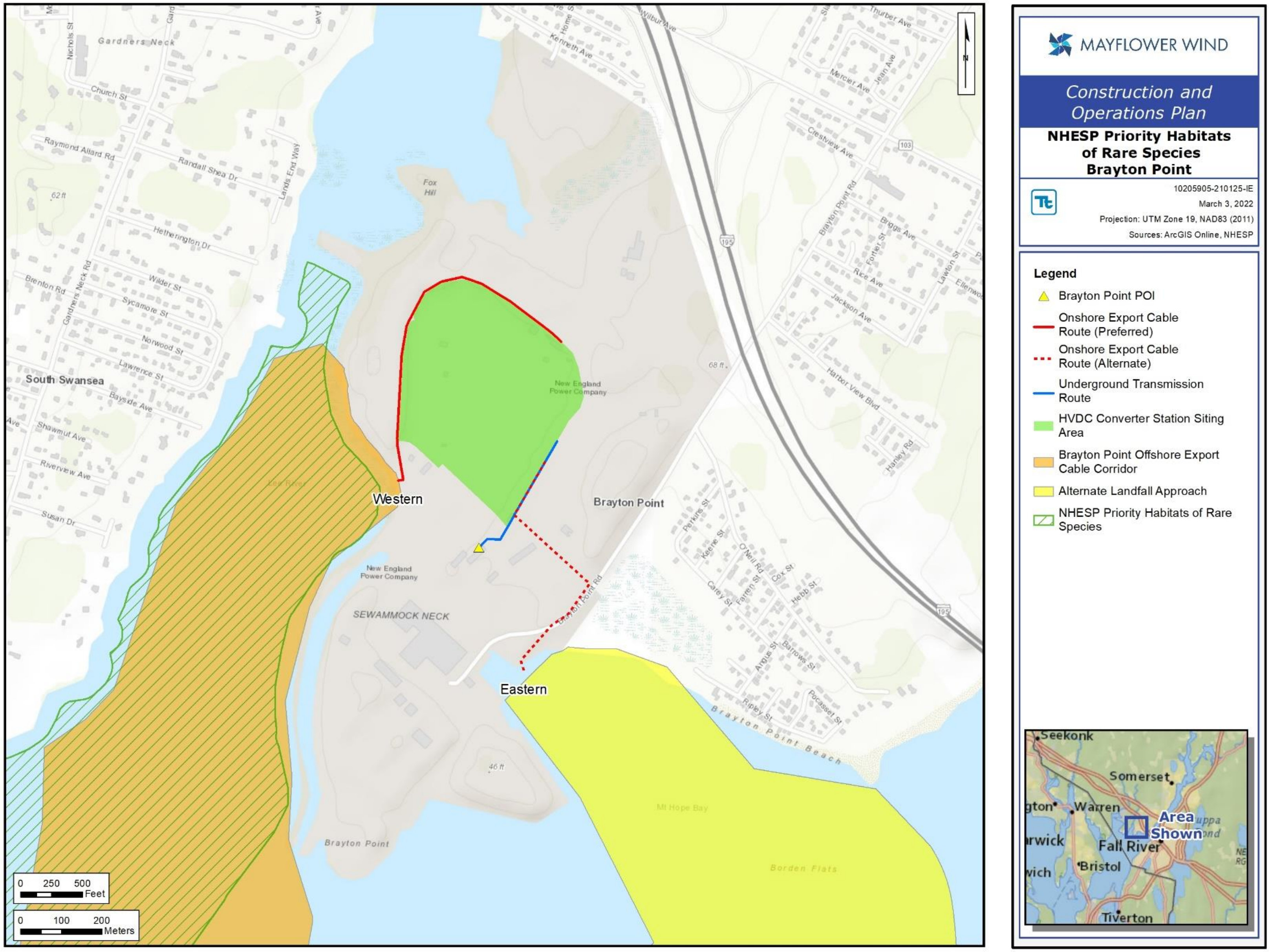


FIGURE 6-6. BRAYTON POINT ONSHORE PROJECT AREA NHESP PRIORITY HABITATS OF RARE SPECIES

__State-listed species__: There are three bat species listed under MESA that are not federally listed with the potential to occur in the Onshore Project Areas, including eastern small-footed bat (Endangered), little brown bat (Endangered) and tri-colored bat (Endangered). Tri-colored bat has also been petitioned for federal listing under ESA and little brown bat is currently under discretionary review by USFWS. Rhode Island does not currently list any bat species on its endangered and threatened species list but does list all of its bat species on its 2015 State Wildlife Action Plan as Species of Greatest Conservation Need.

6.2.1.2.1 Eastern small-footed bat

The eastern small-footed bat is present in Massachusetts and is threatened by disturbances during hibernation that can cause bats to prematurely wake during their hibernation and expend energy that is otherwise necessary to maintain them throughout the winter, resulting in increased fatality rates (MassWildlife, 2019; Alves et al., 2014). Eastern small-footed bats roost under tree bark, and in rock talus and deep fissures (Naughton, 2012). The species is known to forage in open areas with large trees, over waterways and waterbodies, and along the edges of forests (MassWildlife, 2015b). Eastern small-footed bats occasionally roost in barns and buildings and hibernate in high-humidity limestone caves and abandoned mines (MassWildlife, 2019, 2015a, 2015b). The eastern small-footed bat generally travels short distances (approximately 12.0 mi [20.0 km]) between summer and winter roosts (Naughton, 2012). According to the NHESP response for an information request for the proposed Project, no NHESP Priority Habitats for eastern small-footed bat were identified within the Falmouth Onshore Project Area (**Figure 6-5**, NHESP, 2020); however, the species has been detected during acoustic surveys at Camp Edwards JBCC, located approximately 4.0 mi (7.0 km) from the Falmouth POI and 8.0 mi (13.0 km) from the nearest proposed onshore substation site (WEST, 2017; Tetra Tech, 2017, 2015; Tetra Tech et al., 2015). A review of the NHESP Priority Habitat did not indicate any known Priority Habitat in the Brayton Point Onshore Project Area (MassWildlife, 2017). Eastern small-footed bats (*Myotis leibii*) were recorded on Block Island NWR off the coast of Rhode Island (Smith & McWilliams, 2016, 2012). The information request response dated June 24, 2021 from RIDEM did not identify any presence of eastern small-footed bat in the Rhode Island portions of the Brayton Point export cable corridor (P. Jordan, personal communication, June 24, 2021).

6.2.1.2.2 Little brown bat

Once widely distributed throughout Massachusetts, the little brown bat has been devastated by WNS with a greater than 90 percent loss of the species' population in the Northeast (USFWS, 2012). Little brown bats primarily roost in buildings but will occasionally roost in small caves, trees, under rocks and in piles of wood (MassWildlife, 2015a) and hibernate in high-humidity limestone caves and abandoned mines (MassWildlife, 2019, 2015a, 2015b). The species is known to forage in open areas with large trees, over waterways and waterbodies, and along the edges of forests (MassWildlife, 2015b). Little brown bats may migrate long distances between winter and summer habitats, and recent research indicates that individuals captured and tagged in Massachusetts were found hibernating at sites in Vermont and Connecticut up to 168 mi (270 km) away (MassWildlife, 2015a, 2015b). Recent research also indicates that little brown bats exhibit long-distance (greater than 311 mi [500 km]) latitudinal migratory movements (Norquay et al., 2013). According to the NHESP response for an information request for the proposed Project, no NHESP Priority Habitats for little brown bat were identified within the Falmouth Onshore Project Area (**Figure 6-5**) (NHESP, 2020); however, the species has been detected during acoustic surveys at Camp Edwards JBCC (WEST, 2017; Tetra Tech, 2017, 2015; Tetra Tech et al., 2015). A review of the NHESP Priority Habitat did not indicate any known Priority Habitat in the Brayton Point Onshore Project Area (Mass.gov, 2017). Anecdotal evidence from animal control/removal companies indicates the presence of little brown bats on Aquidneck Island, Rhode Island (BatGuys Corporation, 2019). A review of RIDEM Wildlife Action Plan indicate that little brown bat are widespread in the state of Rhode Island (RIDEM, 2015); however, the information request response dated June 24, 2021 from RIDEM did not identify any presence of little brown bat in the Rhode Island portions of the Brayton Point export cable corridor (P. Jordan, personal communication, June 24, 2021).

6.2.1.2.3 Tri-colored bat

Tri-colored bat populations were reduced by heavy pesticide use in the mid-1900s and had been steadily recovering until an approximately 90 percent loss of tri-colored bat populations in WNS-infected hibernacula due to the outbreak in the winter of 2007-2008 (USFWS, 2012). Tri-colored bats roost in forest canopies in dead leaves on mature, living, or recently dead deciduous trees, and maternity colonies are typically found among the dead needles of living pines (Perry & Thill, 2007). The species rarely roosts in barns and buildings (MassWildlife, 2015a) and hibernates in high-humidity limestone caves and abandoned mines (MassWildlife, 2019, 2015a, 2015b). Tri-colored bat forages in open areas with large trees, over waterways and waterbodies, and along the edges of forests, but typically avoids deep woods and open fields (MassWildlife, 2015b). Tri-colored bat may migrate long distances between winter and summer habitats and the species has been recorded migrating up to 85 mi (137 km) to hibernation sites (MassWildlife, 2015a, 2015b). Recent research also indicates that the species exhibits long-distance (greater than 311 mi [500 km]) latitudinal migratory movements and male tri-colored bats may travel further south than previously known (Fraser et al., 2012). According to the NHESP response for an information request for the proposed Project, no NHESP Priority Habitats for tri-colored bat were identified within the Falmouth Onshore Project Area (**Figure 6-5**; NHESP, 2020); however, the species has been detected during acoustic surveys at Camp Edwards JBCC (WEST, 2017; Tetra Tech, 2015, 2017; Tetra Tech et al., 2015). A review of the NHESP Priority Habitat did not indicate any known Priority Habitat in the Brayton Point Onshore Project Area (Mass.gov, 2017). Information from RIDEM indicates little is known about the status and distribution of this species in Rhode Island (RIDEM, 2015). The information request response dated June 24, 2021 from RIDEM did not identify any presence of northern long-eared bat in the Rhode Island portions of the Brayton Point export cable corridor (P. Jordan, personal communication, June 24, 2021).

TABLE 6-26. BAT SPECIES SEASONALITY IN THE ONSHORE PROJECT AREAS

Species	Seasonality in Project Area
Eastern red bat ***Hoary bat*** **Silver-haired bat** **Little brown bat** **Big brown bat**	Potential roosting habitat present in the vicinity of the Project Area, and occurrence likely limited to summer.
Northern long-eared bat	Species have been observed in vicinity of Project Area. Likely limited to spring migration and summer.
Eastern small-footed bat **Tri-colored bat**	Species have been observed in Massachusetts and Rhode Island but are unlikely to occur within onshore components of the Project Area. Likely winter outside of the state of Rhode Island.

6.2.1.2.4 Risk Factors

Literature investigating bat sensitivity to noise generally indicates that bats are very tolerant of anthropogenic noise, including persistent and sudden noises near airports (FAA, 1992) and near highways (Brack et al., 2004). Bats have also been recorded roosting under concrete road bridges and underpasses (Kiser et al., 2002) and roosting and foraging on active military bases where construction and training activities take place during the active season (3D/E, 1996). These studies indicate that bats are not displaced by and may habituate to anthropogenic noise.

Review of literature suggests that bat species react differently to light; some appear to be unaffected by city and other artificial lights (Spoelstra et al., 2017; Hale et al., 2015; Mathews et al., 2015), whereas others may seek out light sources in search of prey (e.g., for insects that are attracted to lights, Rydell & Racey, 1995; Rydell, 1992). For example, in residential areas, bats can often be seen foraging for insects near porch lights, stadiums, and pole lights. For other species, illuminated roadways and similar “light barriers” limit movement across the landscape as the bats, perhaps avoiding a perceived increase in predation risk, avoid those lit corridors (Hale et al., 2015).

Researchers have also found that migrating bats did not make more “feeding buzzes” (rapid echolocations across a broad frequency range associated with the taking of a prey item) in the presence of light, which may indicate that migrating bats are not attracted to light sources primarily as foraging grounds (Voigt et al., 2018; Voigt et al., 2017). Voigt hypothesized that bats may be attracted to lights during migration because they are relying on vision more than echolocation or other environmental cues for orientation. This hypothesis finds support in other studies which demonstrated that nonmigratory bat species seem to use polarized light at dusk to aid in orientation and navigation (Greif et al., 2014), whereas migratory bats do not (Lindecke et al, 2015).

6.2.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM’s *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3.3, Project Components and Project Stages, is considered for the analysis of potential effects.

Appendix I2, Bat Risk Assessment, completed for the proposed Project includes IPFs (e.g., discharges and releases, trash and debris) that were determined to not affect bats and therefore are not presented in this evaluation. IPFs are listed in **Table 6-27** below.

TABLE 6-27. IPFS AND POTENTIAL EFFECTS TO BATS IN THE PROPOSED PROJECT AREA

IPF	Potential Effects				Project Phase		
	Project Components						
	Offshore Project Area		Onshore Project Areas				
	Lease Area	Offshore Export Cable Corridors	Onshore Substation and Converter Station	Landfalls and Onshore Cable Routes	Construction	O&M	Decomm.
Ground Disturbance	—	—	Habitat loss/ fragmentation	Habitat loss/ fragmentation	X	X	X
Introduced Sound	Behavioral disturbance	Behavioral disturbance	Behavioral disturbance	Behavioral disturbance	X	X	X
Changes in Ambient Lighting	Displacement/attraction	—	Displacement/ attraction	—	X	X	X
Actions that may cause displacement or direct injury or death of biological resources - Tree Clearing	—	—	Roost disturbance from tree trimming or removal	Roost disturbance from tree trimming or removal	X	X	—
Actions that may cause direct injury or death of biological resources – Presence of Structures	Collision with WTGs	—	—	—	—	X	—
Changes in Ambient Electric and Magnetic Fields (EMFs)	Displacement/harassment	—	—	—	—	X	—

6.2.2.1 Ground Disturbance

6.2.2.1.1 Construction and Decommissioning

No Project activities in the Lease Area or nearshore environment (e.g., landfall location) are expected to cause loss of roosting or foraging habitat. Construction activities in the Onshore Project Areas may result in destruction or disturbance of limited amounts of bat habitat. Although the final onshore substation location in Falmouth has not yet been determined, it will be sited to minimize effects to forested areas. The HVDC converter station in Somerset was sited in a previously disturbed industrial area which minimizes disturbance of bat habitat.

Any potential disturbance to bat habitat during construction will be short-term. However, depending on the amount and timing of tree clearing required, bat surveys may be conducted to identify presence of species, utilization of habitat, and presence of roosts. Habitat fragmentation is not expected given that Mayflower Wind's facilities will follow previously disturbed areas and no open corridors will be created. Additionally, Mayflower Wind will coordinate with USFWS, MassWildlife, and RIDEM to determine appropriate mitigation measures (Section 16).

Decommissioning activities are expected to be similar to construction activities, therefore, IPFs and potential effects will be similar. Prior to decommissioning, Mayflower Wind will consult with BOEM and the USFWS to discuss best practices available to avoid and minimize potential effects from decommissioning to bats.

6.2.2.1.2 Operations

During Project operations, small amounts of routine habitat disturbance are likely because of maintenance activities which may consist of vegetation maintenance at the onshore substation and converter station. Where practicable, vegetation within approximately 50 feet (15.2 m) of the onshore substation and converter station fence will be maintained to knee level or lower using a lawn mower, string trimmer, pruner, hedge trimmer, or similar based on final landscaping plans. The Project will not conduct vegetation maintenance outside of the property or lease boundary. Planting and maintenance plans will account for the safety, security, and visual screening needs of the Project. Similar vegetation maintenance practices will be followed along any underground cable easements outside of paved roadway. Vegetation, where present, will be maintained to knee level or lower along a corridor up to 35 feet (10.7 m) in width to protect the cables from potential damage due to large root systems.

6.2.2.2 Introduced Sound

6.2.2.2.1 Construction and Decommissioning

Construction activities may introduce sound into the environment because of construction equipment and vehicle traffic (onshore). Construction-related disturbance to bats in the Lease Area and offshore export cable corridor is not anticipated to affect bats. The overall construction-related disturbance in the Onshore Project Areas is anticipated to be minimal and limited to the approximate construction area (see Section 3.3.6 through Section 3.3.11 and Appendix G, Air Emissions Report), though some amount of sound may be perceptible outside the physical workspace. Therefore, the introduction of sound from construction activities is anticipated to be short-term and temporary.

Decommissioning activities are expected to be like construction activities, therefore, IPFs and potential effects will be similar. Prior to decommissioning, Mayflower Wind will consult with BOEM and the USFWS to discuss best practices available to avoid, minimize, and/or mitigate potential effects from decommissioning to bats.

6.2.2.2.2 Operations

Operational WTGs and the onshore substation and converter station may produce some amount of noise that may disturb bats. However, operational noise is expected to be significantly less than that of construction, and bats are not likely to be sensitive to such disturbance.

6.2.2.3 Changes in Ambient Lighting

6.2.2.3.1 Construction

Construction activities may introduce light into the environment as a result of construction equipment, vehicle traffic (onshore), vessel traffic (offshore), and equipment and safety lighting. Potential disturbance to bats from vessel traffic is expected to be very low and limited to the migration period. Bat exposure to lighting effects in the Offshore Project Areas is expected to be low. Mayflower Wind will minimize lighting during offshore construction activities to reduce potential effects related to bats, where practicable (Section 16).

The overall construction-related disturbance in the Onshore Project Areas is anticipated to be minimal and limited to the approximate construction area, though some amount of light may be perceptible outside the physical workspace. Therefore, changes to ambient lighting from construction activities is anticipated to be short-term and temporary.

Decommissioning activities are expected to be similar to construction activities, therefore, IPFs and potential effects will be similar. Prior to decommissioning, Mayflower Wind will consult with BOEM and the USFWS to discuss best practices available to avoid, minimize, and/or mitigate potential effects from decommissioning to bats.

6.2.2.3.2 Operations

The OSPs and WTGs will both require artificial lighting during operations, including both safety lighting (illumination of work areas) and aviation avoidance lighting on the offshore structures. At the intervals at which WTGs will be placed within the Lease Area (one per nautical mile in a grid layout), it is unlikely that a significant light barrier would be produced by either construction vessels or operational turbines. The introduction of lighting in the offshore environment may also create light barriers for movements of bats during migration periods. Offshore lighting is anticipated to be a low-intensity effect due to the minimal amount of lighting required and the amount of distance between each light source (approximately 1.0 nm [1.9 km]).

Bats may be exposed to lighting on vessels or OSPs during O&M activities as they may prey on insects that are attracted to lights. Bats may also be exposed to lighting around the onshore substation and converter station, which may create a slight barrier effect or create a foraging ground for attracted insects. However, the overall exposure for bats to lighting effects onshore is expected to be low because Project components are unlikely to present significant changes to baseline lighting conditions.

6.2.2.4 Tree Clearing

6.2.2.4.1 Construction

In addition to habitat disturbance addressed in Section 6.2.2.1, it is possible that construction activities may alter bat behavior by causing them to change roosts or alter their foraging or local migration patterns during the period of construction. However, Mayflower Wind's facilities follow previously disturbed areas that will result in no additional habitat fragmentation, open corridors, or significant new open spaces.

Potential causes of injury or death during construction include tree trimming or removal (if required), collisions between bats and construction equipment (including vessels), or disruption of bat activity which may result in roost abandonment or significant energy expenditure during the migratory or pup-rearing time periods. Potential risks from tree trimming, which could result in bat fatalities or injuries if roosts are destroyed while occupied, are greatest during the early summer period when pups are not yet volant. Some limited tree clearing may be necessary for the construction of the onshore Project components and activities that may result in injury or death would be short-term, temporary, and localized. As noted in Section 6.2.2.1.1, bat surveys may be conducted depending on the amount and timing of tree clearing required. Mayflower Wind will coordinate with USFWS, RIDEM, and MassWildlife to determine appropriate mitigation measures (Section 16).

Not all onshore infrastructure may be removed during decommissioning. Although some individual bats may occasionally roost on the Project's aboveground structures, it is unlikely that significant numbers will do so, and the overall disturbance of decommissioning activities would likely disrupt roosting bats before the structures were taken down. It is unlikely that decommissioning of these structures will result in meaningful impacts to bats through direct injury or death.

6.2.2.4.2 Operations

Any habitat that was permanently altered during construction may also pose a risk of resource displacement. Bats that used those areas for foraging, roosting, or maternity sites will necessarily seek out alternative areas, resulting in their displacement.

6.2.2.5 Presence of Structures in the Offshore Project Area

6.2.2.5.1 Operations

As discussed in Section 6.2.1.1, cave-hibernating and migratory tree-roosting bats are expected to be present in the Offshore Project Area primarily during migration periods: July-October for cave-hibernating species and October-November for migratory tree-roosting species. Cave-hibernating bats are less likely to occur in the Offshore Project Area because evidence indicates they do not typically occur more than 10 mi (16 km) from shore (Sjollema et al., 2014). Migratory tree-roosting bats are more frequently observed offshore and have been recorded further offshore (e.g., 21.0 and 27.0 mi [33.8 and 43.4 km], Hatch et al., 2013; Cryan & Brown, 2007) than cave-hibernating bats but are also unlikely to be exposed to WTGs in the Lease Area, which is located approximately 29.8 mi (48.0 km) south of Martha's Vineyard, 23.0 mi (37.0 km) south of Nantucket, and at its closest point, 44.7 mi (72.0 km) from the mainland at Nobska Point in Falmouth, Massachusetts. Similarly, exposure to the Offshore Project Area for federally and state-listed species is expected to be insignificant to unlikely as the species have not been observed far offshore, with migratory movements primarily limited between nearshore islands (e.g., Martha's Vineyard and Nantucket) and the mainland. In Europe, there is evidence of bats interacting with WTGs nearer to shore (2.5 to 4.3 mi [4.0 to 7.0 km]) in the Baltic Sea (Rydell & Wickman, 2015; Ahlén et al., 2009; Ahlén et al., 2007). Overall bat exposure to the Offshore Project Area is likely to be limited to a few individuals and as a result population level impacts are unlikely; therefore, potential effects to bats from collision with WTGs are expected to be low and to be very low for ESA/MESA-listed species.

6.2.2.6 Changes to EMF

6.2.2.6.1 Operations

The potential effects of electromagnetic radiation on bats are unclear and the subject of a limited amount of research. Some studies have indicated a reduction of bat activity in the presence of electric and magnetic fields (EMFs), using radar units as the source of the EMF (Nichols & Racey, 2009, 2007). Researchers have theorized several mechanisms by which EMFs may deter bats, including disturbance to prey species, thermal induction, and high-frequency interference with echolocation. Bat activity was reduced significantly in habitats exposed to an EMF (from radar installations) strength of 2 volts per meter or greater when compared to matched sites with no measurable EMF; however, the reduction in activity was not statistically significant at EMF strengths less than 2 volts per meter within 1,300 ft (400 m) of the EMF source (Nicholls & Racey, 2007).

6.2.2.7 Conclusion

Bats have potential to be exposed to IPFs in the Project Area. Based on an analysis of best available science and data, there may be infrequent occurrences of federally and state-listed northern long-eared bat. Eastern small-footed bat, little brown bat, and tri-colored bat occurrence is expected to be limited to nearshore and between the islands and the mainland during migration periods.

The bat species that could occur in the Project Area offshore (**Table 6-25**) and onshore (**Table 6-26)** have some likelihood of being exposed to IPFs such as introduced sound, habitat disturbance and modification, EMF emissions, and risk of collision with operational WTGs. However, all potential effects would be localized to the Project Area, and exposure to IPFs in the Offshore Project Area are likely limited to migration periods. Seasonal exposure to IPFs from onshore Project components (e.g., onshore substation and converter station) may include summer roosting periods. Finally, and as discussed in Section 16, avoidance, minimization, and mitigation measures and other BMPs are expected to reduce impacts to bats in the Project Area.

6.3 TERRESTRIAL VEGETATION AND WILDLIFE

This section describes the terrestrial vegetation and associated wildlife species, including terrestrial or inland birds, with the potential to occur in the Onshore Project Areas, and includes an evaluation of the potential Project-related effects. This section assesses the Falmouth and Brayton Point Onshore Project Areas for the proposed Project components that are predominately onshore; including the landfall locations, onshore export cables, onshore substation, converter station, and underground transmission lines. This evaluation is based on a review of published scientific literature and field surveys conducted in the Onshore Project Areas and vicinity by Mayflower Wind (limited to Falmouth Onshore Project Area) or land management agencies, and supplemented by consultation with state wildlife agencies and anecdotal records. In response to an information request, the NHESP, a subdivision of the Massachusetts Division of Fisheries and Wildlife (MassWildlife), provided data on likely species presence in the Falmouth Onshore Project Area on May 1, 2020 (NHESP, 2020). NHESP provided data on likely species presence in the Brayton Point Onshore Project Area on July 23, 2021 (E. Schlüter, personal communication, July 23, 2021). In addition, the Rhode Island Natural Heritage Program responded to a data request on June 24, 2021 regarding threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat within the Rhode Island portions of the Brayton Point export cable corridor (USFWS, personal communication [two separate letters: one regarding Sakonnet River and Mount Hope Bay, the other Lower Narragansett], June 23, 2021). RIDEM also provided a list of species for the portions of the Brayton Point export cable corridor and onshore Project components in Rhode Island on June 24, 2021.

Technical appendices related to terrestrial vegetation and wildlife include:

- Appendix J, Terrestrial Vegetation and Wildlife Assessment

Coastal and marine birds are discussed in Section 6.1, bats are discussed in Section 6.2. Wetlands and waterbodies are discussed in Section 6.4, and coastal habitats are discussed in Section 6.5.

6.3.1 Affected Environment

6.3.1.1 Terrestrial Habitats

The natural environment in the Falmouth Onshore Project Area is classified by the United States Environmental Protection Agency as the Atlantic Coastal Pine Barren Level III Ecoregion (Griffith et al., 2009), and further classified by MassWildlife as the Cape Cod Coastal Lowlands and Islands Ecoregion (Swain, 2020). The Brayton Point Onshore Project Area is classified as the Narragansett/ Bristol Lowland (Griffith et al., 2009).

The Cape Cod Coastal Lowlands and Islands Ecoregion is characterized by coastal deposits and outwash plains left by receding glaciers. The Falmouth Onshore Project Area is situated along the terminal moraine, or the point of maximum glacial advance, of the Wisconsin glaciation. The soils are predominantly sandy, acidic, and nutrient poor. Vegetation common to this ecoregion includes short or stunted oaks (*Quercus* sp.; primarily scrub oak [*Quercus ilicifolia*]) and pines (*Pinus* sp.; primarily pitch pine [*Pinus rigida*]) (Swain, 2020). As a result, pitch pine-oak forests and scrub-shrub habitats dominate Cape Cod.

The Narragansett/ Bristol Lowlands is classified by Pennsylvanian-age sedimentary rock and extends south across Buzzards Bay (Griffith et al., 2009). The Brayton Point Onshore Project Area is situated in an ecoregion that is relatively flat with most elevations under 200 ft (61 m) (Griffith et al., 2009).

Each of the different components of the Onshore Project Areas (i.e., landfalls, onshore export cable routes, onshore substation, converter station, transmission line, and POIs) are summarized below, and full details of the components are discussed in Section 3.3. Project facilities are currently sited to follow existing infrastructure (e.g., existing roads, existing utility rights-of-way [ROWs]) to the extent practicable.

6.3.1.1.1 Falmouth Landfall Location

The onshore components of the proposed Project in Falmouth will originate from a landfall in Falmouth, Massachusetts (**Figure 6-7**). The three landfall locations currently under consideration include Central Park, Shore Street, and Worcester Avenue (refer to Section 2.2.7 and Section 3.2.9). Landfall construction using HDD will be used to reduce or eliminate impacts to the sensitive shoreline environments and nearshore areas of the Massachusetts coast. The Worcester Avenue and Central Park landfall locations consist of similar conditions, and are of lower ecological value than other communities, largely consisting of mowed lawns and other areas common to human disturbance and presence. The Shore Road landfall location is largely developed and devoid of natural communities. Potential effects to coastal habitats at the landfall location are further discussed in Section 6.5. Natural communities present at the Falmouth landfall locations include the following:

- Bare Land
- Coastal Beach
- Deciduous Forest
- Developed Open Space
- Impervious
- Unconsolidated Shore

6.3.1.1.2 Falmouth Onshore Export Cable Route/Transmission Line

Each of the proposed onshore export cable routes will be installed within and below existing public roadways to the onshore substation sites (**Figure 6-7**). As a result, some areas of previously disturbed and maintained roadside vegetation may be affected during construction. Should the alternate onshore substation site be selected (see Section 6.3.1.1.3), short sections (0.1 mi [0.2 km] or less) of the onshore export cable route will be installed through areas of Pitch Pine-Oak Forest habitat. However, tree and vegetation clearing would be minimal (less than 0.5 ac [0.2 ha]) for each of the alternate onshore export cables routes.

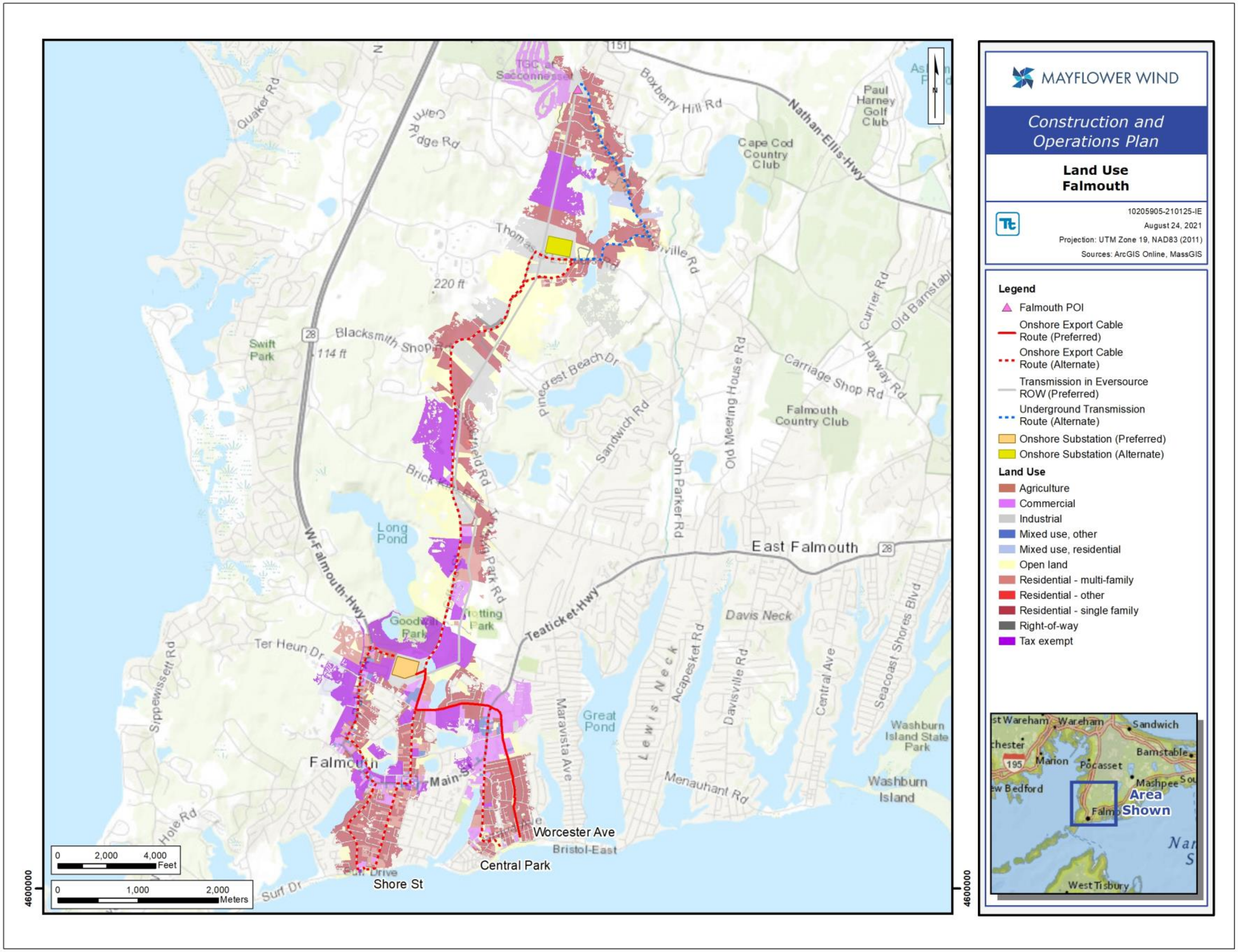


FIGURE 6-7. LAND USE WITHIN FALMOUTH ONSHORE PROJECT AREA

The Falmouth alternate transmission route will consist of underground cables from the onshore substation to the POI, should the preferred route in the existing utility ROW not be feasible. Natural communities present along the Falmouth onshore export cable routes and underground transmission route, if necessary, include the following:

- Bare Land
- Deciduous Forest
- Developed Open Space
- Evergreen Forest
- Grassland
- Impervious
- Palestine Aquatic Bed
- Palustrine Emergent Wetland
- Palustrine Forested Wetland
- Palustrine Scrub/Shrub Wetland
- Scrub/Shrub
- Unconsolidated Shore
- Water

6.3.1.1.3 Falmouth Onshore Substation

Two sites are under consideration for the onshore substation, including Lawrence Lynch (preferred) and Cape Cod Aggregates site (alternate) (**Figure 6-7**). Only one of these sites will be developed, but both sites are described herein.

The Lawrence Lynch site is approximately 27.3 ac (11.01 ha) in size and primarily consists of disturbed and developed land that is currently used as a sand and gravel mine and aggregate processing facility. There are several constructed stormwater ponds on the site for management of stormwater runoff. these features are not considered a valuable resource for wildlife, fish, or other aquatic life due to their highly altered nature and function as a stormwater management facility (see Appendix J, Terrestrial Vegetation and Wildlife Assessment Report).

The Cape Cod Aggregates alternate substation site is approximately 25.0 ac (10.1 ha) in size and predominately consists of disturbed land that is currently used for sand and gravel mining and processing. Additionally, there are no open fresh surface waters located on the site. This site includes areas of mature pitch pine-oak forest around its perimeter.

6.3.1.1.4 Aquidneck Island Intermediate Landfall

The Brayton Point export cable route includes an intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island (**Figure 6-8**). There are three onshore underground export cable routes under consideration. Natural communities present at the intermediate landfalls and along the export cable routes on Aquidneck Island include the following:

- Developed Land
- Developed Recreation
- Impervious Surfaces (roads)
- Wetlands

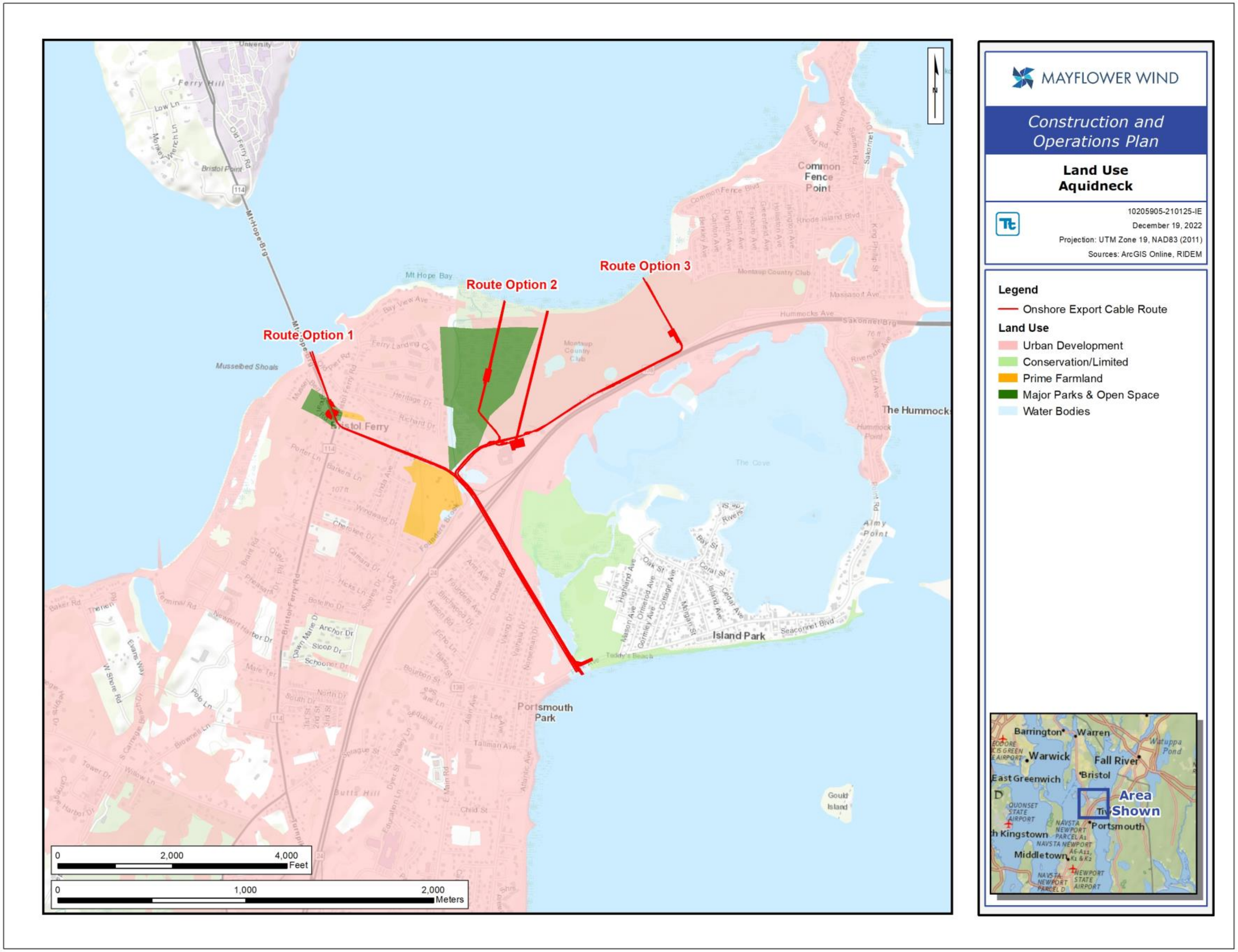


FIGURE 6-8. LAND USE WITHIN BRAYTON POINT ONSHORE PROJECT AREA – AQUIDNECK ISLAND

Landfall construction using HDD will be used to reduce or eliminate impacts to sensitive shoreline environments and nearshore areas of the Rhode Island coast. Potential effects to coastal habitats at the landfall location are further discussed in Section 6.5.

6.3.1.1.5 Brayton Point Landfall Location

The onshore components of the proposed Project in Somerset will originate from a landfall location in Somerset, Massachusetts (**Figure 6-9**). The two landfall locations currently under consideration include a preferred landfall (Western) from the Lee River on the western side of Brayton Point, and an alternate landfall (Eastern) from the Taunton River on the eastern side of Brayton Point (refer to Section 3, Description of Proposed Activities). Landfall construction using HDD will be used to reduce or eliminate impacts to the sensitive shoreline environments and nearshore areas of the Massachusetts coast. Both landfall locations' areas of likely disturbance are generally devoid of natural communities as they consist of roads and former industrial uses. Potential effects to coastal habitats at the landfall location are further discussed in Section 6.5.

6.3.1.1.6 Brayton Point Onshore Export Cable Route

The proposed onshore export cable route at Brayton Point will be installed within and below existing developed land to the converter station (**Figure 6-9**). As a result, some areas of previously disturbed and maintained roadside vegetation may be affected during construction. Tree and vegetation clearing is not expected for construction of onshore Project components at Brayton Point.

6.3.1.1.7 Brayton Point Converter Station

The converter station at Brayton Point will be constructed at the former Brayton Point Power Station in Somerset, Massachusetts (**Figure 6-9**). The converter station site is approximately 7.5 ac (3.0 ha) in size and primarily consists of disturbed and developed land that is currently not in use, but previously housed a coal-fired power plant that was decommissioned in 2017.

6.3.1.2 Terrestrial Wildlife and Plants

6.3.1.2.1 Habitats and Wildlife

Terrestrial habitats for wildlife in the Onshore Project Areas and immediate vicinity of the proposed Project include forested land, disturbed or developed land, wetland areas, grasslands, scrub-shrub areas, fragmented vegetated habitats, and coastal habitat. Although the habitats in the Onshore Project Area are predominately comprised of disturbed or developed lands, there are some relatively undisturbed lands in the vicinity in Falmouth. Wildlife species that occur in these undisturbed habitats may be affected by Project activities.

Representative wildlife species that are known or are likely to occur in areas potentially affected by Project components are discussed in this section and summarized in **Table 6-28**. Species that are federally or state-listed or are Massachusetts and Rhode Island Species of Concern are discussed in Section 6.3.1.2.2. Except for coastal habitats, the habitat matrix and associated wildlife species with potential to be affected by onshore Project components is expected to be generally similar across the Onshore Project Areas. Species known to commonly occur in coastal habitats and likely to occur in the vicinity of the potential landfall locations are discussed further in Sections 6.1 and 6.5.

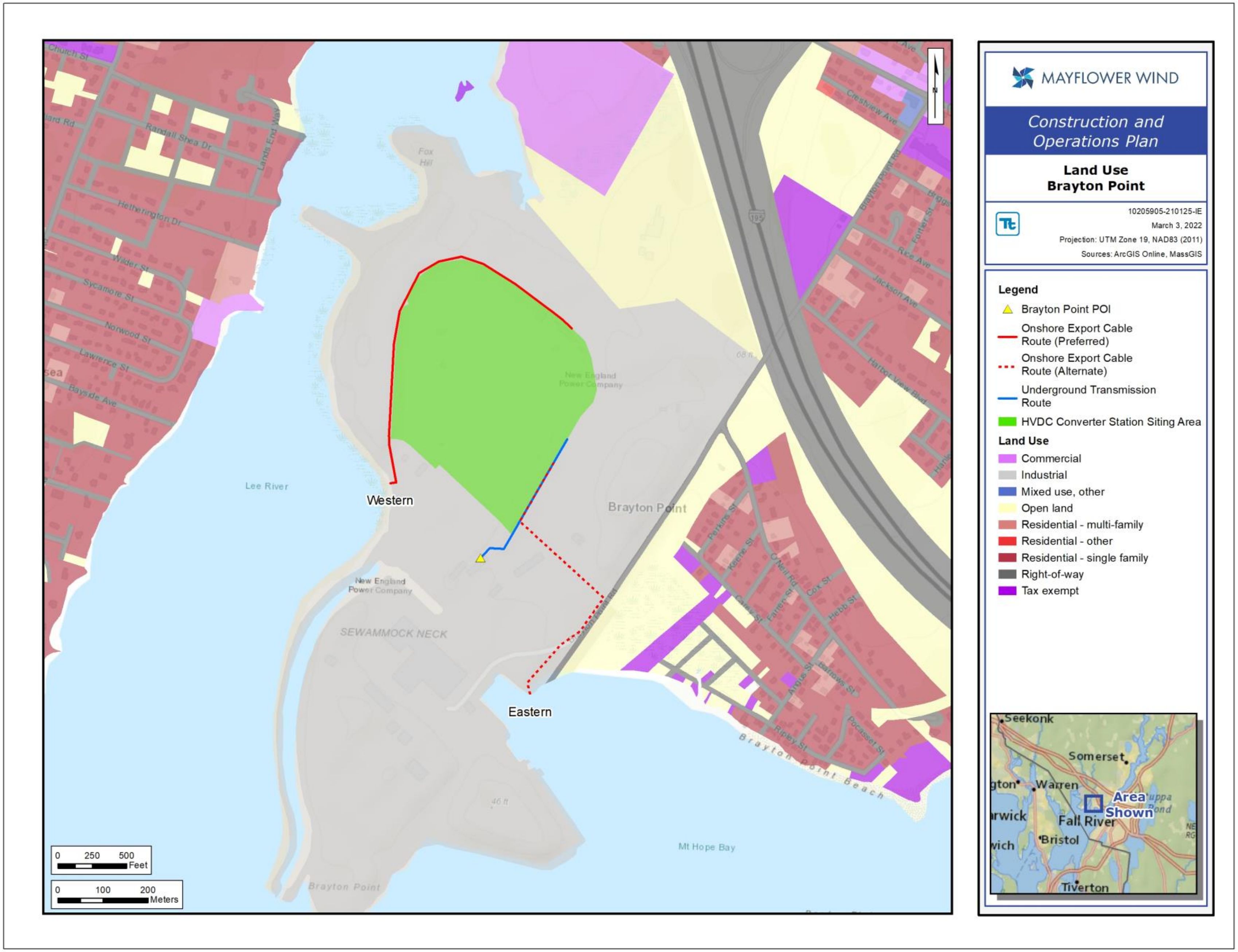


FIGURE 6-9. LAND USE WITHIN BRAYTON POINT ONSHORE PROJECT AREA

TABLE 6-28. REPRESENTATIVE TERRESTRIAL WILDLIFE SPECIES IN THE ONSHORE PROJECT AREAS

Common Name a/	Scientific Name	Habitat
Mammals b/		
Virginia opossum	*Didelphis virginiana*	Forest and open woodlands
Gray squirrel	*Sciurus carolinensis*	Forest and open woodlands
Meadow vole	*Microtus pennsylvanicus*	Grasslands
White-footed mouse	*Peromyscus leucopus*	Grasslands
Eastern coyote	*Canis latrans*	Forest and open woodlots
Striped skunk	*Mephitis mephitis*	Forest and open woodlots
Raccoon	*Procyon lotor*	Forest and open woodlots
White-tailed deer	*Odocoileus virginianus*	Forest and open woodlots
Birds b/		
Tree swallow	*Tachycineta bicolor*	Ponds and lakes
European starling	*Sturnus vulgaris*	Developed areas
American robin	*Turdus migratorius*	Open woodlots
American crow	*Corvus brachyrhynchos*	Open woodlots
Mourning dove	*Zenaida macroura*	Open woodlots
Red-winged blackbird	*Agelaius phoeniceus*	Wetlands
American goldfinch	*Spinus tristis*	Open woodlots
Chipping sparrow	*Spizella passerine*	Open woodlots
Dark-eyed junco	*Junco hyemalis*	Forests
Blue jay	*Cyanocitta cristata*	Forests
Black-capped chickadee	*Poecile atricapillus*	Forests
Reptiles		
Painted turtle	*Chrysemys picta*	Ponds and lakes
Spotted turtle	*Clemmys guttata*	Ponds and lakes
Eastern ribbon snake	*Thamnophis sauritus*	Wetlands
Northern water snake	*Nerodia sipedon*	Wetlands
Northern ring-necked snake	*Diadophis punctatus*	Open woodlots
Black racer	*Coluber contrictor*	Open woodlots
Amphibians		
Grey treefrog	*Hyla versicolor*	Wetlands
Spring peeper	*Pseudacris crucifer*	Ponds and lakes
Green frog	*Rana clamitans*	Wetlands
American bullfrog	*Lithobates catesbeianus*	Ponds and lakes
Spotted salamander	*Ambystoma maculatum*	Wetlands
Eastern red-backed salamander	*Plethodon cinereus*	Wetlands
Fowler's toad	*Anaxyrus fowleri*	Open woodlots
Fish		
Yellow perch	*Perca flavescen*	Ponds and lakes
Largemouth bass	*Micropterus salmoides*	Ponds and lakes
Chain pickerel	*Esox niger*	Ponds and lakes
Black crappie	*Pomoxis nigromaculatus*	Ponds and lakes
Bluegill	*Lepomis macrochirus*	Ponds and lakes

Common Name a/	Scientific Name	Habitat
Pumpkinseed	*Lepomis gibbosus*	Ponds and lakes

Notes:
*a/ Species listed on the federal Endangered Species Act or Massachusetts Endangered Species Act or Rhode Island Status Codes (under RIDEM) are presented in **Table 6-29** below.*
b/ List does not include coastal and marine bird species or bat species, which are discussed in Sections 6.1 and 6.2, respectively.

6.3.1.2.1.1 Mammals

The geographic ranges of 43 species of mammals encompass eastern Massachusetts (DeGraaf & Rudis, 1983), including 24 species of rodents, 7 species of bats, and larger species such as white-tailed deer (*Odocoileus virginianus*) and eastern coyote (*Canis latrans*). Surveys of Camp Edwards on JBCC, located in proximity to the onshore Project features in Falmouth, estimate 28 species of mammals inhabit the area, the most common of which is the white-footed mouse (*Peromyscus leucopus*) (MARNG, 2009). The Camp Edwards surveys identified that mammals prefer the mixed woodlots on the site, while they tend to avoid disturbed areas. White-tailed deer are an important recreational hunting species in the area, and Camp Edwards allows an annual hunting season for white-tailed deer to occur as a method of population management for this species within the military installation boundaries (MARNG, 2009). Similar species are anticipated to occur in the areas where the Brayton Point onshore Project components are sited in Somerset, Massachusetts and Portsmouth, Rhode Island.

6.3.1.2.1.2 Birds

Migratory birds are protected under the Migratory Bird Treaty Act and could potentially be affected by construction and operations activities in the Onshore Project Areas. A variety of bird species are supported by the landforms, habitats, and vegetative communities within the Commonwealth of Massachusetts. At least 78 species of birds are known to use the eastern portion of the state as a breeding area, many of which are neotropical migrants (Mass Audubon, 2011; DeGraaf & Rudis, 1983). Approximately 18 species use eastern Massachusetts as a wintering area and migrate to other portions of North America to breed in the spring. Approximately 56 species within the same area are considered permanent residents. These numbers are seasonally dependent as not all species use the same areas every year. Some of the species mentioned above may also be state-listed species, which are further discussed in Section 6.3.1.2.2.

Surveys conducted by the Massachusetts Army National Guard at the Camp Edwards site, located in proximity to the onshore Project features in Falmouth, identified 105 species of birds since annual surveys began in 1994 (MARNG, 2020a). Surveys traversed many different habitat types documenting all birds observed. Coastal and marine birds are further discussed in Section 6.1.

In addition to the state-listed species discussed in Section 6.3.1.2.2, the USFWS designates Birds of Conservation Concern that are identified as non-listed migratory and non-migratory bird species of high conservation priority. The Onshore Project Areas are in USFWS Region 5 and Bird Conservation Region 30. There are 28 Birds of Conservation Concern species in USFWS Region 5 and Bird Conservation Region 30 that have the potential to be affected by Project activities (Appendix J, Terrestrial Vegetation and Wildlife Assessment). The JBCC, located in proximity to the onshore Project features in Falmouth, is also designated as a National Audubon Society Important Bird Area (IBA). Significant concentrations of terrestrial bird species have been documented in the JBCC (e.g., during USGS Breeding Bird Surveys), including; grasshopper sparrow (*Ammodramus savannarum*), northern harrier (*Circus hudsonius*), northern parula (Parula americana), upland sandpiper sandpiper (*Bartramia longicauda*), vesper sparrow (*Pooecetes gramineus*), and eastern whip-poor-will (*Antrostomus vociferous*) (National Audubon Society, 2020a), all of which are also state-listed species and are discussed further in Section 6.3.1.2.2.

Migratory birds come to the Narragansett Bay region in the spring and fall, including nesting shorebirds (Save the Bay, 2018). The Brayton Point Onshore Project Area is directly adjacent to the Lee and Cole Rivers IBA, which is home to a significant population of waterfowl (National Audubon Society, n.d). The Lee and Cole Rivers IBA covers 2,569 ac (1,040 ha) and is at the opening of Mount Hope Bay (National Audubon Society, 2020a).

Avian species expected to be present in and in the vicinity of the Falmouth Onshore Project Area, including at the Falmouth preferred and alternate onshore substation sites, and Falmouth POI include species known to inhabit pine-oak forests, which is the dominant forest type found on Cape Cod and southeastern Massachusetts. Typical species include, but are not limited to; turkey vulture (*Cathartes aura*), sharp-shinned hawk (*Accipiter structus*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), wild turkey (*Meleagris gallopavo*), mourning dove (*Zeneida macroura*), northern saw-whet owl (*Aegolius acadicus*), downy woodpecker (*Picoides pubescens*), blue jay (*Cyanocitta cristata*), American crow (*Corvus brachyrhynchos*), fish crow (*Corvus ossifragus*), tufted titmouse (*Beeoloptus bicolor*), white-breasted nuthatch (*Sitta caroliniensis*), hermit thrush (*Catharus guttatus*), ovenbird (*Seiurus aurcopillus*), eastern towhee (*Pipilo erythrophthalmus*), yellow-rumped warbler (*Setophaga coronata*), eastern phoebe (*Sayornis phoebe*), and chipping sparrow (*Spizella passerine*) (DeGraaf and Yamasaki, 2001).

Avian species expected to be present in and in the vicinity of the Brayton Point Onshore Project Area typically inhabit coastal terrestrial habitats and include red knots (*Calidris canutus*), piping plovers (*Charadrius melodus*), wading birds, raptors, songbirds, sea ducks, shearwaters, petrels, storm-petrels (*Hydrobates pelagicus*), fulmars (*Fulmarus glacialis*), northern gannets (*Morus bassanus*), gulls, terns, cormorants, skuas, auks, and loons.

6.3.1.2.1.3 Reptiles and Amphibians

A total of 36 species of reptiles and amphibians are found within the eastern half of Massachusetts, including nine salamander species, seven turtle species, ten frog species, and ten snake species (DeGraaf & Rudis, 1981).

Surveys and incidental sightings at Camp Edwards, located in proximity to the onshore Project features in Falmouth, including surveys conducted in 1995 as part of the Massachusetts Herpetological Atlas Project (Jackson et al., 2010), identified 12 species of reptiles and 11 species of amphibians. Reptile species observed included five turtles and seven snakes. The most commonly observed amphibians included bullfrogs (*Rana catesbeiana*), green frogs (*Rana clamitans*), grey treefrogs (*Hyla versicolor*), wood frog (*Rana sylvatica*), and spring peepers (*Pseudacris crucifer*). American toads (*Bufo americanus*), spotted salamanders (*Ambystoma maculatum*), and eastern newts (*Notophthalmus viridescens*) were also frequently observed (MARNG, 2009). Many of these amphibians depend upon ephemeral wetlands (e.g., vernal pools) for breeding, egg laying, and egg, embryo and juvenile development. There are ponds and wetlands that occur within, and adjacent to, the onshore export cable route and transmission line. Potential effects to wetlands and waterbodies are further discussed in Section 6.4.

The Brayton Point Onshore Project Area, including the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island, is highly urbanized. As such, only species which have adapted to living in urban environments would likely utilize the area.

6.3.1.2.1.4 Fish

Perennial, deepwater aquatic habitats exist within the Falmouth Onshore Project Area, including one named freshwater pond (Sols Pond). The Falmouth Onshore Project Area crosses Sols Pond in Falmouth. This waterbody may provide habitat for warmwater fish species, such as yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis gibbosus*), and various smaller minnows and forage fish.

Coldwater fisheries (e.g., stream, river, tributaries), including those that support brook trout (*Salvelinus fontinalis*), are present on Cape Cod. However, according to areas mapped by MassGIS (2019), there are no mapped coldwater fisheries within the Onshore Project Areas.

As previously mentioned, the Rhode Island portion of the Brayton Point Onshore Project Area is largely urban environment. There are no mapped coldwater fisheries within the vicinity of the onshore export cable route which crosses through Aquidneck Island, Rhode Island and at Brayton Point in Somerset, Massachusetts.

Wetlands and waterbodies are discussed in Section 6.4, finfish are discussed further in Section 6.7, and commercial fisheries are discussed in Section 11.

6.3.1.2.1.5 Invertebrates

Invertebrates cover a broad range of taxonomic classifications of animals, including insects, arachnids, arthropods, mollusks, and crustaceans. Specific subclassifications (e.g., butterflies, moths, dragonflies, damselflies) have been studied extensively in Camp Edwards because many are unique, rare, and/or sensitive to habitat disturbances. Surveys within the Camp Edwards area, located in proximity to onshore Project features in Falmouth, identified 528 species of moths and butterflies, most of which were observed in the pitch pine-oak forest community present at Camp Edwards (MARNG, 2009). A recent two-year study completed in the JBCC identified a total of 634 species of moths, 40 butterflies, 63 beetles (including two tiger beetles), and 14 species of odonates (e.g., dragonflies, damselflies) (Mello, 2018).

The beach dune tiger beetle (*Cicindela hirticollis*) and salt marsh tiger beetle (*Ellipsoptera marginate*) are Rhode Island state threatened species within or near the Brayton Point Onshore Project Area. These beetles are threatened due to habitat disturbance form humans, tidal erosion, and sea level rise (Leonard and Bell, 1999).

Dragonflies and damselflies are known to occur within freshwater aquatic habitats occurring near the Falmouth Onshore Project Area. These species depend on perennial, deepwater habitat such as ponds and inundated marshes for larval development, and will use a variety of terrestrial and wetland habitats during adulthood for foraging and mating.

6.3.1.2.2 Federally and State-Listed Species

Species protected by the ESA and/or MESA with the potential to be present in the Onshore Project Areas, based on their geographic ranges and occurrence records from the USFWS IPaC tool (USFWS, n.d.) and MassWildlife NHESP data (MassWildlife, 2020a) for the towns of Falmouth and Somerset Massachusetts, and the town of Portsmouth, Rhode Island are discussed in the sections below and summarized in **Table 6-29**.

TABLE 6-29. FEDERALLY AND STATE-LISTED TERRESTRIAL WILDLIFE AND PLANT SPECIES WITH POTENTIAL TO OCCUR IN THE ONSHORE PROJECT AREAS

Common Name	Scientific Name	Federal (ESA or BGEPA) a/	State (MESA) a/	State (RIDEM)
Mammals				
Eastern small-footed bat	*Myotis leibii*	-	E	-
Little brown bat	*Myotis lucifugus*	c/	E	-
Northern long-eared bat b/	*Myotis septentrionalis*	T	E	-
Tri-colored bat b/	*Perimyotis subflavus*	P	E	-
Birds b/				
Common loon	*Gavia immer*	-	SC	-
Pied-billed grebe	*Podilymbus podiceps*	-	E	-
Roseate tern	*Sterna dougallii*	E	E	E
Common tern	*Sterna hirundo*	-	SC	-
Arctic tern	*Sterna pardiasaea*	-	SC	-
Least tern	*Sternula antillarum*	-	SC	ST
Upland sandpiper	*Bartramia longicauda*	-	E	-
Red knot	*Calidris canutus rufa*	T	T	-
Piping plover	*Charadrius melodus*	T	T	SE
Northern harrier	*Circus hudsonius*	-	T	-
Peregrine falcon	*Falco peregrinus*	-	T	-
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	T	-
Long-eared owl	*Asio otus*	-	T	-
Eastern whip-poor-will	*Antrostomus vociferous*	-	SC	-
Grasshopper sparrow	*Ammodramus savannarum*	-	T	-
Northern parula	*Parula americana*	-	T	-
Vesper sparrow	*Pooecetes gramineus*	-	T	-
Eastern meadowlark	*Sturnella magna*	-	SC	-
Seaside sparrow	*Ammodramus maritimus*	-	-	SC
Gadwall	*Anas strepera*	-	-	SC
Great egret	*Ardea alba*	-	-	SC
Cattle egret	*Bubulcus ibis*	-	-	SC
Little blue heron	*Egretta caerulea*	-	-	SC
Snowy egret	*Egretta thula*	-	-	SC
American oystercatcher	*Haematopus palliates*	-	-	SC
Least bittern	*Ixobrychus exilis*	-	-	ST

Common Name	Scientific Name	Federal (ESA or BGEPA) a/	State (MESA) a/	State (RIDEM)
Black-crowned night heron	*Nycticorax nycticorax*	-	-	SC
Least tern	*Sterna antillarum*	-	-	ST
Barn owl	*Tyto alba*	-	-	SE
Glossy ibis	*Plegadis falcinellus*	-	-	SC
Reptiles				
Diamond-backed terrapin	*Malaclemys terrapin*	-	T	-
Northern red-bellied cooter	*Pseudemys rubriventris* pop. 1 (Federal = *bangsi*)	E	E	-
Eastern box turtle	*Terrapene carolina*	-	SC	-
Eastern hog-nosed snake	*Heterodon platirhinos*	-	SC	-
Amphibians				
Marbled salamander	*Ambystoma opacum*	-	T	-
Eastern spadefoot	*Scaphiopus holbrookii*	-	T	-
Northern leopard frog	*Lithobates pipiens*	-	-	SC
Invertebrates				
Coastal heathland cutworm	*Abargrotis nefascia*	-	SC	-
Barrens dagger moth	*Acronicta albarufa*	-	T	-
Frosted elfin	*Callophrys irus*	-	SC	-
Gerhard's sack bearer	*Catocala Herodias gerhardi*	-	SC	-
Cow path tiger beetle	*Cicindela purpurea*	-	SC	-
Melsheimer's sack bearer	*Cicinnus melsheimeri*	-	T	-
Chain dot geometer	*Cingilia catenaria*	-	T	-
Collared cycnia	*Cycnia collaris*	-	T	-
The pink-streak	*Dargida rubripennis*	-	T	-
Imperial moth	*Eacles imperialis*	-	T	-
Scrub euchlaena	*Euchlaena madusaria*	-	SC	-
Slender clarwing sphinx	*Hemaris gracilis*	-	SC	-
Buck moth	*Hemileuca maia*	-	SC	-
Pine barrens lycia	*Lycia ypsilon*	-	T	-
Heath metarranthis	*Metarranthis pilosaria*	-	SC	-
Water-willow stem borer moth	*Papaipema sulphurata*	-	T	-
Pink sallow moth	*Psectraglaea carnosa*	-	SC	-
Pine barrens speranza	*Speranza exonerata*	-	SC	-
Pine barrens zale	*Zale lunifera*	-	SC	-
Herodias underwing moth	*Catocala herodias*	-	SC	-
Scarlet bluet	*Enallagma pictum*	-	T	-
Pine barrens bluet	*Enallagma recurvatum*	-	T	-
Beach-dune tiger beetle	*Cicindela hirticollis*	-	-	ST
Salt marsh tiger beetle	*Ellipsoptera marginate*	-	-	ST
Plants				
Purple milkweed	*Asclepias purpurascens*	-	T	-

Common Name	Scientific Name	Federal (ESA or BGEPA) a/	State (MESA) a/	State (RIDEM)
Wright's panic-grass	*Dichanthelium writhtianum*	-	SC	-
Ovate spike-sedge	*Eleocharis ovata*	-	E	-
Saltpond pennywort	*Hydrocotyle verticillata*	-	T	-
Creeping St. John's-wort	*Hypericum adpressum*	-	T	-
Weak rush	*Juncus debilis*	-	E	-
Redroot	*Lachnanthes caroliana*	-	SC	-
Saltpond grass	*Leptochloa fusca ssp. fascicularis*	-	T	-
New England blazing star	*Liatris scariosa var. novae-angliae*	-	SC	-
Dwarf bulrush	*Lipocarpha micrantha*	-	T	-
Climbing fern	*Lygodium palmatum*	-	SC	-
Bayard's green Adder's-mouth	*Malaxis bayardii*	-	E	-
Pondshore knotweed	*Persicaria puritanorum*	-	SC	-
Sea-beach knotweed	*Polygonum glaucum*	-	SC	-
Adder's tongue fern	*Ophioglossum pusillum*	-	T	-
Prickly pear	*Opuntia humifusa*	-	E	-
Short-beaked bald-sedge	*Rhynchospora nitens*	-	T	-
Long-beaked bald-sedge	*Rhynchospora scirpoides*	-	SC	-
Plymouth gentian	*Sabatia kennedyana*	-	SC	-
Terete arrowhead	*Sagittaria teres*	-	SC	-
Papillose nut sedge	*Scleria pauciflora*	-	E	-
Bristly foxtail	*Setaria parviflora*	-	SC	-
American sea-blite	*Suaeda calceoliformis*	-	SC	-
Broad Tinker's-weed	*Triosteum perfoliatum*	-	E	-
Resupinate bladderwort	*Utricularia resupinate*	-	T	-
Yellow thistle	*Cirsium horridulum var. horridulum*	-	-	ST
Black ash	*Fraxinus nigra*	-	-	SC
Herb-Robert	*Geranium robertianum*	-	-	SC
Seabeach-sandwort, sea-purslane, sea-chickweed	*Honckenya peploides ssp. robusta*	-	-	SC
Small purple fringed orchid	*Platanthera psycodes*	-	-	SC
Seaside-knotweed	*Polygonum glaucum*	-	-	ST
Atlantic mock bishop's-weed	*Ptilimnium capillaceum*	-	-	SC
Sesame-grass	*Tripsacum dactyloides*	-	-	SC
Early yellow violet	*Viola rotundifolia*	-	-	SE

Notes:

a/ BGEPA = Bald and Golden Eagle Protection Act; ESA = Endangered Species Act; MESA = Massachusetts Endangered Species Act; E = Endangered; T = Threatened; SC = Special Concern; Rhode Island Status Codes (under RIDEM) SE= State Endangered, ST= Sate Threatened, SC= Special Concern "-" = not listed.

b/ Coastal and marine species are discussed in Section 6.1.

c/ Species is currently under USFWS discretionary review and is likely to be petitioned for listing.

Federally listed species: Five federally listed faunal species may occur in Falmouth, Massachusetts and have the potential to be present within the Falmouth Onshore Project Area, including northern long-eared bat (*Myotis septentrionalis*), roseate tern (*Sterna dougallii dougallii*), rufa red knot (*Calidris canutus rufa*), piping plover (*Charadrius melodus*), and northern red-bellied cooter (*Pseudemys rubriventris pop. 1*). All five species are also listed under the MESA. Coastal and marine birds are further discussed in Section 6.1, and federally listed bats are discussed further in Section 6.2.

In Massachusetts, the northern red-bellied cooter primarily inhabits freshwater ponds and rivers with abundant aquatic vegetation, logs, rocks, and vegetation mats that are used as basking sites. The species has also been documented in manmade reservoirs and cranberry bogs (MassWildlife, 2016). Cooters nest in exposed sand and in gravel, lawns, gardens, and roadsides that are near ponds and rivers. There are ponds and wetlands that occur within, and adjacent to, onshore export cable routes and transmission line. Potential effects to wetlands and waterbodies are further discussed in Section 6.4.

Within the Brayton Point Onshore Project Area, four federally listed faunal species may have potential occurrence within the Onshore Project Area: piping plover, roseate tern, rufa red knot, and northern long-eared bat. Two of these are listed under the RINHP, the piping plover and roseate tern.

State-listed species: According to the NHESP, portions of the proposed Falmouth Onshore Project Area on upper Cape Cod as well as portions of the proposed Brayton Point Onshore Project Area overlap Priority and Estimated Habitats of Rare Species (**Figure 6-10**). These habitats may include those defined for state-listed species, including those listed in **Table 6-29** above, but species-specific information is not public. Potential effects to state-listed bats are discussed in Section 6.2.

According to RIDEM, portions of the proposed Project on Aquidneck Island overland Rhode Island Natural Heritage Areas (**Figure 6-11**). These habitats may include those defined for state-listed species, including those listed in **Table 6-29** above, but species-specific information is not public.

6.3.1.2.2.1 Mammals

Three state-listed mammal species that are not federally listed have the potential to occur in the Onshore Project Areas, including eastern small-footed bat (*Myotis leibii*), little brown bat (*Myotis lucifugus*), and tri-colored bat (*Perimyotis subflavus*). State-listed bats are discussed further in Section 6.2.

6.3.1.2.2.2 Birds

There are 18 state-listed bird species with the potential to occur in the Falmouth Onshore Project Area and 23 state-listed bird species with the potential to occur in the Brayton Point Onshore Project Area, including the underground export cable route on Aquidneck Island (**Table 6-29**), including roseate tern, common tern (*Sterna hirundo*), least tern (*Sternula antillarum*), piping plover, and eastern whip-poor-will. Roseate tern, common tern, least tern, and piping plover are considered coastal and marine birds which are further discussed in Section 6.1. The eastern whip-poor-will has the potential to occur within and adjacent to the Onshore Project Area based on distribution of the species, publicly available records of occurrence (e.g., eBird, 2020; Mass Audubon, 2011; USGS, n.d.; National Audubon Society, 2020b), and potentially suitable habitat throughout upper Cape Cod. The eastern whip-poor-will is a nocturnal woodland nightjar. Habitat preference is not fully understood. However, they are known to use dry, open woodlands with little understory for nesting and which are adjacent to meadows and shrublands that are used for foraging (Peterson, 2010).

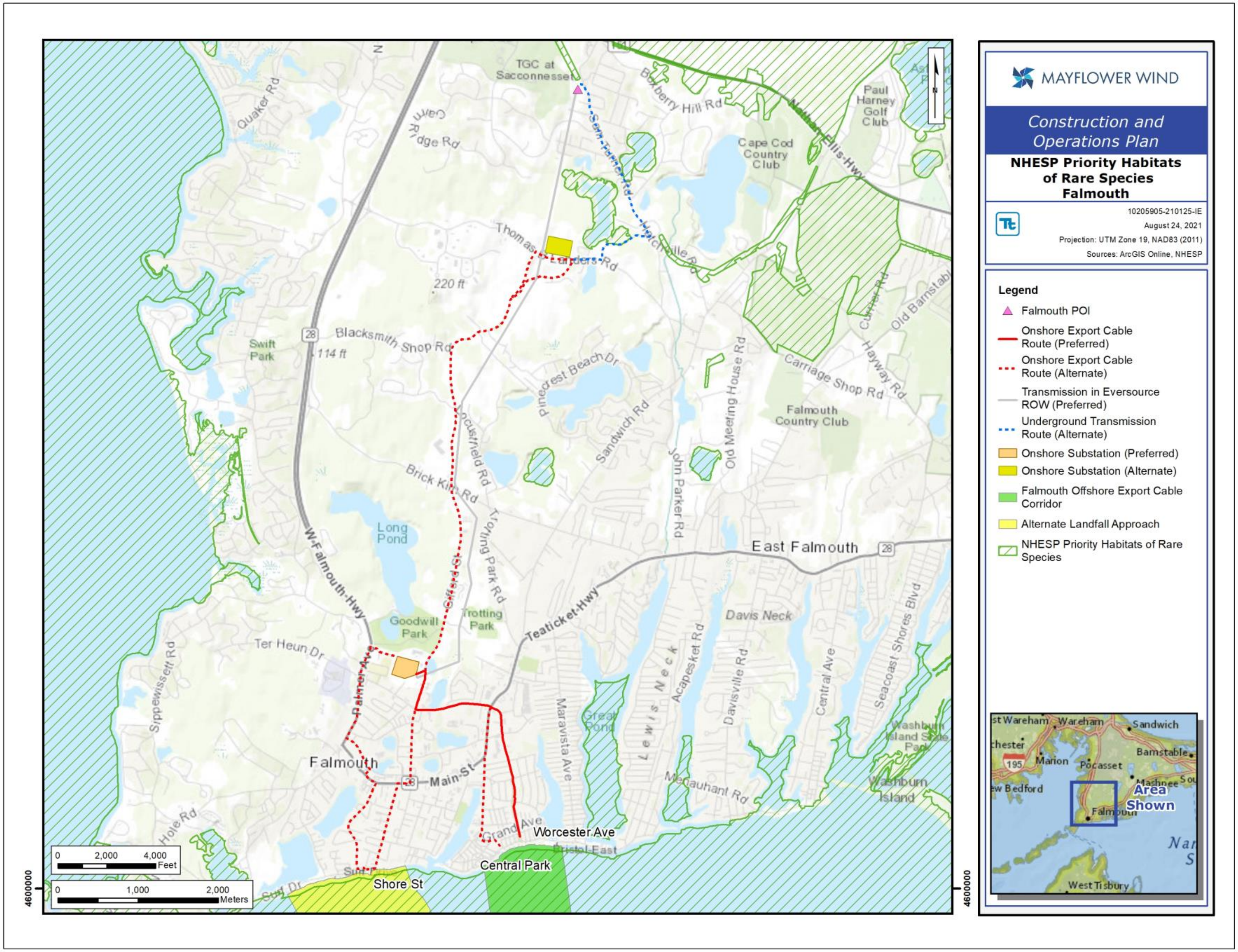


FIGURE 6-10. NHESP PRIORITY HABITATS IN THE VICINITY OF THE FALMOUTH ONSHORE PROJECT AREA

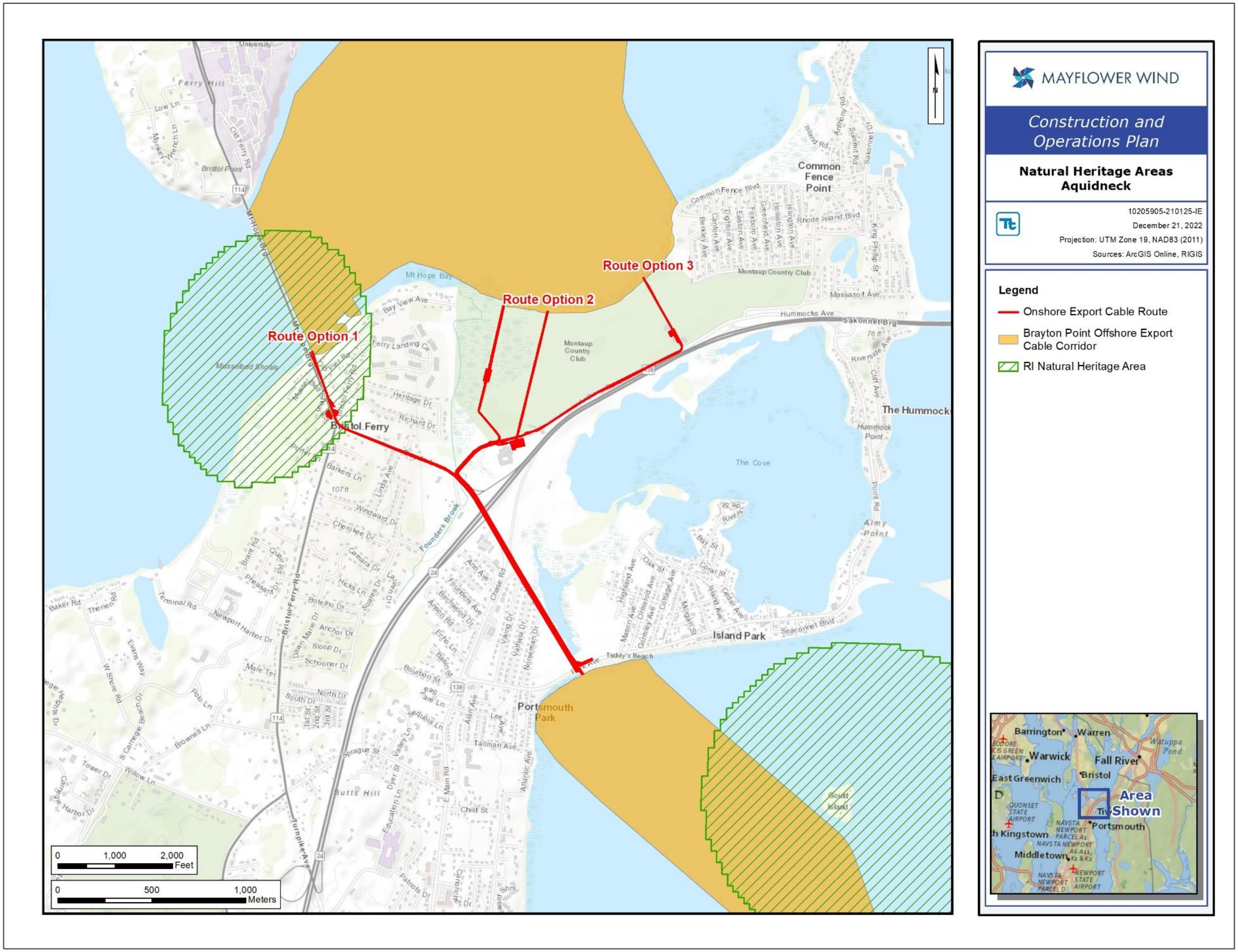


FIGURE 6-11. NATURAL HERITAGE AREAS IN THE VICINITY OF THE BRAYTON POINT ONSHORE PROJECT AREA – AQUIDNEK ISLAND

Other state-listed birds may also be present in the Onshore Project Areas and immediate vicinity based on their ranges and through a review of publicly available information (e.g., eBird 2020; Mass Audubon, 2011; USGS, n.d; National Audubon Society, 2020b). These include bald eagle, northern harrier, peregrine falcon (*Falco peregrinus*), pied-billed grebe (*Podilymus podiceps*), upland, grasshopper sparrow, northern parula, and eastern meadowlark (*Sturnella magna*). The Bald eagle is also federally protected by the Bald and Golden Eagle Protection Act and is also listed as threatened under the MESA.

Bald eagles are found year-round in Massachusetts, primarily in terrestrial environments near water, and the statewide breeding population is increasing (MassWildlife, 2020b). Bald eagles are known to forage near Cape Cod and typically inhabit areas within 1.0 mi (1.6 km) of large waterbodies where they forage for food. Bald eagles typically nest in tall trees for their large nests. A bald eagle nest had not been seen in Barnstable County in over 115 years, until Spring 2020 when a new bald eagle nest was observed on Cape Cod in Barnstable, Massachusetts. This may be attributed to the lack of tourist activity seen during the Spring of 2020 due to the COVID-19 pandemic or simply due to the increasing number of bald eagles overall in the region (MassWildlife, 2020b). No known bald eagle nesting sites are in the Onshore Project Areas (MassWildlife, 2020b).

6.3.1.2.2.3 Reptiles

There are four state-listed reptiles with the potential to occur in the Falmouth Onshore Project Area. Two of the four species were identified as potentially occurring in the Falmouth Onshore Project Area based on potentially suitable habitat, including eastern box turtle (*Terrapene carolina*) and eastern hog-nosed snake (*Heterodon platirhinos*). There are no reptiles of concern within or near the Brayton Point Onshore Project Area.

The eastern box turtle is a terrestrial turtle that occurs within a wide variety of habitats, including both dry and moist woodlands, brushy fields, thickets, marshes, bogs, and stream banks. On Cape Cod, the optimal habitat for this species includes pine barrens and oak thickets, interspersed with huckleberry ground cover, low bush blueberries, and thickets of bracken fern (MassWildlife, 2015a).

Between 2001 and 2009, approximately 170 individual eastern box turtles have been recorded at Camp Edwards (located in proximity to onshore Project features in Falmouth, Massachusetts), of which 46 were marked and transmitters attached to 10, in order to gain information on habitat usage and behavior. These data revealed a roughly equal usage of habitat types throughout Camp Edwards and JBCC (MARNG, 2009).

The eastern hog-nosed snake can be found in both forested and non-forested areas, typically favoring forest edge habitats dominated by pitch pine and scrub oak, blueberry, white pine, huckleberry, and other herbaceous communities. Habitat also includes glacial outwash plains and areas with abundant ground debris, including rock piles. They may also be associated with wetlands, as their primary prey (toads) occur in these areas.

6.3.1.2.2.4 Amphibians

Three state-listed amphibian species have the potential to occur in the Onshore Project Areas, including Marbled salamander (*Ambystoma opacum*), eastern spadefoot toad (*Scaphiopus holbrookii*) and northern leopard frog (*Lithobates pipiens*). One state-listed amphibian species, the eastern spadefoot toad, was identified as potentially occurring in the Onshore Project Areas based on potentially suitable habitat. This burrowing species prefers habitats that consist of dry, sandy, loam soils which are characteristic of pitch pine barrens, coastal oak woodlands, or shrubby areas interspersed with temporary ponds (MassWildlife, 2015b). During the winter, they hibernate by burrowing up to 8 ft (2.4 m) underground and come out to mate during the warm weather months. This species is dependent on ephemeral wetlands and vernal pools for breeding and completion of its larval development. One known amphibian of concern has the potential to occur in the Brayton Point Onshore Project Area at Aquidneck Island, the northern leopard frog (RIDEM, personal communication, June 24, 2021). They can be found in a variety of aquatic habitats that include slow moving or still water along streams, rivers, wetlands vernal pools and even human created habitats.

6.3.1.2.2.5 Invertebrates

There are 22 species of invertebrates with the potential to occur in the Falmouth Onshore Project Area. Of these 22 invertebrate species, 11 were identified as potentially occurring in the Falmouth Onshore Project Area based on potentially suitable habitat. Surveys and studies near the Falmouth Onshore Project Area in Camp Edwards have documented that state-listed butterflies and moths prefer grasslands and the pitch pine-oak natural community because scrub oak and heath are the primary host or forage plant for numerous moth species (MARNG, 2020b). Two moth species, water-willow stem borer moth (*Papaipema sulphurata*) and heath metarranthis (*Metarranthis pilosaria*), are considered wetland-dependent as they use wetland obligate plant species waterwillow (*Decodon verticillatus*) and cranberry (*Vaccinium macrocarpon*) as their host or forage plants.

Only one odonate (damselfly), the pine barrens bluet (*Enallagma recurvatum*), was identified by the NHESP as potentially occurring within or in the vicinity of the Falmouth Onshore Project Area based on potentially suitable habitat. The pine barrens bluet primarily occurs in coastal plain ponds and their presence in an area depends upon the distribution and characteristics of the ponds, which typically include sandy shores, heavy vegetation close to the shore, and annual water level fluctuations. The nymphs are aquatic, and the adults inhabit the coastal shoreline and nearby uplands.

Through correspondence with RIDEM, it was determined that the state-threatened beach dune tiger beetle (*Cicindela hirticollis*) and salt marsh tiger beetle (*Ellipsoptera marginate*) may occur within or near the Brayton Point Onshore Project Area in Rhode Island. Adult tiger beetles may emerge in the fall, feed until cold weather, and then burrow underground for the winter. They then emerge again in the spring to feed, mate, and lay eggs. These beetles are threatened due to habitat disturbance form humans, tidal erosion, and sea level rise (Leonard and Bell, 1999).

6.3.1.2.2.6 Plants

There are 25 state-listed plant species with the potential to occur in the Falmouth Onshore Project Area. Four of the 25 species were identified as potentially occurring in the Falmouth Onshore Project Area based on potentially suitable habitat, including saltpond pennywort (*Hydrocotyle verticillata*), sea-beach knotweed (*Polygonum glaucum*), broad Tinker's-weed (*Triosteum perfoliatum*), and adder's tongue fern (*Ophioglossum pusillum*). Saltpond pennywort and sea-beach knotweed occur in coastal habitats and are discussed further in Section 6.5.

The broad Tinker's-weed (*Triosteum perfoliatum*) and adder's tongue fern (*Ophioglossum pusillum*) have been identified during surveys at Camp Edwards on JBCC (MARNG, 2020c). The broad Tinker's-weed can be found in dry, open woods, usually shunning heavy shade. There are only three known stations in Massachusetts where this plant is growing, all in the upper Cape Cod region (MassWildlife, 2015c).

Adder's tongue fern can be found in boggy meadows, on the borders of marshes, within wet fields, and moist woodland clearings where there is ample sun availability (MassWildlife, 2019).

There are nine species of plants that are of concern in the area of Aquidneck Island. Round leaf yellow violet (*Viola rotundifolia)*, a state endangered species in Rhode Island, is a low growing perennial native to the northeastern U.S. found in wooded areas. Sea-beach knotweed (*Polygonum glaucum),* classified as threatened in the state, occurs in coastal habitats and has also been identified in the Brayton Point Onshore Project Area in Rhode Island. Sea-beach sand wort (*Honckenya peploides ssp. Robusta)* another coastal plant in the area is common along ocean shoreline in sandy, rocky or gravel substrate (Native Plant Trust, 2021). The sand wort is of special concern according to RIDEM. Project activities onshore are not likely to affect these plants due to the minimal anticipated shoreline disturbance.

Based on the mapped and observed habitats on site, the likelihood that portions of the Onshore Project Areas may serve as a resource for a protected species is very low or low for a majority of the Falmouth Onshore Project Area, as well as the Brayton Onshore Project Area.

6.3.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

Impact Producing Factors relating to terrestrial vegetation and wildlife are summarized in **Table 6-30**.

TABLE 6-30. IPFS AND POTENTIAL EFFECTS TO TERRESTRIAL VEGETATION AND WILDLIFE

IPF	Potential Effects		Period of Effect		
	Project Components		Project Phase		
	Landfalls and Onshore Export Cable Routes	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Ground Disturbance	Habitat loss/fragmentation	Habitat loss/fragmentation	X	X	X
Introduced Sound	Behavioral disturbance and displacement	Behavioral disturbance and displacement	X	X	X
Changes in Ambient Lighting	Displacement/attraction	Displacement/attraction	X	X	X
Changes in Ambient EMF	Behavioral disturbance	Behavioral disturbance	-	X	-
Actions that may cause direct injury or death of biological resources: Operation of Equipment and Heavy Machinery	Collision with equipment and heavy machinery	Collision with equipment and heavy machinery	X	X	X
Planned Discharges	Disruption of water flow or alteration of turbidity	-	X	-	X
Accidental Events	Release of hazardous materials into environment	Release of hazardous materials into environment	X	X	X

6.3.2.1 Ground Disturbance

6.3.2.1.1 Construction

As described in Section 6.3.1.1 above, onshore Project components are proposed to be sited in existing ROWs and previously disturbed or developed habitats which will minimize the loss and fragmentation of sensitive habitats or known habitats for federally or state-listed species. Ground disturbance activities will be required during the construction phase across the majority of the Onshore Project Areas, which will occur predominately within areas that have been formerly disturbed. The onshore export cable routes will be located within existing paved public roadways and the preferred location for the onshore substation in Falmouth will be within an active sand and gravel pit. The preferred location for the converter station at Brayton Point will be located within the footprint of the former Brayton Point Power Station.

Ground disturbance activities within the underground portion of the proposed Project will involve the cutting of roadway, the excavation of ground under the roadway, the installation of the underground cables, backfill, and the resurfacing of the roadway.

Construction of the onshore substation and converter station will result in ground disturbance, including grading to create a level working surface and the creation of additional impervious surfaces. Vegetation clearing would likely be minimal for the preferred Lawrence Lynch site and the alternate Cape Cod Aggregates site in Falmouth and converter station site and onshore Project components in Somerset. If tree clearing is required for the installation of onshore Project components, Mayflower Wind will conduct habitat assessments and presence/absence surveys and will coordinate with MassWildlife, RIDEM, and USFWS as appropriate.

Additionally, Mayflower Wind will train construction staff on biodiversity management and environmental compliance requirements.

6.3.2.1.2 Operations and Maintenance

No additional ground disturbance will occur during Project O&M activities for the lifespan of the proposed Project. No additional ground disturbance is expected at the onshore substation, and converter station, with the exception of ongoing maintenance to maintain vegetative cover and repair areas where erosion is evident. Should repair or replacement of equipment be necessary, ground disturbing activities will be expected to be similar to those characterized for construction during the temporary duration required for the repair or replacement activity to occur.

6.3.2.1.3 Decommissioning

Minimal decommissioning work is planned for the onshore Project components. However the removal of onshore export cables or the underground transmission route may occur, if required. Ground disturbance activities within the underground portion of the proposed Project would be minimal or nonexistent as sections of the underground cables will likely be cut and pulled out of the duct bank from the underground splice vault locations, or remain in place. Any ground disturbance will be limited to areas where work is directly performed, if required. Therefore, the effects will be local and temporary. The onshore substation and converter station will likely remain in place and be repurposed.

6.3.2.2 Introduced Sound

6.3.2.2.1 Construction

Potential negative effects may include behavioral disturbance and temporary displacement of wildlife species. Because onshore Project components were primarily sited within areas that are previously disturbed or undergoing active management, construction noise is not expected to cause long-term displacement. Introduced sound at the landfall location will primarily be from the use of HDD and the operation of machinery transporting equipment for the installation of the onshore export cables (see Section 3.3.6, Sea-to-Shore Transition, and Appendix U1, In-Air Acoustic Assessment). Construction noise will result from the operation of construction equipment and heavy machinery across the proposed Project alignment and at the onshore substation and converter station sites. During the construction stage, noise from activities will be limited to areas where work is directly being performed (e.g., local) and will be temporary and short-term.

6.3.2.2.2 Operations and Maintenance

Noise during O&M of the proposed Project will typically be confined to the areas surrounding the onshore substation or converter station, and it is anticipated to have little to no effects on wildlife resources. There will be little to no noise associated within the operation of the onshore substation and converter station, and no noticeable noise associated with the operation of the onshore export cables and the underground transmission routes.

6.3.2.2.3 Decommissioning

During the decommissioning stage, noise will result from the operation of removal equipment and heavy machinery across the Project sites (e.g., landfall, onshore substation, converter station, and onshore export cable routes). However, decommissioning is expected to be minimal or nonexistent for most of the onshore Project components that will be left in place and repurposed (e.g., onshore substation and converter station). If decommissioning or demolition of facilities is required, such decisions will be made in consultation with the community.

6.3.2.3 Changes in Ambient Lighting

6.3.2.3.1 Construction

Changes to ambient light during the construction stage of the proposed Project will consist of any lighting needed during construction activities. Construction lighting is typically used if there is not sufficient daylight during work hours or if a construction activity is planned that requires 24-hour operations (such as the HDD) or must be executed in a continuous manner until complete (such as the pouring of a concrete foundation) and would extend past daylight hours. Construction lighting will be accomplished in a manner consistent with the Massachusetts Energy Facilities Siting Board (MA EFSB) and Rhode Island Energy Facility Siting Board (RI EFSB)'s required construction management plans.

6.3.2.3.2 Operations and Maintenance

Changes to ambient lighting during operations may consist of security lighting for the proposed onshore substation, and converter station. This will have little to no effect on the surrounding wildlife population but may cause some animals to be attracted to or avoid the additional light sources. This effect will be direct and localized to the areas surrounding the substation, POIs, and converter station. This lighting is anticipated to have less of an effect on wildlife resources than security lighting for the onshore substation and converter station, as these lights will be installed on the poles at a significant height above the ground and would only be likely to have a minimal effect on nocturnal avian or bat species. Potential effects on bats are further described in Section 6.2.

6.3.2.3.3 Decommissioning

There may be a need for additional temporary and localized lighting during decommissioning activities if certain activities cannot be performed during daylight hours. If Project facilities are decommissioned, security lighting will be removed from the onshore substation and converter station facilities, which will reduce ambient light in the area of the Project. However, decisions regarding the decommissioning or demolition of facilities will be made in consultation with the community.

6.3.2.4 Changes in Ambient Electric and Magnetic Fields

6.3.2.4.1 Operations and Maintenance

Generally, EMFs generated by powerlines (e.g., electrical transmission lines) are highest immediately around the line and diminish rapidly with distance away from the source (Fernie & Reynolds, 2005). The effects of a change in ambient EMF have been the subject of recent widespread debate in the biological community and some studies have shown that EMFs may influence the development, reproduction, and physiology of insects and mammals (Balmori, 2010; Burchard et al., 1996; Greenberg et al., 1981). Other studies have indicated that EMFs from powerlines may affect avian behavior and reproductive success; however, effects vary by species and level of exposure (Fernie & Reynolds, 2005). Most studies have concluded that transmission lines and electrical substations emit extremely low frequency EMFs that generally have little appreciable effect on the health, behavior, or productivity of terrestrial wildlife and plants (Berger, 2010). In addition, studies performed to date have found little evidence of EMF effects on fauna at levels below the International Commission on Non-Ionizing Radiation Protection's guideline levels (ICNIRP, 2020; Redlarski et al., 2015; WHO, 2005). The Onshore EMF Assessment completed for the proposed Project indicates that magnetic fields generated by the onshore export cables and underground transmission route are expected to be below the International Commission on Non-Ionizing Radiation Protection's health-based guideline of 2,000 milligauss for continuous exposure for humans (see Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project for further details). The onshore export cables from landfall to the onshore substation and the alternate underground transmission line in Falmouth, as well as the onshore export cables from the landfall to the converter station and underground transmission route at Brayton Point are not anticipated to disturb most terrestrial wildlife species or plants due to the depth at which the cables will be buried (e.g., 3.0 ft [0.9 m]). Some EMF may be produced by the onshore substation and converter station; however, studies indicate that such electrical facilities emit extremely low frequency EMFs and it is anticipated that plants or wildlife in vicinity of the onshore substation and converter station would sustain long-term exposure (Berger, 2010). Therefore, potential effects to terrestrial wildlife and plants from changes in EMF are anticipated to be minor and dependent on level of exposure to EMF.

6.3.2.5 Operation of Equipment and Heavy Machinery

6.3.2.5.1 Construction

Direct injury or fatalities may occur as a result of the operation of equipment and heavy machinery during construction activities. For example, species that are unable to move away from disturbed areas (e.g., avian nests) or occupy single trees that are removed (e.g., invertebrates) may be affected. Mayflower Wind will, to the extend practicable, conduct construction activities outside of periods when highly sensitive species are likely to be present. Additionally, vehicle speed limits will be enforced at all Project sites to minimize potential for vehicle collisions with wildlife. Due to the short term and localized nature of this potential effect as well as the proposed avoidance, minimization, and/or mitigation measures (see Section 6.3.2.9), population level effects to vegetation or wildlife resources are not anticipated.

6.3.2.5.2 Operations and Maintenance

The potential for direct injury or fatalities of terrestrial vegetation and wildlife resources during the operations stage of the proposed Project is anticipated to be less than the potential during construction activities. However, routine O&M activities, including vegetation management, may result in direct injury or fatalities. This potential effect is anticipated to be mitigated through BMPs and specific avoidance, minimization, and/or mitigation measures under a required ROW Vegetation Management Plan that would be submitted to and approved by relevant state agencies.

6.3.2.5.3 Decommissioning

Heavy equipment use is expected to be limited during decommissioning. As described above, use of this equipment could result in localized and short-term effects to terrestrial vegetation and wildlife through direct injury or fatality. However, as onshore Project structures are largely anticipated to be abandoned in situ or re-purposed, heavy equipment use and the associated potential effect to terrestrial vegetation and wildlife is anticipated to be less than that associated with construction or operations of the proposed Project.

6.3.2.6 Presence of Overhead Transmission Lines and Electrical Structures

6.3.2.6.1 Operations and Maintenance

Collision: Birds can be injured or killed when they collide with overhead electrical transmission lines mid-flight.

The Project’s onshore export cables will be underground from the landfall locations to the onshore substation and converter station. The alternate transmission line in Falmouth will run from the onshore substation to the Falmouth POI underground. The transmission line from the converter station to the Brayton Point POI will also be underground.

Electrocution: Electrocutions occur when a bird simultaneously touches two energized parts of a transmission/distribution line or an energized part and a ground conductor or equipment. Most electrocutions occur on distribution rather than transmission lines, as distribution line conductors are placed closer together, increasing the risk of electrocution.

The Project's onshore export cables will be underground from the landfall locations to the onshore substation and converter station. The alternate transmission line in Falmouth will run from the onshore substation to the Falmouth POI underground. The transmission line from the converter station to the Brayton Point POI will also be underground.

6.3.2.7 Planned Discharges

6.3.2.7.1 Construction

Planned dewatering and the addition of stormwater runoff to the area will only affect areas in the direct vicinity of the construction activities (see Section 5.2). If there are wetlands or waterbodies in the direct vicinity of construction activities requiring discharges of stormwater, potential direct effects to wildlife species may include a disruption to water flow or alteration of turbidity, among other effects. This activity, however, would be temporary, short term and localized, and is anticipated to have minimal effects on vegetation and wildlife resources through implementation of standard construction BMPs to avoid, minimize, or mitigate dewatering discharge scour and siltation to nearby receiving waters, including wetlands. Stormwater discharges will also be regulated by appropriate federal and state construction permits (e.g., NPDES permit).

6.3.2.7.2 Decommissioning

Planned dewatering and the addition of stormwater runoff to the area will only affect areas in the direct vicinity of the decommissioning activities. This activity is anticipated to have minimal effects on vegetation and wildlife resources through implementation of standard construction best management practices to avoid, minimize, or mitigate dewatering discharge scour and siltation to nearby receiving waters, including wetlands.

6.3.2.8 Accidental Events

6.3.2.8.1 Construction and Decommissioning

There is a remote chance of accidental events occurring during construction and/or decommissioning, such as spills of oils and other hazardous materials or other unforeseen events, incidental to use of construction equipment. These events will most likely be local in nature and affect only the immediate area surrounding the site of the accidental event. Potential effects would be mitigated to the extent practicable through implementation of a Spill Response Plan to immediately contain and clean up any accidental spills of oil, fuel, or other hazardous materials. Best management practices will be used during refueling and lubrication of equipment to reduce potential effects to terrestrial vegetation and wildlife from accidental spills (see Appendix AA, Oil Spill Response Plan, for further details).

6.3.2.8.2 Operations and Maintenance

The onshore substation and converter station will have oil-filled transformers as part of the operating equipment; however, an unplanned, accidental release of oil from this equipment is a low probability event. There is also remote potential for an unplanned accidental release from the use of heavy machinery or other hazardous materials that are required for certain activities. Both of these potential events have a low probability of occurrence and would be coupled with mitigation measures that would be incorporated into the onshore substation's design (such as secondary containment around transformer equipment) or the maintenance activity (such as spill response plans).

6.3.2.9 Conclusion

Terrestrial vegetation and wildlife have potential to be affected by IPFs in the Onshore Project Areas. Based on an analysis of best available science and data, potential effects from IPFs to federal and state-listed species are anticipated to be very low to low.

The wildlife and plant species that could occur in the Onshore Project Areas (**Table 6-28** and **Table 6-29**) have some likelihood of being exposed to IPFs such as ground disturbance, introduced sound, changes in ambient lighting and EMFs, direct injury or fatalities from collision with operating equipment and heavy machinery and collision (i.e., onshore substation and converter station), and planned discharges and accidental events. However, all potential effects would be localized to the Onshore Project Areas and short-term during the duration of construction, operations, and/or decommissioning. Avoidance, minimization, and/or mitigation measures and other BMPs are anticipated to reduce effects to terrestrial vegetation and wildlife in the Onshore Project Areas (see Section 16, Summary of Avoidance, Minimization, and Mitigation Measures).

6.4 WETLANDS AND WATERBODIES

This section describes the wetlands and waterbodies in proximity to the proposed Project, potential effects to wetlands and waterbodies from proposed Project activities, and measures to avoid, minimize, and mitigate any potential effects the proposed Project may have on local wetlands and waterbodies. Wetland and waterbody resources were identified using publicly available information such as geographic information systems data layers published by local government agencies and information collected from field surveys conducted on or near the site by land management agencies or Mayflower Wind.

Technical appendices relating to wetlands and waterbodies include:

- Appendix J, Terrestrial Vegetation and Wildlife Assessment

6.4.1 Affected Environment

6.4.1.1 Wetlands

Wetland areas are unique ecosystems and, as such, are often protected through federal, state, and local laws. Federal- and state-regulated wetlands were identified and delineated during field surveys conducted within the onshore substation sites in Falmouth; the Brayton Point Onshore Project Area was evaluated based on desktop data. The field delineation report for the onshore substation sites under consideration in Falmouth is private data and therefore has not been provided. Additional field delineations will be completed as part of the state permitting process as necessary. Palustrine wetland types occurring near the Falmouth Onshore Project Area include red maple swamps, Atlantic white cedar bogs, kettlehole bogs, highbush blueberry thickets, shrub swamps, and emergent marshes. **Figure 6-12**, **Figure 6-13**, and **Figure 6-14** show the relative locations of wetlands and vernal pools within the Onshore Project Areas. Falmouth wetlands and vernal pools were mapped using the MassGIS 2005 DEP Wetlands detailed data set (MassGIS, 2017) and the URI Environmental Data Center and RIGIS Wetlands data set was used to map wetlands on Aquidneck Island within the intermediate landfalls of the Brayton Point export cable corridor (RIDEM, 2020). No wetlands are located within the Brayton Point Onshore Project Area at Brayton Point in Somerset, Massachusetts.

According to RIDEM (2020) the Brayton Point intermediate landfall routes on Aquidneck Island in Portsmouth, Rhode Island, are generally located within existing roadways or previously developed non-wetland areas. However, portions of the routes have wetlands adjacent to them, the exception to this is a portion of the Route Option 2 which crosses an area mapped as Estuarine Emergent Habitat.

Should the Project result in impacts to regulated wetland resources, coverage under permit(s) issued by the U.S. Army Corps of Engineers (USACE) pursuant to the U.S. Clean Water Act; the Massachusetts Wetlands Protection Act; the RIDEM Coastal Resources Management Council; and/or local municipal wetland bylaws, will be required.

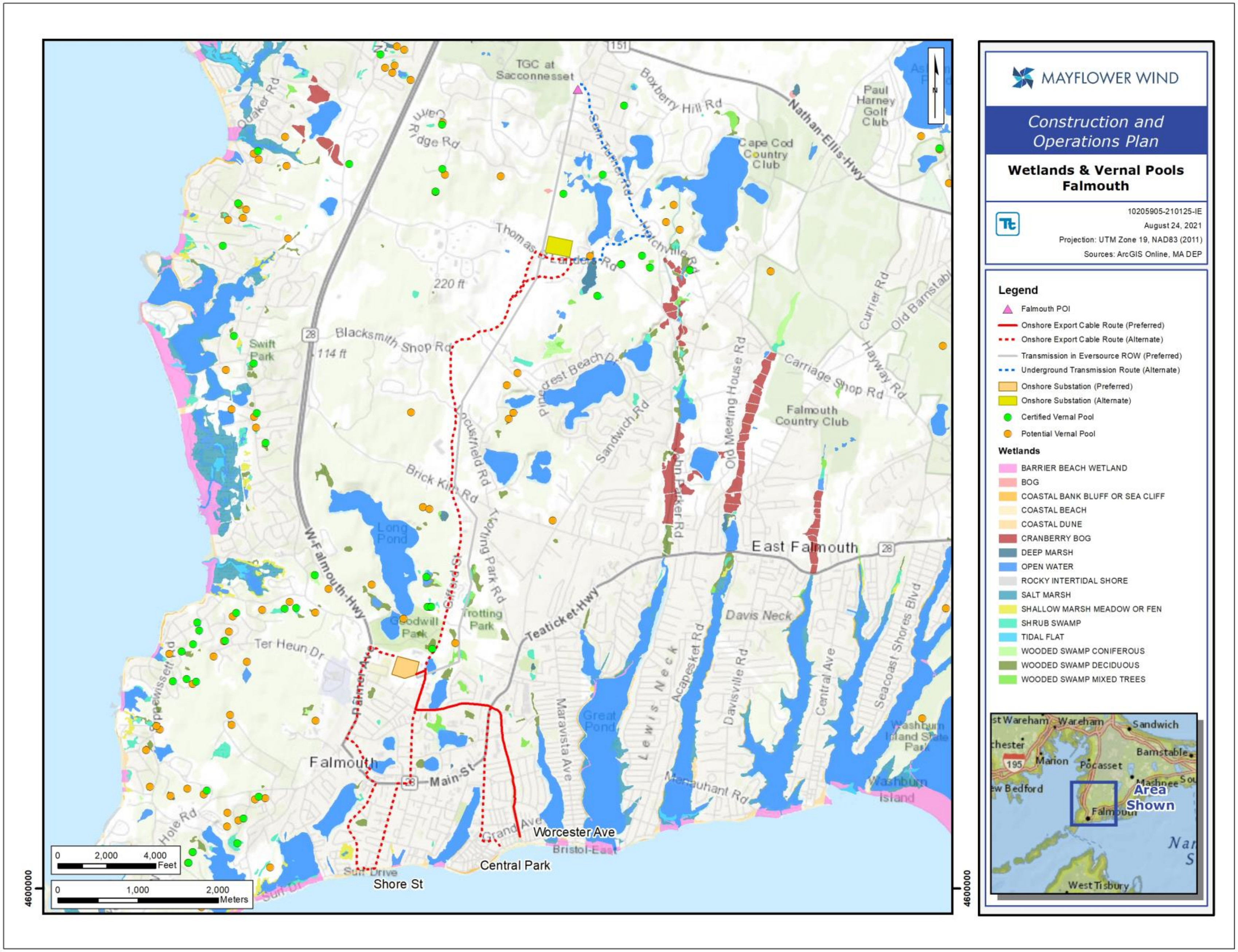


FIGURE 6-12. FALMOUTH ONSHORE PROJECT AREA WETLANDS AND VERNAL POOLS

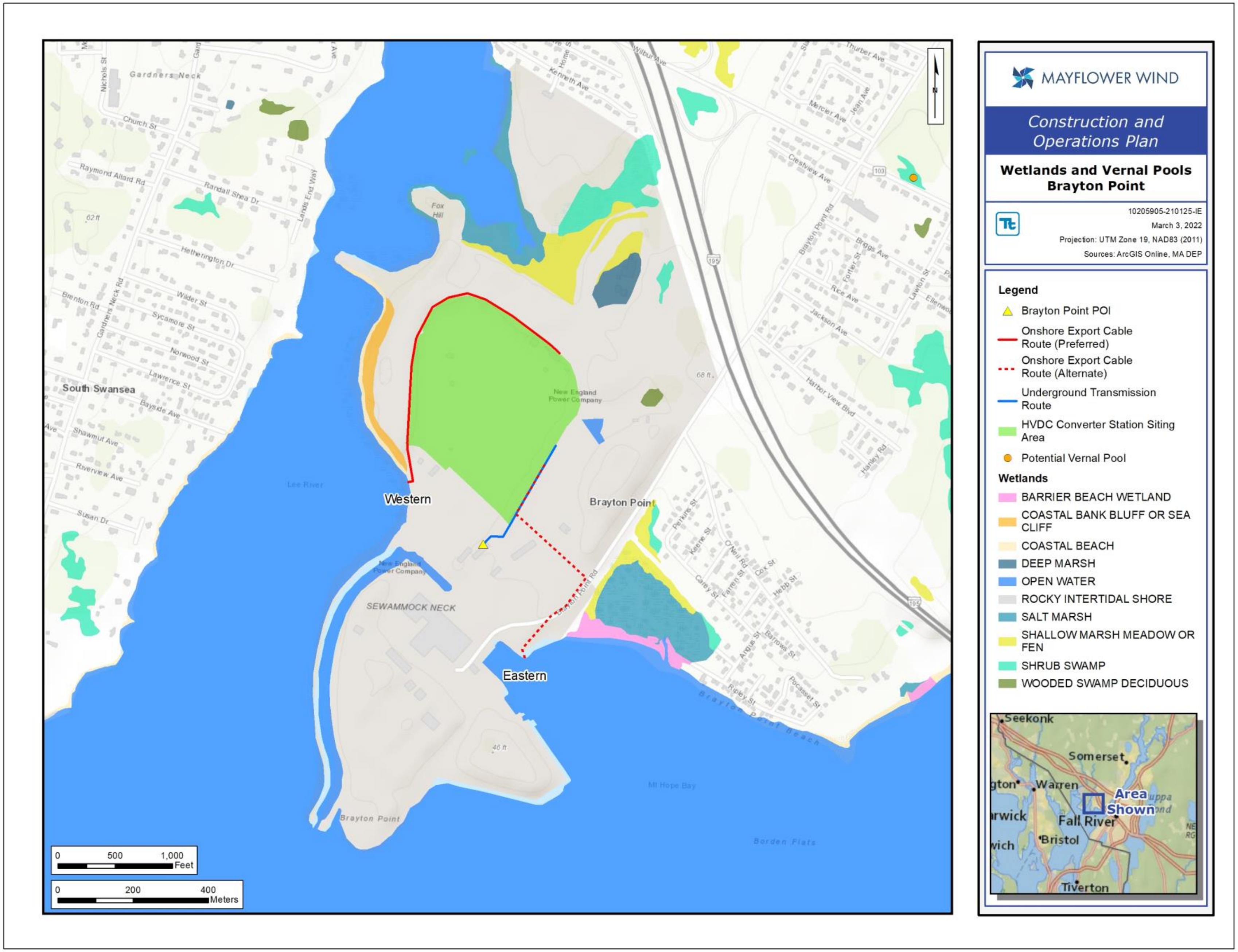


FIGURE 6-13. BRAYTON POINT ONSHORE PROJECT AREA WETLANDS AND VERNAL POOLS

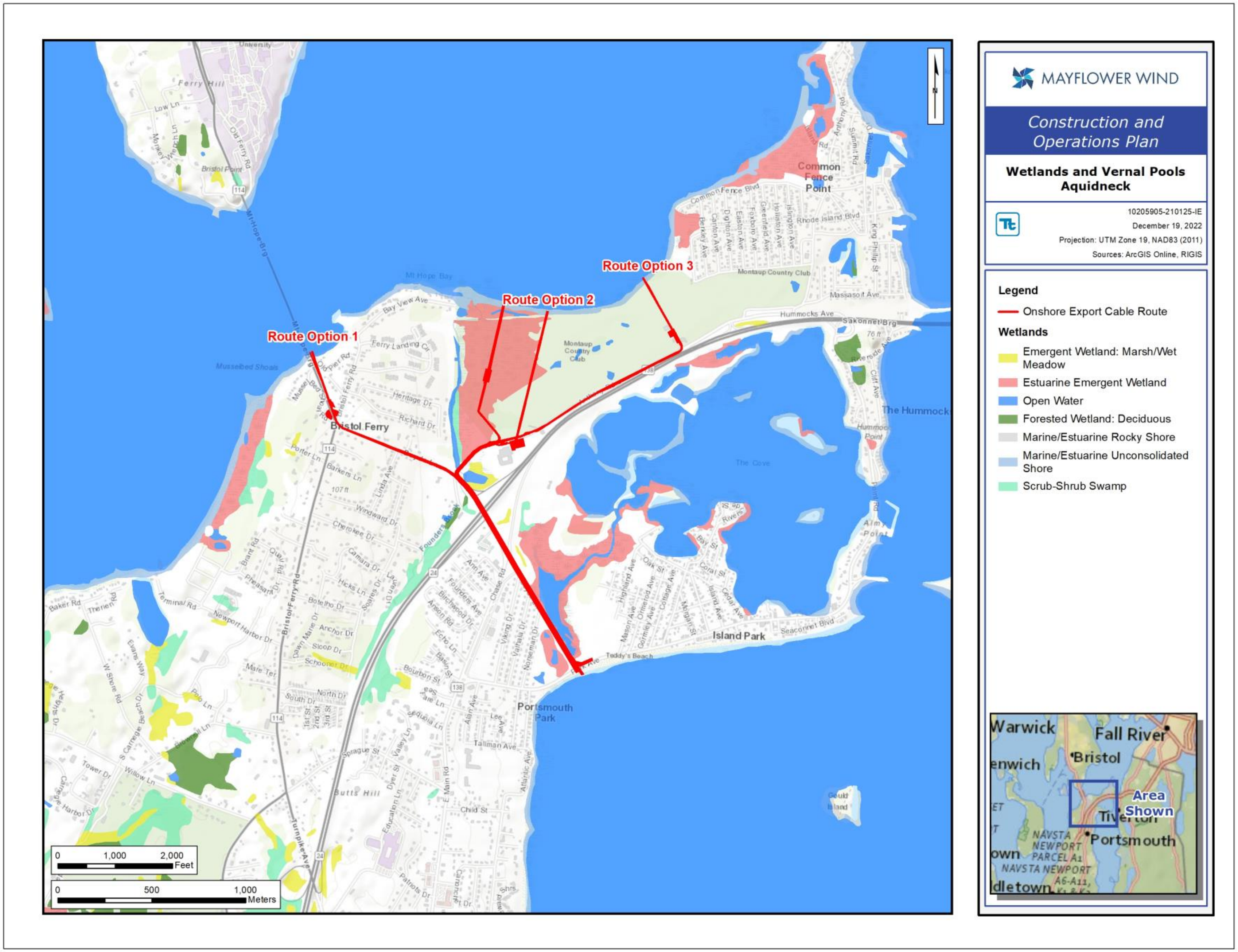


FIGURE 6-14. BRAYTON POINT AQUIDNECK ISLAND INTERMEDIATE LANDFALL ROUTE OPTIONS WETLANDS AND VERNAL POOLS

6.4.1.1.1 Red Maple Swamp

Red maple (*Acer rubrum*) swamps are the most common forested wetlands in Massachusetts (Swain, 2020). Within these wetlands, red maple is the dominant species in the tree stratum. The shrub layer within red maple swamps in Eastern Massachusetts typically includes sweet pepperbush (*Clethra alnifolia*), highbush blueberry (*Vaccinium corymbosum*), northern arrow-wood (*Viburnum dentatum*), spicebush (*Lindera benzoin*), and greenbrier (*Smilax rotundifolia*). Ferns are abundant with cinnamon fern (*Osmundastrum cinnamomeum*) being the most common. Other ferns include sensitive fern (*Onoclea sensibilis*), royal fern (*Osmunda regalis*), marsh fern (*Thelypteris palustris*), and spinulose wood fern (*Dryopteris carthusiana*). Skunk cabbage (*Symplocarpus foetidus*) is one of the most common herbaceous species local to the Falmouth Onshore Project Area.

6.4.1.1.2 Atlantic White Cedar Bog

Atlantic white cedar bogs are semi-forested, acidic, dwarf-shrub wetlands (NHESP, 2016a). Short, 6 to 30 ft (2 to 10 m) Atlantic white cedar (*Chamaecyparis thyoides*) trees dominate the open canopy. An open to nearly continuous, low, 3 ft (1 m) shrub layer can include small Atlantic white cedars. Scattered red maple may be present in the bog with occasional associates including white and pitch pine, grey birch (*Betula populifolia*), and black spruce (*Picea mariana*). Scattered tall shrubs may also be present and include highbush blueberry (*Vaccinium corymbosum*) and swamp azalea (*Rhododendron viscosum*). A dense low shrub layer is often comprised of leatherleaf (*Chamaedaphne calyculata*), sheep laurel (*Kalmia angustifolia*), black huckleberry (*Gaylussacia baccata*), rhodora (*Rhododendron canadense*), and bog rosemary (*Andromeda polifolia* var. *glaucophylla*). There is typically a well-formed sphagnum moss layer below the shrubs, and large and small cranberry (*Vaccinium macrocarpon* and *V. oxycoccos*), sundews (*Drosera* spp.), and pitcher plants (*Sarracenia purpurea*) may be present within an Atlantic white cedar bog as well.

6.4.1.1.3 Kettlehole Level Bog

Kettlehole level bogs are unique peatland ecosystems that develop in valley bottoms without inlets or outlets. Species composition in this ecosystem includes sphagnum moss (*Sphagnum* spp.), blueberries, leatherleaf (*Chamaedaphne calyculata*), and laurel species (*Kalmia* spp.). The NHESP (2016b) identifies this ecosystem as Imperiled.

6.4.1.1.4 Highbush Blueberry Thicket

Highbush blueberry thickets are peatlands that host tall shrubs and small red maple trees. Common species within this ecosystem include the namesake highbush blueberry along with other common blueberry species including, swamp azalea (*Rhododendron viscosum*), winterberry (*Ilex verticillata*), and sweet pepperbush. The NHESP (2016c) identifies this ecosystem as Secure.

6.4.1.1.5 Shrub Swamp

Shrub swamps are shrub-dominated wetlands that commonly occur within overhead electric utility ROWs as a result of previous tree clearing for installation of the utility infrastructure and subsequent vegetation maintenance activities. Maintenance activities target removal of tree species while allowing for continued growth and establishment of low-growing species, such as shrubs. The species composition of shrub swamps in Massachusetts is highly variable and can include meadowsweet (*Spiraea alba* var. *latifolia*), steeplebush (*Spirea tomentosa*), swamp azalea, silky dogwood (*Swida* *amomum*), winterberry (*Ilex verticillata*), sweet gale (*Myrica gale*), and arrowwood (*Viburnum dentatum*). Low-growing, weak-stemmed shrubs include dewberry (*Rubus hispidus*), water-willow (*Decodon verticillatus*), and Canadian burnet (*Sanguisorba canadensis*). The herbaceous layer often includes common arrowhead (*Sagittaria latifolia*), skunk cabbage, ferns, sedges (*Carex* spp.), bluejoint grass (*Calamagrostis canadensis*), bur reed (*Sparganium* spp.), virgin's-bower (*Clematis virginiana*), swamp candles (*Lysimachia terrestris*), clearweed (*Pilea pumila*), and turtlehead (*Chelone glabra*). Sphagnum moss is often abundant. Invasive species include reed canary-grass (*Phalaris arundinacea*), glossy buckthorn (*Frangula alnus*), common buckthorn (*Rhamnus alnifolia*), and the invasive purple loosestrife (*Lythrum salicaria*) (Swain, 2020).

6.4.1.1.6 Emergent Marsh

The deep emergent marsh wetland type occurs along rivers, streams, lakes, ponds, and other waterbodies. Water depths are generally less than 3 ft (1 m), though some depth of water is typically present in most years and influences the vegetation present. Often this wetland type is part of a wetland mosaic with shrub swamp and forested wetland bordering the emergent portions of the wetland. Vegetation consists primarily of herbaceous species and graminoids. These often include broad-leaved cattail (*Typha latifolia*), sphagnum moss, wool-grass (*Scirpus cyperinus*), common threesquare (*Schoenoplectus pungens*), bluejoint grass, reed canary-grass, rice cut-grass (*Leersia oryzoides*), tussock-sedge (*Carex stricta*), arrow-leaf tearthumb (*Persicaria sagittata*), beggar-ticks (*Bidens* spp.), bedstraw (*Galium* spp.), common arrowhead, slender-leaved goldenrod (*Euthamia caroliniana*), marsh-fern, marsh St. John's-wort (*Triadenum virginicum*), Joe-Pye-weeds (*Eutrochium* spp.), bonesets (*Eupatorium* spp.), and water-horehound (*Lycopus* spp.). Areas with more permanent open water often support floating-leaved plants like water-lilies (*Nymphaea odorata* and *Nuphar* spp.). Shrubs can include red osier dogwood (*Swida sericea*), leatherleaf (*Chamaedaphne calyculata*), sweet-gale, meadowsweet, steeplebush, and highbush blueberry; however, shrub cover is generally sparse (Swain, 2020).

6.4.1.1.7 Vernal Pools

Vernal pools are temporary pools or ponds, typically occurring within wetlands, that fill with water in the fall or winter due to rainfall and seasonal high groundwater levels and remain ponded through the spring and into summer. Often vernal pools dry up completely by the middle or end of the summer, or at least every few years, which prevents fish populations from becoming established within the pool. The absence of fish is critical to the reproductive success of many amphibian and invertebrate species that rely exclusively on vernal pools to provide breeding habitat, including wood frog (*Lithobates sylvaticus*), mole salamanders (*Ambystoma* spp.), and fairy shrimp (*Eubranchipus* spp.). For this reason, vernal pools have specific protections under both the Massachusetts Wetlands Protection Act regulations (310 CMR 10.00) and the USACE New England District's General Permits for the Commonwealth of Massachusetts for activities subject to USACE jurisdiction in waters of the U.S., including wetlands. In Rhode Island, at least 11 species of amphibians breed in vernal pools. The wood frog, spotted salamander, marbled salamander, and Eastern spadefoot toad depend on pool drying and the absence of fish for breeding success and survival. Activities in or near a vernal pool may require a permit from RIDEM (250-RICR-150-15-1).

6.4.1.1.8 Estuarine Emergent

Estuarine emergent includes areas that are inundated twice daily saltwater tides, but the upper edges may be inundated by brackish water and are dominated by non-woody species. Dominate species often include saltwater cordgrass (*Spartina alternifolia*) between the low mean high tide and salt-meadow cord grass (*Spartina patens*) between the mean high tide and the spring high tide. At the upper edges; seaside goldenrod (*Solidago sempervirens*), cattail (*Typha* sp.), and common reed (*Phragmites australis*) may be present.

6.4.1.1.9 Marine/Estuarine Unconsolidated Shore

Marine or estuarine unconsolidated shore includes coastal wetland areas that have the following characteristics, unconsolidated substrates, vegetation does not exceed 30 percent areal cover, and are flooded or exposed regularly, irregularly, seasonally, temporarily, intermittently, or artificially. Dominant species often include nassa mud snail (*Nassarius sp.)* and clamworms (*Nereis sp.)* where the substrate is mud, acorn barnacle (*Balanus sp*.) and periwinkle (*Littorina sp.)* in gravel substrate, or quahog (*Mercenaria sp.)* and the beach hopper (*Orchestia sp.)* in sand substrate.

6.4.1.1.10 Marine/Estuarine Rocky Shore

Marine or estuarine unconsolidated shore includes coastal wetland areas that are characterized by bedrock or large boulders making up three quarters of the substrate. The vegetation does not exceed 30 percent areal cover, and are flooded or exposed regularly, irregularly, seasonally, temporarily, or intermittently. Dominant species often include periwinkles and lichens in the uppermost zone. The balanoid zone, defined as a portion of the mid-littoral zone usually dominated by members of the *Balanidae* family, will likely be dominated by mollusks and barnacles.

6.4.1.1.11 Coastal Bank Bluff or Sea Cliff

Coastal bank bluffs are steep shorelines that have three or more feet of vertical elevation, from loose materials (i.e., not bedrock), above the high tide line. These areas are susceptible to erosion, especially when unvegetated. Dominant species include sweet fern (*Comptonia peregrina*) and Carolina rose (*Rosa Carolina*).

6.4.1.2 Streams and Ponds

Based on the USGS 24K topographic map (USGS, 1972), the proposed Project crosses two mapped streams. **Figure 6-12**, **Figure 6-13**, and **Figure 6-14** show the relative location of streams and ponds in relation to the Falmouth and Brayton Point Onshore Project Areas, including the Aquidneck Island intermediate landfall in Portsmouth, Rhode Island onshore export cable route. The Brayton Point Onshore Project Area in Somerset does not contain any streams or ponds. An unnamed stream crossed in Falmouth will be crossed once by the Worcester Avenue underground onshore export cable route. This stream drains adjacent wetland areas into Jones Pond and further downstream to Morse Pond. Depending on the route chosen, the underground onshore export cable route over Aquidneck Island will either crosses Founders Brook once or twice.

According to RIDEM (2020), the onshore export cable route options over Aquidneck Island are located within existing roadways or previously developed non-wetland areas. However, portions of the routes have ponds adjacent to routes. The exception to this is a portion of the Route Option 2 which crosses an area mapped as Estuarine Emergent Habitat.

6.4.1.3 *Wetlands and Waterbodies in the Onshore Project Area*

Wetland resources within and adjacent to the Project will be further delineated and verified as required for compliance to meet applicable wetland regulation(s). No wetlands are located within the Brayton Point Onshore Project Area at Brayton Point in Somerset, Massachusetts (MassGIS, 2018; MassGIS, 2020; RIGIS, 2011).

6.4.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

Potential effects of the proposed Project listed in **Table 6-31** may affect wetlands and waterbodies due to activities performed during construction, operation, and decommissioning of the proposed Project. Avoidance, minimization, and mitigation measures to avoid potential effects to wetlands and waterbodies are summarized in Section 16, Summary of Avoidance, Minimization, and Mitigation Measures.

TABLE 6-31. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON WETLANDS AND WATERBODIES

IPF	Potential Effect		Period of Potential Effect		
	Project Component		Project Phase		
	Landfalls, Onshore Export Cables, and Transmission Routes	Onshore Substation and HVDC Converter Station	Construction	O&M	Decomm.
Ground Disturbance	Temporary habitat disturbance	Temporary habitat disturbance	X	-	X
Planned Discharges	Dewatering, stormwater runoff	Dewatering, stormwater runoff	X	X	X
Accidental Events	Release of hazardous materials into environment	Release of hazardous materials into environment	X	X	X

6.4.2.1 *Ground Disturbance*

6.4.2.1.1 Construction

Construction activities that disturb the ground may occur within areas that include wetlands and waterbodies. The underground portion of the onshore export cable routes will be located within existing paved public roadway in Falmouth, the preferred location for the substation will be within an active sand and gravel pit, and the alternate underground transmission route from the onshore substation to the Falmouth POI will be located along existing paved public roadway. All Project components in

Somerset will be located within the former Brayton Point Power Station, a closed power plant facility that was decommissioned in 2017.

The onshore substation and converter station facilities will necessitate ground disturbance from construction of the facility within the chosen location. This will require grading to create a level working surface followed by the construction of an onshore substation and converter station, including the addition of impervious surfaces to the area. No jurisdictional wetlands have been identified at any substation sites in Falmouth or the converter station site in Somerset.

As the proposed Project is mostly concentrated within areas that are previously disturbed or undergoing active management and/or as HDD is proposed for certain crossings, impacts to wetlands and waterbodies have largely been avoided through siting.

6.4.2.1.2 Decommissioning

Onshore decommissioning activities are anticipated to be minimal as much of the infrastructure will be repurposed after the lifespan of the proposed Project. Ground disturbance activities within the proposed Project will be minimal or nonexistent as described in Section 3.4, Summary of Impact Producing Factors. This effect will be limited to the areas directly surrounding the worksites. Decommissioning land disturbance will only affect the environment while crews are working in the immediate vicinity. Wetlands are not known to exist at the substation and converter station sites; therefore, impacts are not anticipated during onshore decommissioning activities.

6.4.2.2 Planned Discharges

6.4.2.2.1 Construction

Planned dewatering and the addition of stormwater runoff to the area will only affect areas in the direct vicinity of the construction activities. This activity is anticipated to have minimal effects on discharge interacting with wetlands or waterbodies through implementation of stormwater management systems at the onshore substation, and converter station designed in accordance with Massachusetts and Rhode Island BMPs. These BMPs aim to avoid, minimize, or mitigate displacing dewatering discharge scour and siltation to nearby receiving wetlands or waterbodies. Potential effects are expected to be further minimized and regulated by construction permits.

6.4.2.2.2 Operation

Occasional, infrequent dewatering could be required during operational activities (for example, during a manhole inspection). As portions of the Onshore Project Areas occur within the vicinity of wetlands or waterbodies, discharges as a result of dewatering will be managed in accordance with the requirements for applicable EPA, MassDEP, RIDEM, and/or local regulations pertaining to dewatering. In addition, the Project will be designed and operated in accordance with applicable stormwater management standards issued by EPA, MassDEP, RIDEM, and local regulations, as applicable.

6.4.2.2.3 Decommissioning

Planned dewatering and the addition of stormwater runoff to the area will only affect areas in the direct vicinity of the decommissioning activities. This activity is anticipated to have minimal effects to vegetation and wildlife resources through implementation of standard construction BMPs to avoid, minimize, or mitigate dewatering discharge scour and siltation to nearby receiving waters, including wetlands. Potential effects are expected to be further minimized and regulated by construction permits.

6.4.2.3 Accidental Events

6.4.2.3.1 Construction

When working with heavy machinery and construction equipment there is a low chance of accidental events occurring such as spills of oils and other hazardous materials incidental to use of construction equipment, or other unforeseen events. These events, depending on their nature, will most likely be local and affect only the local area surrounding the site of the accidental event. Further, potential effects will be mitigated to the extent practicable through implementation of BMPs and safety and environmental plans including a Safety Management System) detailed in Appendix Z, an Oil Spill Response Plan detailed in Appendix AA, and a spill plan to avoid, control, and address any accidental releases during all proposed Project activities.

6.4.2.3.2 Operation

There is a potential for accidental events to occur in all stages of the proposed Project, but likelihood of occurrence will be rare during operations. O&M of the proposed Project will not contain numerous inherent risks for accidental events. The onshore substation and converter station will have oil-filled transformers as part of the operating equipment; however, an unplanned accidental release of oil from this equipment is a low-probability event. Whenever heavy machinery or other hazardous materials incidental to O&M activities are required for specific activities, there is also the potential for an unplanned accidental release. Such an event also has low probability of occurrence. Potential effects will be mitigated to the extent practicable through implementation of BMPs and safety and environmental plans including an Safety Management System detailed in Appendix Z, an Oil Spill Response Plan detailed in Appendix AA, and a spill plan to avoid, control, and address any accidental releases during all proposed Project activities.

6.4.2.3.3 Decommissioning

When working with heavy machinery and construction equipment during decommissioning activities, there is a low chance of accidental events occurring such as spills, or other unforeseen events. These events, depending on their nature, will most likely be local in nature and affect only the local area surrounding the accident. Further, these effects will be mitigated to the extent practicable through implementation of BMPs and safety and environmental plans including a Safety Management System detailed in Appendix Z, an Oil Spill Response Plan detailed in Appendix AA, and a spill plan to avoid, control, and address any accidental releases during all proposed Project activities.

6.5 Coastal Habitats

Coastal habitat is defined as ranging from the high-water mark of the beach up to 2 nm (3.7 km) offshore. Within the Project Area, coastal habitats include the northern offshore export cable corridors and the landfall locations under consideration.

The coastal habitat of Falmouth, Massachusetts is typical of upper Cape Cod; sandy and beach shoreline with developed features such as rock jetties and sea walls. Beaches tend to have coarse to very coarse sand and gravelly sediments (see Appendix M, Benthic and Shellfish Resources Characterization Report).

The coastal habitat along the Sakonnet River portion of the Brayton Point export cable corridor varies from bedrock outcrops to sand and mud flats. The Sakonnet River and Mount Hope Bay shorelines have a long history of development with recent and remanent structures.

Included in the characterization of the affected environment are results from surveys performed in the Spring and Summer of 2020 for the Falmouth export cable corridor, as well as existing data and literature as further described below. Benthic surveys along the Brayton Point export cable corridor took place in 2021 and 2022, but since no eelgrass beds are indicated on available mapping, no comprehensive eelgrass surveys are currently planned for the Aquidneck Island or Brayton Point landfalls.

Technical appendices related to coastal habitats include:

- Appendix F1, Sediment Plume Impacts from Construction Activities
- Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment
- Appendix K, Seagrass and Macroalgae Report
- Appendix M, Benthic and Shellfish Resources Characterization Report

6.5.1 Affected Environment

For descriptions of coastal habitats within this section, the term ‘eelgrass’ will refer to the type of seagrass found in salt water off the coast of Massachusetts and Rhode Island, while the term ‘seagrass’ will refer to flowering vascular plants with roots, stems, and leaves which reproduce by producing flowers, fruits, and seeds. ‘Submerged aquatic vegetation (SAV) beds’ will refer to areas of submerged vegetation dominated by eelgrass, and ‘macroalgae’ will refer to a variety of multicellular red, brown, and green algae species visible to the human eye. These macroalgae may be detached from or attached to a hard substrate by a holdfast. Macroalgae is not considered a SAV species, but may occur within a SAV bed as well as outside of a SAV bed.

6.5.1.1.1 Seagrass

The seagrass commonly found in southern New England waters primarily include eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*) (ESS Group, Inc., 2006). Seagrass is an essential component of coastal ecosystems, providing nursery and foraging habitat for benthic organisms and commercially and recreationally significant fisheries (Macreadie et al., 2017). Seagrasses are marine vascular plants that have roots, stems, and leaves but have adapted to saline aquatic environments, which includes having more hydrodynamic tissues and having hydrophilous, abiotic pollination mechanisms. Seagrass also promotes nutrient cycling, works as a bioindicator of the water quality in the area, and provides ecosystem services to humans, including providing shoreline stabilization.

6.5.1.1.2 Macroalgae

Macroalgae are protists that include fungi, protozoans, sponges, and microalgae (Macreadie et al., 2017). Macroalgae can occur in marine, estuarine, and freshwater environments, but the highest biodiversity occurs in marine systems.

The main differences between seagrass and macroalgae are that seagrasses have vascular tissues whereas macroalgae do not (resulting in differences in nutrient and gas transport). Additionally, Macroalgae attach directly to hardbottom substrates, whereas seagrasses have underground root systems. While macroalgae are able to grow in areas with less light (due to having a wide variety of light-harvesting pigments and the ability to photosynthesize with all tissues), seagrasses depend on leaf cells only for photosynthesis (Raven and Hurd, 2012; Zimmerman, 2006).

6.5.1.1.3 Submerged Aquatic Vegetation Beds

Submerged aquatic vegetation beds were identified at the Falmouth landfall areas from a review of eelgrass field surveys completed in August 2020 (CR Environmental, Inc., 2020) (see Attachment 1 of Appendix K, Seagrass and Macroalgae Report), and through benthic habitat surveys completed by Fugro and Integral Consulting in Spring and Summer 2020 (Appendix M, Benthic and Shellfish Resources Characterization Report), and from MassDEP (MassDEP, 2020) Eelgrass Mapping Project data and mapping. The MassDEP seagrass mapping and monitoring program began in 1994 and includes a combination of aerial photography and digital imagery, as described in Costello and Kenworthy (2011). Since no eelgrass beds were indicated following a review of available mapping resources within the Brayton Point export cable corridor, no comprehensive eelgrass surveys are currently planned for the Aquidneck Island or Brayton Point landfalls. Should previously unmapped seagrass beds be observed during the Summer 2021 benthic surveys, these areas will be addressed during the permitting process.

A series of seasonal benthic surveys, consistent with BOEM 2019 guidance and National Marine Fisheries Service (NMFS) recommendations (NMFS, 2020), have been conducted along the Falmouth export cable corridor (extending 1.0 km to either side of the route centerline) (see Section 6.6 and COP Appendix M, Benthic and Shellfish Resources Characterization Report) (BOEM, 2019 and NMFS, 2020). Additional surveys along the Brayton Point export cable corridor are planned for Summer 2021. As part of these benthic surveys, SPI/PV imaging were used to determine the presence of macrofauna and SAV. Real time video, in conjunction with grab samples, were also used to support the characterization of SAV. While the benthic surveys were not intended specifically to target SAV, images collected during the surveys were used in establishing the presence of SAV beds, as well as identifying favorable habitats for SAV beds. Additional benthic surveys will be conducted along the Brayton Point export cable corridor, using similar methodology, to determine the presence of macrofauna and SAV.

The benthic survey performed in Spring of 2020 did not identify any SAV beds in the Lease Area or the southern portion of the proposed Falmouth export cable corridor. These portions of the Project Area are primarily comprised of mobile, sandy sediments and high currents which is unsuitable habitat for eelgrass or seagrass growth. The water depths in the Lease Area and southern portion of the Falmouth export cable corridor also exceed levels that support the successful colonization of SAV beds. Due to these findings, those portions of the Project Area are not included in this section. More information regarding benthic seafloor conditions and resources occurring within the Project Area are detailed in Section 6.6 and Appendix M, Benthic and Shellfish Resources Characterization Report. Detailed seafloor and subsurface sediment conditions can be found in Section 4 and Appendix E, Marine Site Investigation Report.

6.5.1.2 Eelgrass Surveys

In August 2020, CR Environmental, Inc. conducted eelgrass surveys at three landfall location options at Shore Street, Mill Road, and Worcester Avenue in Falmouth, Massachusetts (**Figure 6-15**), described in Appendix K, Seagrass and Macroalgae Report. (CR Environmental, Inc., 2020). As described in Section 2, Project Siting and Design Development, the Mill Road landfall location has since been eliminated from the PDE. The surveys consisted of a combination of single-beam echo sounding with precision navigation, side-scan sonar, and towed underwater video. This approach provided multiple lines of evidence to accurately map the eelgrass distribution at these potential landfall locations.

Side-scan sonar was used to guide the underwater video surveys at the landfall locations and were collected with CR Environmental, Inc.'s portable, towed video sled. A one day underwater video sled survey was performed at each potential landfall location to confirm the estimated eelgrass distribution derived from the echo sounder and side-scan sonar data. This process also provided photographic documentation of eelgrass density and plant health. Fifteen video transects were completed at the Mill Road landfall location, sixteen were completed at the Shore Street landfall location, and ten were completed at the Worcester Avenue landfall location. Transect length varied from approximately 1,000 to 2,000 ft (304.8 to 609.6 m) at Mill Road, 700 to 2,200 ft (213.4 to 670.6 m) at Shore Street, and 1,700 to 6,500 ft (518.2 to 1,981.2 m) at Worcester Avenue to account for irregularities in the shape of the study areas. The underwater video data for all three landfall locations were reviewed by a marine biologist and field geologist to identify the presence or absence of eelgrass, characterize bottom substrate, and observe biota (see Appendix K, Seagrass and Macroalgae Report).

Nearshore eelgrass mapping using georeferenced, single-beam acoustic data and underwater video was conducted and reported on by CR Environmental, Inc. in October 2020. For more information on survey methodology, see Appendix K, Seagrass and Macroalgae Report. Since the Central Park landfall is located a little more than 700 ft (213 m) to the west of the Worcester Avenue landfall, data collected from Worcester Avenue will be used to inform the approximate extent of eelgrass at the Central Park landfall location.

The MassDEP eelgrass mapping program has obtained multiple years of high-resolution digital imagery, captured under conditions at which eelgrass is at maximum areal extent; i.e., during periods of low tide, low sun angle, and low winds. Extensive fieldwork was conducted to verify questionable areas within the imagery. Field verification was conducted through high accuracy GPS, high resolution sonar, and underwater video cameras. The final data imagery was compiled and processed by MassDEP using ESRI ArcGIS desktop software.

Rhode Island's Eelgrass Mapping Task Force monitors the status of seagrasses and provides maps of the location and extent of seagrass beds. The task force is comprised of a number of organizations, including the Rhode Island Coastal Resources Management Council (CRMC), Save the Bay, the University of Rhode Island, and others. The task force uses GIS aerial photography, remote sensing, and field monitoring with sample collection to document eelgrass populations. The most recent mapping available from 2016 surveys (RIGIS, 2016) shows no eelgrass beds mapped within the Brayton Point export cable corridor.

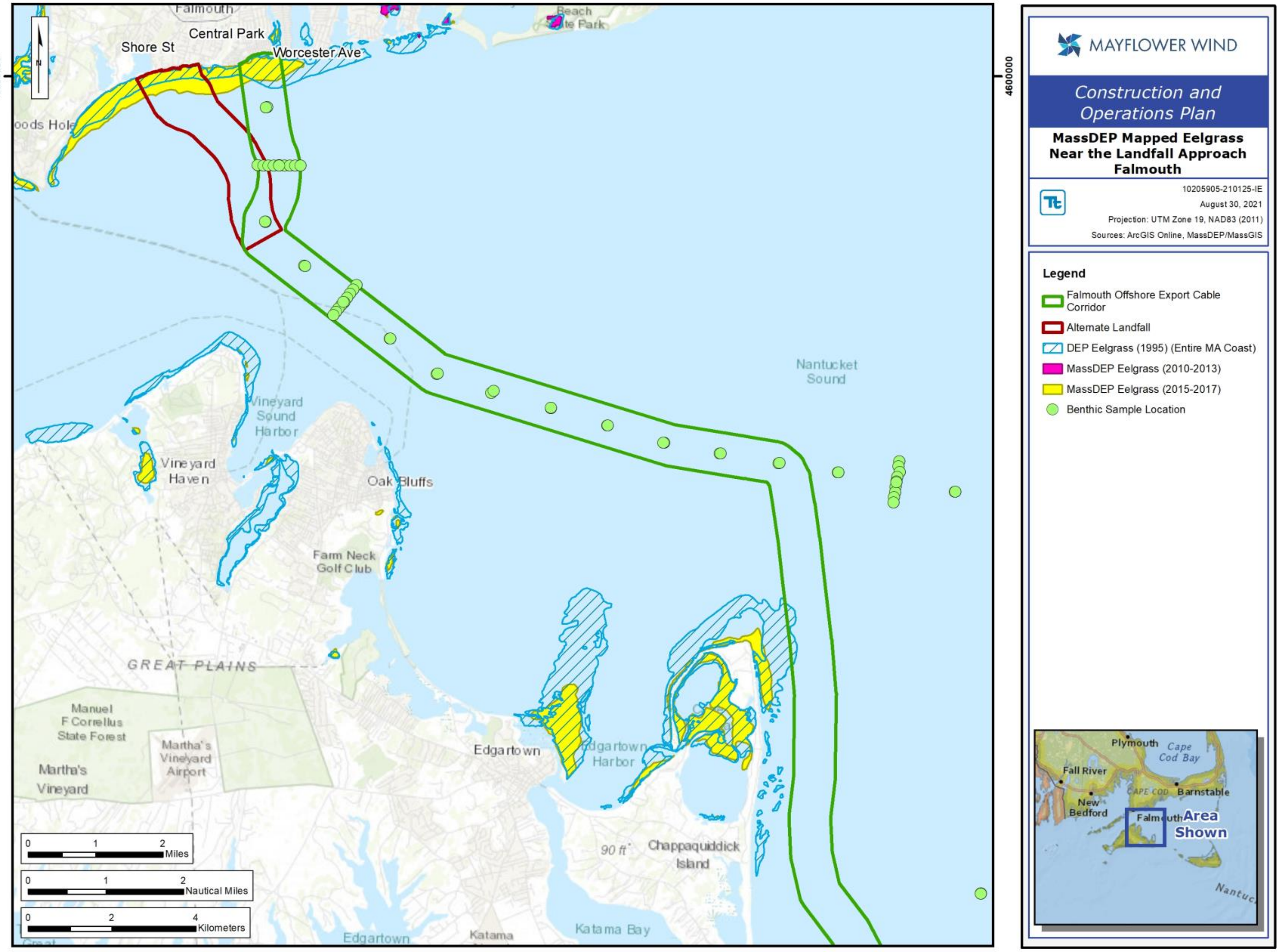


FIGURE 6-15. MASSDEP MAPPED EELGRASS - FALMOUTH

The Brayton Point export cable corridor passes north through Rhode Island Sound, into the mouth of and through the Sakonnet River, and has an onshore underground component on Aquidneck Island. The Brayton Point export cable corridor exits Aquidneck Island into Mount Hope Bay and then makes landfall at Brayton Point. See Section 3, Description of Proposed Activities, for more details. Long-term eelgrass monitoring in Narragansett Bay (provided by the Rhode Island Eelgrass Mapping Task Force) shows two eelgrass beds along the mouth of the Sakonnet River (**Figure 6-16**). There is a 54-ac (22-ha) eelgrass bed located 1 mi (1.6 km) east of the Brayton Point export cable corridor at Little Compton and a 49-ac (20-ha) bed located 0.7 mi (1.0 km) west of the Brayton Point export cable corridor at Sachuest Point. No eelgrass beds are mapped in the export cable corridor.

6.5.1.3 SAV and Macroalgae Observed in the Proposed Project Area

Preliminary data from the Spring 2020 benthic sampling campaign were assessed to identify complex and sensitive habitats on which to focus the Summer 2020 benthic survey (see Appendix M, Benthic and Shellfish Resources Characterization Report). Complex habitats were characterized as vegetated habitats, hardbottom substrates, and those hardbottom substrates with epifauna or macroalgae cover, consistent with NMFS guidance (NMFS, 2020). The northern portion of the proposed Falmouth export cable corridor, inclusive of Muskeget Channel, was defined by areas of complex, heterogenous habitat, ranging from gravel and gravel mixes to sand and muddy sand with epifauna and macroalgae cover (noted at several locations). SAV beds in the Project Area were characterized using seafloor imagery obtained through the PV camera, attached with the SPI camera, as well as with the video camera attached to the benthic grab frame.

During the Spring 2020 benthic survey, with the exception of some fragments at one sample site (station 033), no seagrasses or macroalgae were found at any sample locations along the southern portion of the Falmouth export cable corridor.

Information from CR Environmental, Inc.'s October 2020 report (Appendix K, Seagrass and Macroalgae Report) indicate continuous SAV bed coverage, consisting primarily of eelgrass, on the approach to both the Mill Road and the Shore Street landfall sites. SAV at the Worcester Avenue approach was sparsely distributed in comparison with Mill Road and Shore Street, with several large areas devoid of SAV. However, shallower water depths present at the Worcester Avenue approach allows SAV to extend farther offshore. **Figure 6-16** and **Figure 6-17** show the eelgrass survey study areas and the observed seagrass extent at each landfall approach.

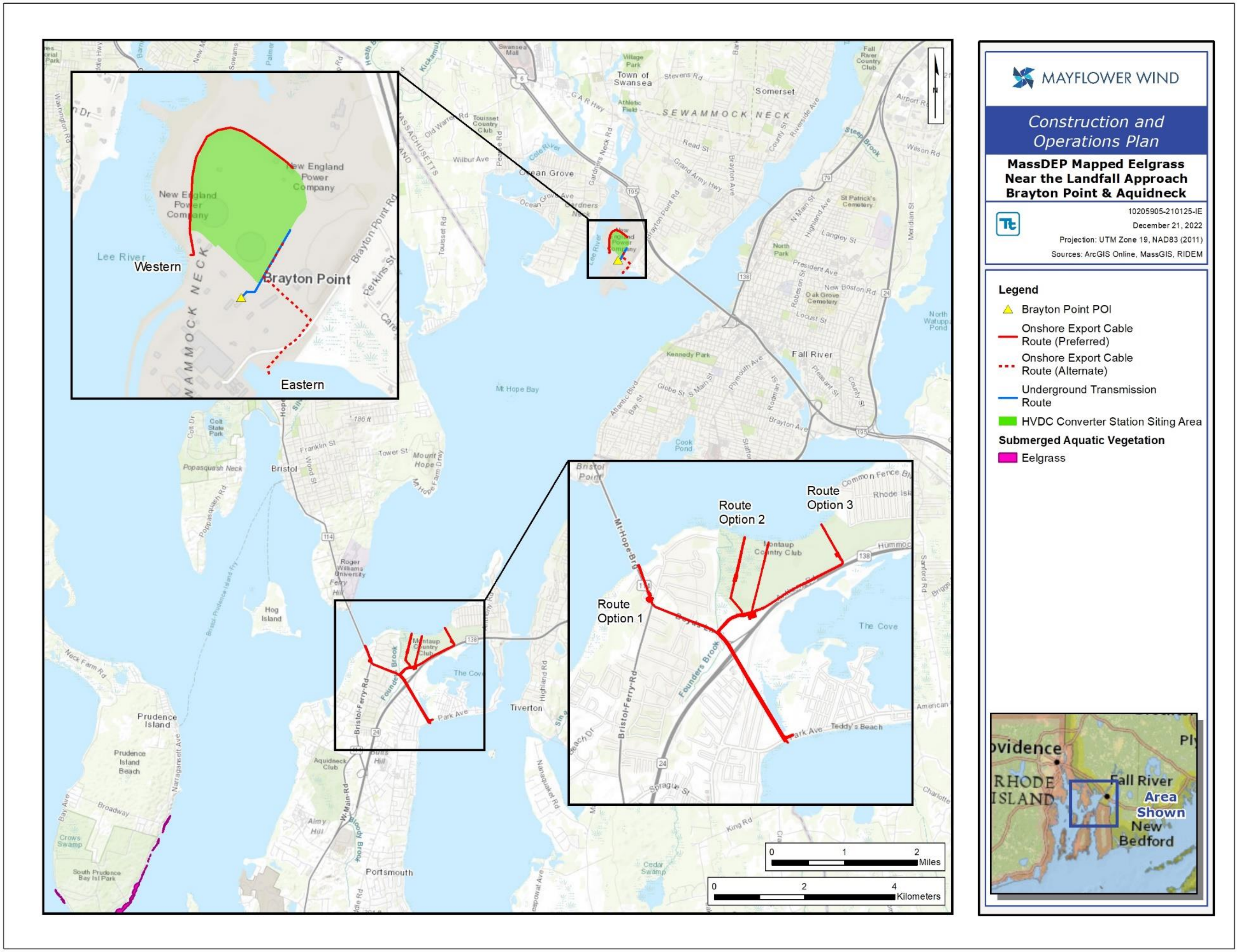


FIGURE 6-16. MASSDEP AND RIDEM MAPPED EELGRASS AREAS - BRAYTON POINT

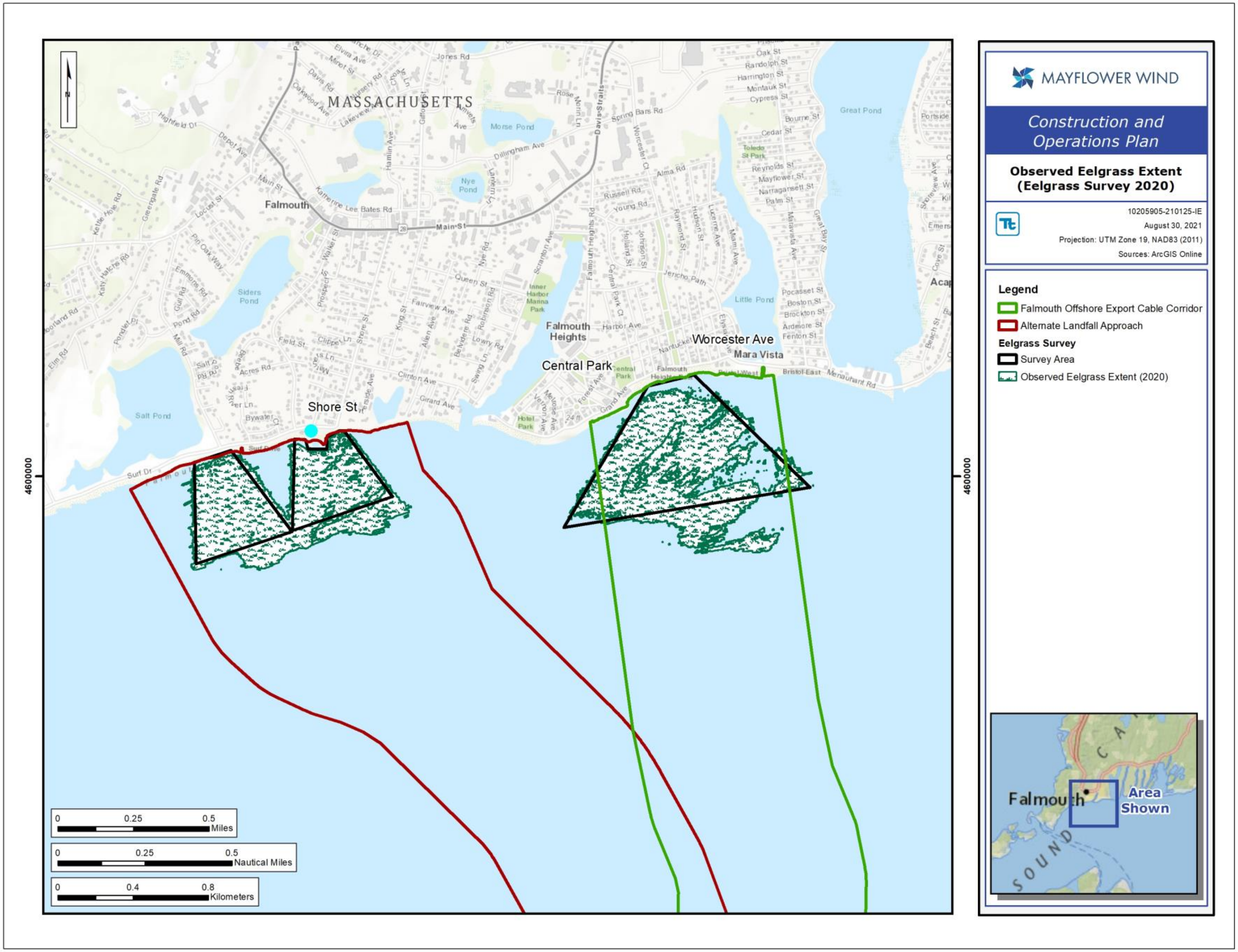


FIGURE 6-17. OBSERVED MACROALGAE EXTENT FROM THE 2020 EELGRASS SURVEY

The maximum water depth for SAV bed growth observed at the three sites was estimated to be 16.8 to 17.8 ft (5.1 to 5.4 m) above MLLW. The primary species present in the SAV bed was eelgrass with some mixed strands of wire weed. Eelgrass was present along the shoreline and a few of the offshore transects. Additionally, two areas of wire weed and dead man's fingers were identified near the nutrient-rich outflow of two coastal ponds: Oyster Pond at the Mill Road location and Green Pond at the Worcester Avenue location. Eelgrass and macroalgae found in these areas were covered with epiphytic algae and bryozoans. Plant heights throughout the three eelgrass beds ranged from 0.5 to greater than 2 ft (0.15 to greater than 0.61 m) and appeared to be in good health. At the Worcester Avenue approach, eelgrass habitat was limited not only by water depth, but also mobile sands. A slipper limpet reef was observed in the side-scan sonar. Review of existing data and literature, including the MassDEP eelgrass program data (MassDEP, 2020), further confirmed the findings from CR Environmental, Inc.'s spring and summer 2020 surveys. HDD will be used in the nearshore areas for the Aquidneck Island and Brayton Point export cable sea-to-shore transitions, which will avoid direct impacts to areas with the potential to support SAV beds. Further, the Summer 2021 benthic surveys will verify the absence of SAV beds at the Brayton Point export cable landfall locations, including the landfall locations for the intermediate landfall portion of the Brayton Point export cable corridor, at Aquidneck Island, in Portsmouth, Rhode Island.

6.5.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

The IPFs (identified in **Table 6-32**) result from Project activities (or accidental events from said activities) that may disturb or harm coastal habitats in the Project Area. Resources that may potentially be affected include green, red, and brown macroalgae throughout the northern portions of the export cable corridors, and eelgrass in the northernmost sections of the Falmouth export cable corridor, in the nearshore areas, and potentially the Brayton Point export cable corridor (to be confirmed following survey activities). No eelgrass or macroalgae is present in the southern part of the export cable corridors or Lease Area. **Table 6-32** presents the summary of the IPFs that are likely to be caused by Project activities and components. More in-depth descriptions of IPFs and details regarding their connection to Project components can be found in Section 3.4, Summary of Impact Producing Factors. Mayflower Wind will employ the methods summarized in Section 16 to avoid, minimize, and mitigate any potential effects the proposed Project may have on coastal habitats.

TABLE 6-32. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON COASTAL HABITATS

IPF	Potential Effects		Period of Effect		
	Project Component		Project Phase		
	Landfall Location	ECCs	Construction	O&M	Decomm.
Seabed (or ground) Disturbance	HDD exit pit dredging	Export cable installation; vessel anchoring and spudding; Export cable scour protection; Routine export cable O&M	X	X	X
Change in Ambient Lighting	HDD exit pit dredging	Export cable installation	X	-	X
Change in Ambient EMF	Operational cables	Operational cables	-	X	-
Actions that may displace biological resources: Displacement of Eelgrass and Macroalgae	HDD exit pit dredging; anchoring and spudding	Export cable installation; anchoring and spudding	X	-	X
Actions that may cause direct injury or death of biological resources	HDD exit pit dredging; anchoring and spudding	Export cable installation	X	X	X
Planned Discharges	Project installation O&M vessels	Project installation O&M vessels	X	X	X
Accidental Events	Project installation O&M vessels	Project installation O&M vessels	X	X	X

6.5.2.1 Seabed (or Ground) Disturbance

6.5.2.1.1 Construction

Construction of the proposed Project will result in the disturbance of the seafloor from the following activities:

- seafloor preparation,
- Installation of WTGs,
- Installation of inter-array cables and OSPs,
- Installation of offshore export cables,
- Scour protection,
- HDD exit pit dredging, and
- Vessel anchoring (including spuds).

Mayflower Wind anticipates that seabed disturbance effects of eelgrass beds will be limited to nearshore areas of the proposed Falmouth export cable corridor and associated landfall locations. Clusters of macroalgae identified along the northern portion of the Falmouth export cable corridor and potentially the Brayton Point export cable corridor (to be confirmed following survey activities) will also be disturbed during construction. The installation of the cables will result in seafloor sediment either being sidecast and backfilled, or temporarily disturbed and suspended if plowing or jet plowing installation methods are used. Seagrass or macroalgae in the area of direct disturbance may be displaced and buried. Seagrasses or macroalgae in the sidecast areas may also be buried.

Vessel anchoring will also result in the temporary disturbance of bottom sediments during the installation of the offshore export cables, and may result in damage to seagrass/macroalgae if vegetation beds are not avoided during anchoring. These activities will also temporarily resuspend soft sediments due to sediment remobilization. More information regarding sediment remobilization can be found in Appendix F1, Sediment Plume Impacts from Construction Activities. The maximum sediment deposition may exceed 5 millimeters (0.20 in) within 24 m (79 ft) around the export cable route and may be thicker around "Segment 3" (KP 45 to KP 88) and around Mount Hope Bay and the Sakonnet River (KP 0 to KP 34) (Appendix F1, Sediment Plume Impacts from Construction Activities; Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment). Eelgrass within this area and beyond may be covered by soft sediments settling on the blades/leaves.

Mayflower Wind is considering a range of offshore export cable installation methods (see Section 3.3.5). Mayflower Wind will use HDD for the installation of the offshore export cables beneath the shallower nearshore areas at all landfall locations. Use of HDD is expected to substantially reduce impacts of sediment disturbance on SAV resources in the nearshore portion of the Project Area. The presence of eelgrass beds will be considered in the evaluation of export cable corridor landfall locations. HDD exit pit dredging is anticipated to disturb the seabed but is planned to be conducted outside of eelgrass beds.

For HDD trajectories in Falmouth see Appendix P1. Note that HDD trajectory details will be refined (and may change slightly within the PDE) as the Project progresses.

6.5.2.1.2 Operations and Maintenance

Seafloor disturbance during the O&M phase of the proposed Project may occur during activities associated with maintenance of the offshore export cables and scour protection, and from vessel anchoring. Scheduled or unscheduled cable maintenance and repair activities may disturb the seafloor as cables will be either covered with a protectant or buried within the subsurface. See Section 3.3.5, Offshore Export Cables, for a description of cable protection methods.

6.5.2.1.3 Decommissioning

Decommissioning of the proposed Project will result in the disturbance of the seafloor from offshore export cable removal (if applicable), scour protection removal, and vessel anchoring (including spuds). If required, the removal of offshore export cables will result in seafloor sediment being sidecast and backfilled, or temporarily disturbed and suspended. Seagrass or macroalgae in the area of direct disturbance may be displaced and buried. Seagrasses or macroalgae in the sidecast areas may also be buried. The proposed Project's offshore export cables may be left in place to minimize environmental effects, thus resulting in minimal or no seabed disturbance. Vessel anchoring or spudding will result in temporary disturbance of bottom sediments during removal of the offshore export cables and may result in damage to seagrass/macroalgae if vegetation beds are not avoided during anchoring. These activities will temporarily resuspend soft sediments due to sediment remobilization. Eelgrass may be covered by soft sediments settling on the blades/leaves.

6.5.2.2 Changes in Ambient Lighting

6.5.2.2.1 Construction

Eelgrass and macroalgae require light penetration through the water column and may be affected by increased turbidity. Turbidity in the water column resulting from offshore export cables, OSPs, inter-array cables, and WTG installation is expected to disperse quickly and be localized to the immediate vicinity of construction activities (see Appendix F1, Sediment Plume Impacts from Construction Activities; Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment). Any effects of changes to ambient light will be limited to proposed landfall locations where eelgrass beds or clusters of macroalgae were identified along the northern portions of the proposed export cable corridors.

6.5.2.2.2 Decommissioning

If the offshore export cables are removed during decommissioning, the potential effects to seagrasses and macroalgae will be similar to those expected during construction. The turbidity in the water column as a result of removing the offshore export cables will be localized to the proposed export cable corridors and will disperse quickly. The proposed Project's offshore export cables may be left in place to minimize environmental effects, thus resulting in no change to ambient lighting.

6.5.2.3 Change in Ambient EMF

Operation of the submarine cables along the proposed export cable corridors will generate EMF, although several elements of the proposed Project's design will contribute to the minimization and mitigation of EMF. EMF modeling conducted for the proposed Project, as described in Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project, indicates that HDD installation in nearshore areas will reduce, but not entirely eliminate magnetic fields in the area where eelgrass beds or clusters of macroalgae were identified. More specifically, along the northern portions of the proposed export cable corridors, near the landfall locations (to be confirmed along the Brayton Point export cable corridor following survey activities). Magnetic fields in offshore areas beyond the eelgrass beds would be anticipated to be greater to some extent, with magnetic fields being greatest at the cable centerline and decreasing almost exponentially as distance from the centerline increases. Some research indicates that EMF may serve as a stressor on plant metabolism and may affect growth and reproduction (Vian et. al., 2016; Cucurachi et. al., 2013).

6.5.2.4 Actions that may Displace Biological Resources (Eelgrass and Macroalgae)

6.5.2.4.1 Construction

Physical displacement of macroalgae will occur during the construction of the offshore export cables with the detachment and fragmenting of the macroalgae. Due to the potential for vegetative regrowth, fragments of macroalgae may be transported away from the immediate work area by currents and reestablish itself at a new location. Macroalgae spores may also be transported away from the area of disturbance and allowed to reestablish in other suitable habitats. Macroalgae may rapidly recolonize disturbed areas.

Offshore export cable installation and the location of the HDD exit pit are planned for outside the mapped eelgrass extents at the cable landfall locations. However, eelgrass may be inadvertently affected if not mapped. The potential for large-scale reestablishment at a new location (of rooted species fragments that may inadvertently be displaced during construction) is unlikely as eelgrass can only propagate via rhizome extension from an extant bed, or from successful seed germination. Reestablishment of eelgrass may naturally occur over a much longer period, but this is less certain. Without mitigation, recolonization of eelgrass in the complex habitat area in the nearshore area is less certain and expected to occur over a longer period of time.

6.5.2.4.2 Decommissioning

If the offshore export cables are removed during decommissioning, the displacement effects will be similar to those expected during construction. The offshore export cables may be left in place to minimize environmental effects, thus resulting in no displacement.

6.5.2.5 Actions that may Cause Direct Injury or Death

6.5.2.5.1 Construction and Decommissioning

During construction and decommissioning, the installation and potential removal of the offshore export cables will result in direct mortality of seagrass and macroalgae, particularly eelgrass, in the offshore export cable footprint. Recolonization of eelgrass is expected to be slow, uncertain and/or incomplete if left unmitigated. Macroalgae recolonization is expected to be faster than eelgrass and other seagrasses due to vegetative regrowth of surviving individuals and/or recruitment from spores. Project offshore export cables may be left in place to minimize environmental effects, thus resulting in no direct injury or death.

6.5.2.5.2 Operations and Maintenance

Regular operations will not cause injury or death to eelgrass or macroalgae. In the case of repair or replacement of offshore export cables, effects will be similar to those anticipated during construction and decommissioning.

6.5.2.6 Planned Discharges

Vessels used during offshore construction, operations, and decommissioning activities may routinely release bilge water, engine cooling water, deck drainage and/or ballast water. Such releases will quickly be dispersed and diluted and will cease when Project activities are complete. Vessels engaged in construction and decommissioning may experience unplanned releases of oil, solid waste, or other materials.

6.5.2.7 Accidental Events

Fuel spills or leaks from vessels can affect vegetation. During the construction, operations, and decommissioning phases of the proposed Project, increased vessel traffic in the area of construction and at nearby ports may increase the likelihood of unplanned releases. See Section 33.17, Chemical and Waste Management, for information on waste generation and disposal. Due to expected dispersion and dilution, no negative effects of discharges to vegetation are anticipated. Vessels and all Project activities will also comply with the regulatory requirements related to the prevention and control of discharges and the prevention and control of accidental spills as documented in Appendix AA, Oil Spill Response Plan.

6.6 BENTHIC AND SHELLFISH

This section describes benthic and economically and ecologically important shellfish resources that may occur in the Offshore Project Area and includes an evaluation of potential Project-related effects. For this section, the Offshore Project Area is defined as the Lease Area and the proposed offshore export cable corridors. The Falmouth export cable corridor extends from the Lease Area through Muskeget Channel and ends at one of the proposed Project's landfall locations in Falmouth (Worcester Avenue with alternate sites at Shore Street and Central Park), Massachusetts. The Brayton Point export cable corridor extends from the Lease Area through Rhode Island Sound, up the Sakonnet River, and into Mount Hope Bay before terminating at one of the proposed Project's landfall locations in Somerset (eastern and western sites at Brayton Point), Massachusetts. Technical appendices relating to benthic and shellfish include:

- Appendix M, Benthic and Shellfish Resources Characterization Report
- Appendix N, Essential Fish Habitat Assessment and Protection Fish Species Assessment
- Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan

This evaluation is based on the results of five benthic field surveys completed by Mayflower Wind in Spring 2020, Summer 2020, Fall 2020, Spring 2021, and Summer 2021, in addition to the published scientific literature and publicly available reports referenced in Appendix M, Benthic and Shellfish Resources Characterization Report. Detailed methods and results for the benthic surveys and analysis are included in Appendix M, Benthic and Shellfish Resources Characterization Report and Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment. To fully evaluate benthic habitat, these technical appendices also integrate geophysical data from the 2020 and 2021 Geophysical and Geotechnical (G&G) (see Appendix E, Marine Site Investigation Report). Benthic information available from surveys completed on leases adjacent to the Lease Area and in Muskeget Channel was also reviewed (Epsilon Associates, Inc., 2020).

Benthic surveys of the Brayton Point export cable corridor are ongoing. Fugro and Integral conducted an initial benthic survey along the Brayton Point export cable corridor in Summer 2021; a second survey is scheduled for Spring 2022. Results of the surveys to Brayton Point will be provided following data acquisition, analysis, and review.

Consistent with BOEM guidance (BOEM, 2019a) and NMFS recommendations (NOAA Fisheries, 2021a), the Project has conducted a series of benthic surveys over the Lease Area, along the export cable corridors, and at control areas to characterize the benthic resources in the Offshore Project Area. The surveys were conducted as described in the *Benthic Infaunal and Seafloor Habitat Study Quality Assurance Project Plan* (AECOM, 2020), including collection of sediment grab samples, real-time video, and sediment profile imaging/plan view (SPI/PV) imaging data. Results of high-resolution geophysical data described in Section 4.1.2 were used to refine the characterization of benthic habitat conditions. The Field Sampling Plans for these surveys are included in Appendix M.

Data from all benthic surveys were evaluated in accordance with BOEM's guidelines on benthic habitat surveys for renewable energy development (BOEM, 2019a) and NMFS's supplemental recommendations on mapping essential fish habitat (NOAA Fisheries, 2021a). The Coastal and Marine Ecological Classification Standard (CMECS) (FGDC, 2012), the use of which is recommended by BOEM's Benthic

Habitat Survey Guidelines (BOEM, 2019a) and modified by NMFS (NOAA Fisheries, 2020), provides a means to categorize habitat using the Substrate and Biotic data. Specific CMECS classifications are capitalized as formal terms (i.e., Substrate, Biotic) to differentiate from qualitative terminology.

6.6.1 Affected Environment

This section identifies and describes the different types of benthic habitats that may be present in the Offshore Project Area during construction, operations, and decommissioning activities. Benthic habitat types that occur in the Offshore Project Area and the species associated with those habitats are evaluated in the subsections below. Habitat characteristics assessed include geomorphological features, surface sediments, and the abundance and distribution of benthos, particularly benthic macrofauna species. Mayflower Wind has included an analysis of whether, and to what extent, benthic resources may be exposed to and potentially impacted by the Project activities. This characterization is primarily based on results of the benthic and geophysical surveys completed by Mayflower Wind (Appendix E, Marine Site Investigation Report; Appendix M, Benthic and Shellfish Resources Characterization Report) and supplemented by desktop analysis to establish a baseline of these resources. Data sources used to support this benthic characterization analysis and baseline follow BOEM's 2019 *Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585* (BOEM, 2019a) and the NMFS Recommendations for Mapping Fish Habitat (NOAA Fisheries, 2020) are listed in **Table 6-33**.

TABLE 6-33. BENTHIC AND SHELLFISH LITERATURE, GUIDELINES, REPORTS, AND DATA SOURCES

Author	Source Title	Citations
BOEM	South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement	BOEM, 2021
BOEM	Vineyard Wind 1 Offshore Wind Energy Project Supplement to the Draft Environmental Impact Statement	BOEM, 2020
BOEM	Benthic and Epifaunal Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Project Report	HDR, 2020
BOEM	Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations	ICF Incorporated, L.L.C., 2020
BOEM	National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf	BOEM, 2019b
BOEM	Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England	CSA Ocean Sciences, 2019
BOEM	Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island–Year 2	HDR, 2019
BOEM	Habitat Mapping and Assessment of Northeast Wind Energy Areas	Guida et al., 2017

Author	Source Title	Citations
BOEM	Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts. Revised Environmental Assessment	BOEM, 2014
BOEM	Effects of EMFs from Undersea Power Cables on Elasmobranch and Other Marine Species	Normandeau Associates, 2011
U.K. Department for Business Enterprise and Regulatory Reform	Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry	BERR, 2008
Epsilon Associates, Inc.	Vineyard Wind Draft Construction and Operations Plan	Epsilon Associates, Inc., 2020
INSPIRE Environmental	Year 1 Report for 2016 Summer Post-Construction Surveys to Characterize Potential Impacts and Response of Hard Bottom Habitats to Anchor Placement at the Block Island Wind Farm	Guarinello et al., 2017
Massachusetts Division of Marine Fisheries (MA DMF)	Shellfish Suitability Areas	Massachusetts Division of Marine Fisheries, 2020
NMFS GARFO	Recommendations for Mapping Fish Habitat	NOAA Fisheries, 2021a
NEFSC	Ecology of the Northeast U.S. Continental Shelf (Species richness and biomass bottom trawl surveys)	NEFSC, 2020a
NEFSC	Spring 2020 Bottom Trawl Survey	NEFSC, 2020b
USGS	Geological Sampling Data and Benthic Biota Classification—Buzzards Bay and Vineyard Sound	Ackerman et al., 2015
USGS	U.S. Geological Survey East-Coast Sediment Texture Database	USGS, 2005
Related COP Appendices		
AECOM	Essential Fish Habitat and Protected Fish Species Assessment	Appendix N
AECOM	Benthic Resource Characterization Report	Appendix M
AECOM	Seagrass and Macroalgae Characterization Report	Appendix K
AECOM	Emergency Response Plan/OSRP	Appendix AA
Fugro	Marine Site Investigation Report (marine geophysical survey of the Offshore Project Area)	Appendix E
Fugro	Sediment Plume Impacts from Construction Activities	Appendix F1, F3
IES and Swanson Environmental	Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment	Appendix F3
Gradient	EMF Assessment for the Proposed Mayflower Wind Project	Appendix P1
Integral Consulting, Inc.	Sediment Profile and Plan View Imaging Survey of the Mayflower Wind Offshore Project Area	Appendix M
JASCO Applied Sciences	Mayflower Wind Underwater Acoustics Technical Report: Underwater Acoustic Modeling and Animal Exposure Estimation for Mayflower Wind Energy, LLC.	Appendix U2

6.6.1.1 Offshore Project Area Overview

A bathymetric map showing the contours of the seabed in the Lease Area and the export cable corridors is included in **Figure 6-18**. Mobility of surficial sediments throughout the Lease Area and export cable corridors is evidenced by the arrangement of unconsolidated sands in waves, megaripples, and ripples that can change over a short period of time. The deeper shelf waters of the Lease Area and export cable corridors are characterized by predominantly rippled sand and silt-clay. Where the Falmouth export cable corridor enters Muskeget Channel and Nantucket Sound, the surficial sediments become coarser sand with gravel and hard bottoms (i.e., pavement), and large sand waves of varying heights were noted in survey data. The coarser material represents reworked glacial materials. The portion of the Brayton Point export cable corridor in Rhode Island Sound ranges from slightly gravelly sand to sandy gravel; grain size generally decreases as the export cable corridor enters the Sakonnet River and Mount Hope Bay (Stokesbury, 2012, 2014). The Brayton Point export cable corridor also crosses areas of moraine mapped in Rhode Island Sound (CRMC, 2010). The complete classification of the seafloor in the Offshore Project Area is provided in Appendix E, Marine Site Investigation Report.

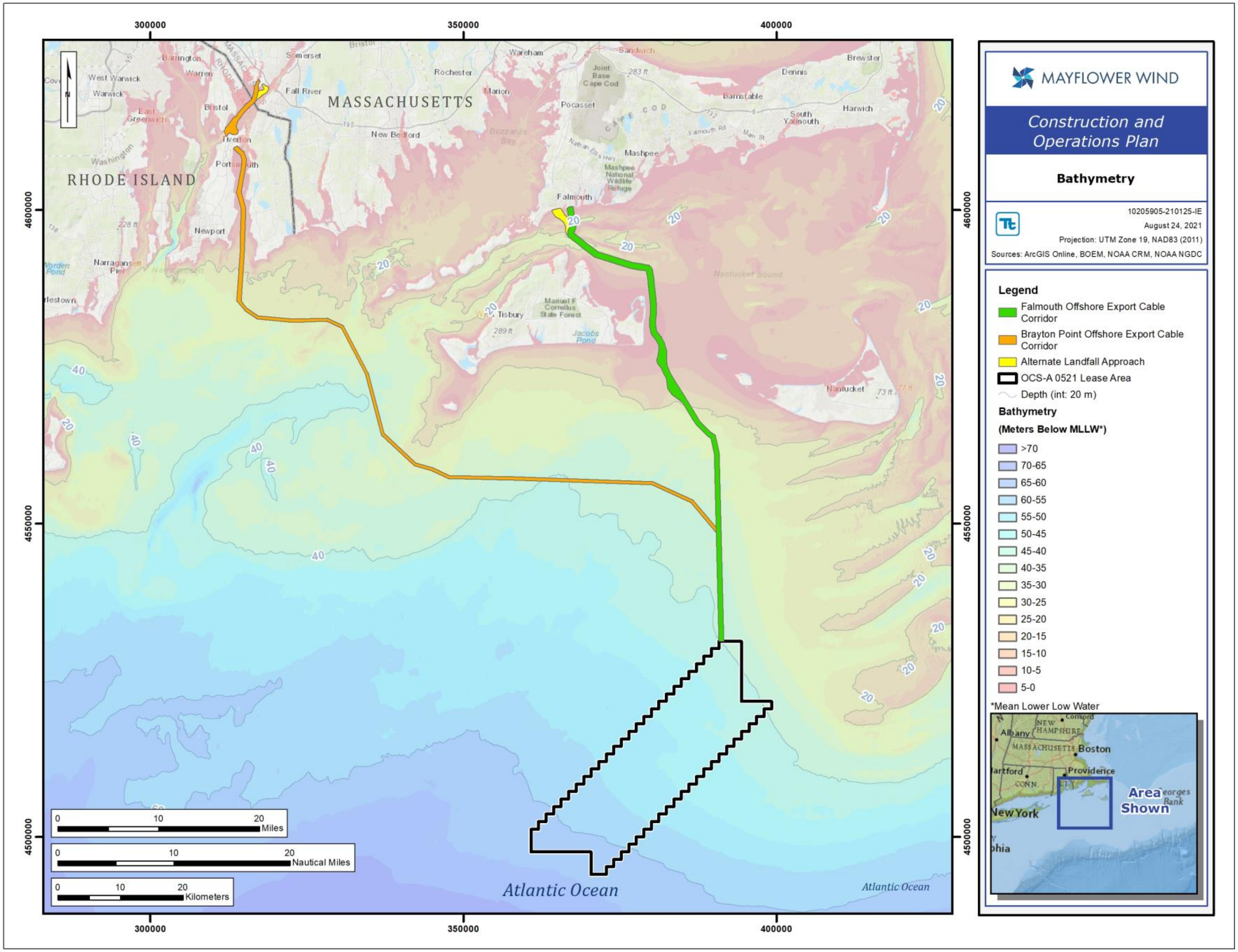
6.6.1.2 Lease Area

The seafloor of the Lease Area is mostly flat with slopes ranging from very gentle (less than 1.0°) to gentle (1.0° to 4.9°, Appendix E, Marine Site Investigation Report). The central section of the Lease Area comprises ridges with moderate slopes (5.0° to 9.9°) that are characterized by shallow channels. The deeper shelf waters of the Lease Area are predominantly rippled sand and soft bottom. The water depths, in relation to MLLW, within the Lease Area range from 121.72 feet (37.1 m) to 208.3 feet (63.5 m), with deeper waters in the southwestern portion. The average depth is 164.0 feet (50.0 m). The WTG/OSP positioned at AQ35, located at latitude 40.602469 and longitude -70.51783, will be the deepest position in the Lease Area, placed at a depth of 206.7 feet (63.1 m).

Based on the NOAA Deep-Sea Coral Data Portal, there are no hard coral areas within or in the immediate vicinity of the Lease Area (NOAA, 2020). The closest hard coral areas are cup corals observed within Buzzards Bay and Vineyard Sound and along the continental shelf edge.

6.6.1.3 Falmouth Export Cable Corridor

Similar to the Lease Area, the southern portion of the Falmouth export cable corridor (defined as the portion of the Falmouth export cable corridor between the Lease Area and the Muskeget Channel) is predominantly rippled sand and silt-clay (Appendix E, Marine Site Investigation Report). As the Falmouth export cable corridor moves northward toward Nantucket Shoals and Muskeget Channel, surface sediment becomes coarser (sand with gravel) and hard bottoms are common, which provides ideal habitat for various shellfish species. A more complete description of the geomorphological and substrate classifications of the Offshore Project Area seafloor is provided below and in Appendix M, Benthic and Shellfish Resources Characterization Report.



Source: NOAA NGDC, 2008; NOAA NGDC, 1999

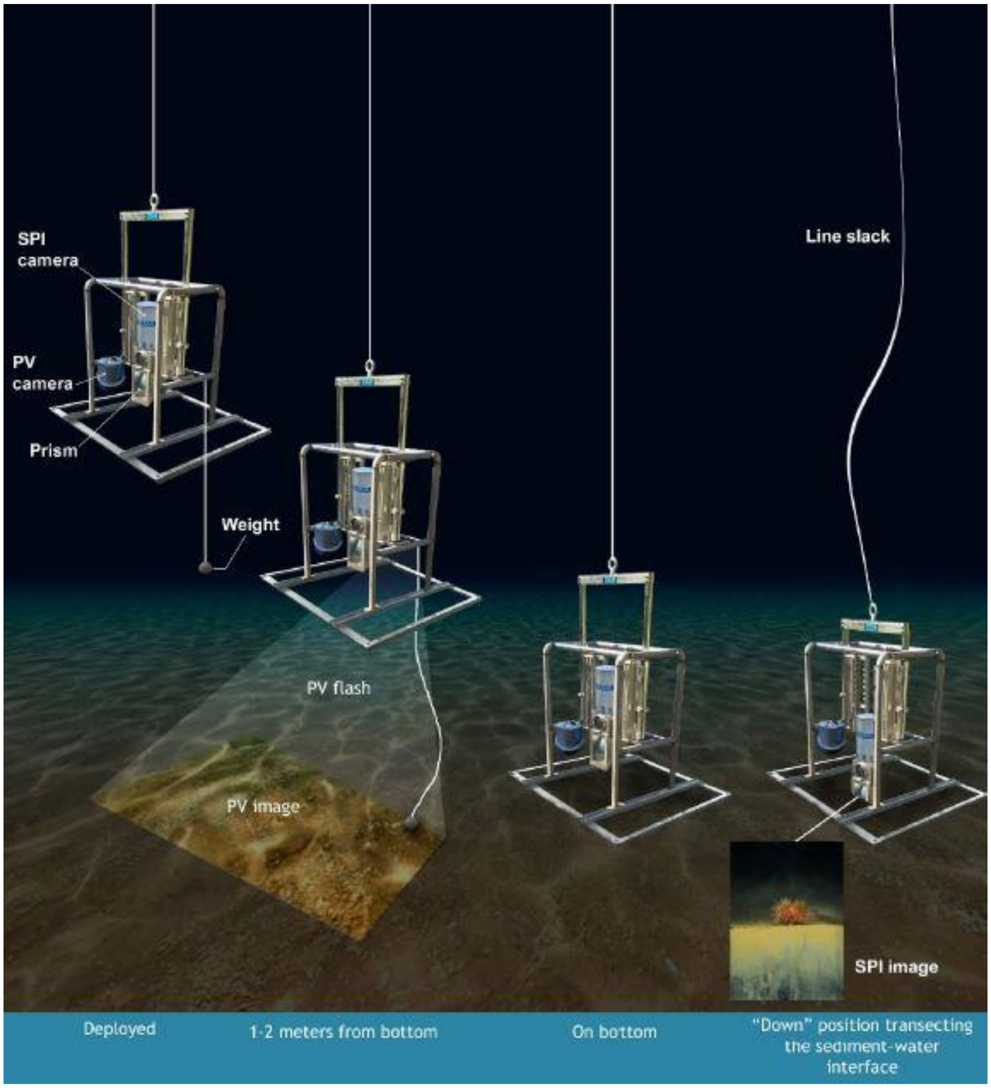
FIGURE 6-18. BATHYMETRY OF THE OFFSHORE PROJECT AREA

6.6.1.4 Brayton Point Export Cable Corridor

Substrate in the offshore portion of the Brayton Point export cable corridor near the Lease Area is characterized as sand and muddy sand; as the export cable corridor enters Rhode Island Sound, sediments increase in grain size and range from slightly gravelly sand to sandy gravel (Appendix E, Marine Site Investigation Report; Stokesbury, 2012, 2014). An area of glacial moraines marking the maximum extent of the Laurentian Ice Sheet lies southwest of Martha's Vineyard in Rhode Island Sound; the glacial till provides heterogeneous and hardbottom substrates in the form of gravel and boulders (Stokesbury, 2014; CRMC, 2010). Grain size generally decreases to sandy gravel and slightly gravelly mud as the export cable corridor enters the Sakonnet River and Mount Hope Bay. A small number of bedforms were present in the southern portion of this area where Mount Hope Bay constricts and focuses tidal currents and likely supports the formation and preservation of the observed bedforms (Appendix E, MSIR). Anthropogenic rock dumps associated with the former Stone and Railroad Bridges provide additional hardbottom habitat in the Sakonnet River, supporting complex communities of attached shellfish and encrusting organisms that provide habitat for mobile benthic and demersal species. Sakonnet River morphology was largely smooth, with interspersed rippled bedforms related to tidal currents and isolated mounds associated with gastropod reefs (*Crepidula*). There was also evidence of anthropogenic debris such as rock and backfill over pipelines. A previously unmapped section of interpreted submerged aquatic vegetation was recognized near the shoreline closest to the Aquidneck Island landfall (near KP 15) (Appendix E, MSIR). Hardbottom is identified as a Special, Sensitive, or Unique Resource in the Massachusetts Ocean Management Plan (MA CZM, 2015) and a sensitive habitat in the Rhode Island Ocean Special Area Management Plan (CRMC, 2010). Epifauna and Infauna CMECS Biotic groups observed in grab, video, and SPI-PV samples collected in this portion of the export cable corridor are characterized as Large Tube Building Fauna and isolated Gastropod Reefs (*Crepidula*). Isolated occurrences of algae, sessile gastropods, large deep-burrowing fauna were also seen. Survey results for epifauna in the Brayton Point export cable corridor are presented in Appendix M (Attachment 4 and 7b; results for infauna are shown in Attachment 7c).

6.6.1.5 Benthic Characterization Methodology

Consistent with BOEM guidance (BOEM, 2019a) and NMFS recommendations (NMFS, 2020), seasonal benthic surveys were conducted in the Lease Area along the Falmouth export cable corridor (survey extending 1 km to either side of the corridor center line) and at control areas to characterize the benthic resources in the Offshore Project Area (Appendix M, Benthic and Shellfish Resources Characterization Report). Benthic habitat surveys conducted for the proposed Project included SPI and PV data (**Figure 6-19**) and benthic grab samples throughout the Offshore Project Area (Appendix M, Benthic and Shellfish Resources Characterization Report). The NMFS guidance Coastal and Marine Ecological Classification Standard (CMECS) substrate classification modifiers (NMFS, 2020) were used for this assessment, and characterization results of the benthic habitat surveys are summarized in Section 6.6.1.6 below



Source: Integral Consulting, Inc., 2020a

FIGURE 6-19. DIAGRAM OF SPI/PV DATA COLLECTION DURING MAYFLOWER WIND BENTHIC SURVEYS

The distribution of benthic epifaunal and infaunal species in the Offshore Project Area was analyzed using benthic grabs and seafloor imagery captured by the benthic survey SPI/PV camera and a video camera that was affixed to the benthic grab apparatus. Each PV replicate image was classified to CMECS standards for biotic components, biotic groups, and co-occurring biotic groups, which provides detailed information on the biological community structure and organisms observed at each sample location (NMFS, 2020; see **Table 6-34**). Benthos characterization results of the benthic habitat surveys are summarized in Section 6.6.1.7 below.

TABLE 6-34. BIOTIC GROUP CLASSIFICATIONS

Biotic Subclass	Biotic Group
Attached Fauna	Attached Bryozoans
	Attached Hydroids
	Attached Sponges
	Attached Tunicates
	Attached Sea Urchins
	Barnacles
	Chitons
	Mobile Crustaceans on Mixed Substrate
	Diverse Colonizers
	Mobile Mollusks on Hard or Mixed Substrate
	Sessile Gastropods
Soft Sediment Fauna	Burrowing Anemones
	Soft Sediment Brittle Stars
	Clam Bed
	Mobile Crustaceans on Soft Sediment
	Diverse Soft Sediment Epifauna
	Larger Deep-burrowing Fauna
	Larger Tube-building Fauna
	Soft Sediment Bryozoans
	Sand Dollar Bed
	Small Surface Burrowing Fauna
	Starfish Bed
	Small Tube-Building Fauna
	Sea Urchin Bed
Mollusk Reef Biota	Gastropod Reef
	Crepidula Reef
	Mussel Reef
Inferred Biota	Tracks and Trails a/
Benthic Macroalgae	Leafy Algal Bed
Other	None Apparent

Note:
a / Tracks and Trails is a biotic group category for unidentified mobile epifauna that have left tracks and trails in the sediment (FGDC, 2012).

6.6.1.6 Benthic Seafloor Substrate Classifications

Substrate classification describes the physical aspects of the seabed based on particle size and composition of the substrate surface features. The SPI/PV images, grain size data from benthic survey grab samples, and images (grab camera) were used to identify the CMECS Substrate Components and potential areas of complex habitat.

NMFS further defines three types of complex habitats based on CMECS classifications (NMFS, 2020):

- **Hard bottom substrates** including CMECS Groups: Gravel, Gravel Mixes, Gravelly and Shell;

- **Hard bottom substrate with epifauna or macroalgae cover**;
- **Vegetated habitats** such as tidal wetlands and submerged aquatic vegetation.

A map showing generalized sediment types in the Project Area is included in **Figure 6-20**. Substrate found in the Lease Area, southern Falmouth export cable corridor, and northern Falmouth export cable corridor are listed in **Table 6-35** and described below.

TABLE 6-35. SUBSTRATE CLASSIFICATIONS IDENTIFIED IN THE OFFSHORE PROJECT AREA, SPRING AND SUMMER, 2020

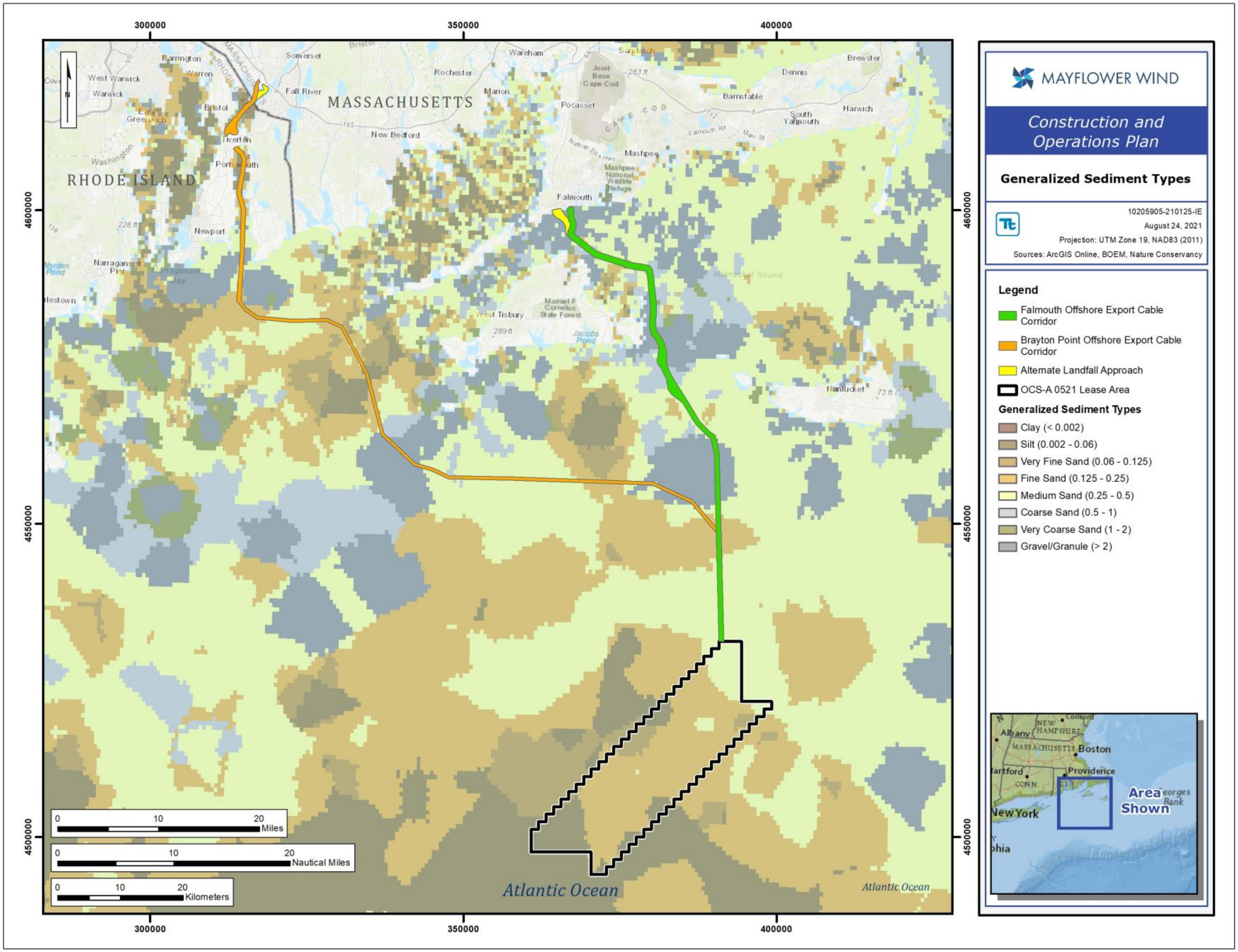
Project Components	Substrate Classifications		
	Subclass	Group	Subgroup
Lease Area	Fine Unconsolidated	Muddy Sand	N/A
		Mud	N/A
		Sand	Fine/Very Fine Sand
	Coarse Unconsolidated a/	Gravelly	Gravelly Muddy Sand
Southern Falmouth Export Cable Corridor	Fine Unconsolidated	Sand	Fine/Very Fine Sand
			Fine Sand
		Muddy Sand	N/A
	Coarse Unconsolidated	Gravelly	Gravelly Sand
Northern Falmouth Export Cable Corridor	Shell Reef	Crepidula reef	N/A
	Fine Unconsolidated	Sand	Fine/Very Fine Sand
			Medium Sand
			Very Coarse/Coarse Sand
	Coarse Unconsolidated	Gravel Mixes	Sandy Gravel
		Gravelly	Gravelly Sand
		Gravels	Pebble/Granule
			Gravel Pavement

Note:

a/ Coarse Unconsolidated Substrate was only identified in the Lease Area during the Mayflower Wind summer benthic surveys

6.6.1.6.1 Lease Area

Within the Lease Area, the CMECS substrate classifications (during the Spring 2020 and Spring 2021 surveys are shown in **Figure 6-21**. Substrate classification information collected during other seasons of surveys can be found in Appendix M. Detailed information on the transects depicted in **Figure 6-21** can be found in Appendix M. The Lease Area is mostly homogenous with little relief; it is considered Soft Bottom habitat with no complex features. Total organic carbon (TOC) was generally less than 1 percent.



Source: Interpolated data from USGS usSEABED: Atlantic Coast offshore surficial sediment data (Data series 118, version 1.0); USGS East Coast Sediment Texture Database (2005); Woods Hole Coastal and Marine Science Center (Anderson et al., 2010)

FIGURE 6-20. GENERALIZED SEDIMENT TYPES OF THE CONTINENTAL SHELF

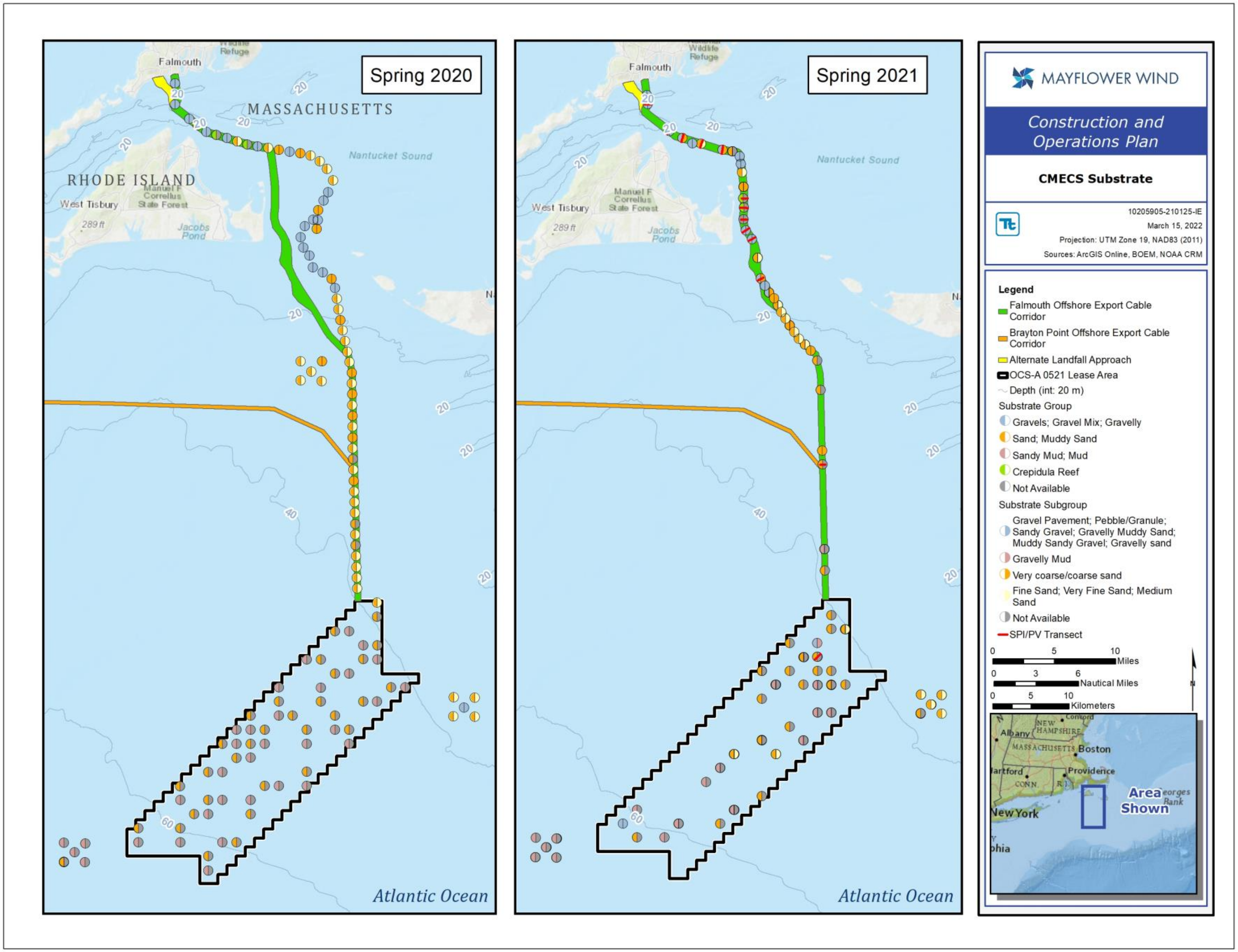


FIGURE 6-21. CMECS SUBSTRATE CLASSIFICATIONS

6.6.1.6.2 Falmouth Export Cable Corridor – Southern Portion

The southern Falmouth export cable corridor samples from Spring 2020 and Spring 2021 are shown in **Figure 6-21**. Substrate classification information collected during other seasons of surveys can be found in Appendix M. Detailed information on the transects depicted in **Figure 6-21** can be found in Appendix M.

6.6.1.6.3 Falmouth Export Cable Corridor – Northern Portion

The northern Falmouth export cable corridor from Spring 2020 and Spring 2021 are shown in **Figure 6-21**. Substrate classification information collected during other seasons of surveys can be found in Appendix M. Detailed information on the transects depicted in **Figure 6-21** can be found in Appendix M. Areas of complex habitat were noted throughout the northern Falmouth export cable corridor, primarily due to the Group Gravel or Gravelly classifications. Some Gravel Pavement was noted in the SPI/PV images. Details of this are discussed in Appendix N, Essential Fish Habitat and Protected Fish Species Assessment.

6.6.1.6.4 Brayton Point Export Cable Corridor

Sediment in the Brayton Point export cable corridor is expected to be finer offshore near the Lease Area, becoming coarser through Rhode Island Sound and towards the shoreline. Areas of moraine are anticipated, extending from Martha's Vineyard and the Elizabeth Islands, and scattered in Rhode Island Sound (Stokesbury, 2012, 2014; Anderson et al., 2010; USGS, 2005). This area is expected to contain Coarse Unconsolidated substrates (e.g., Gravel Subgroups spanning Granule to Boulder, other Subgroups within Gravelly and Gravel Mix Groups). Sediments in the Sakonnet River are expected to be finer sands to silts with areas of boulders (NBEP, 2017; Stokesbury, 2012, 2014; Anderson et al., 2010; USGS, 2005). The portion of the Brayton Point export cable corridor nearest the landfall in Mount Hope Bay is expected to contain fine sands to muds.

Benthic surveys are in progress along the Brayton Point export cable corridor to ground-truth available data. The July 2021 benthic survey collected 34 benthic grab samples, 64 SPI/PV locations, 10 SPI/PV transects, and 7 video transects along the Brayton Point export cable corridor. CMECS Substrate categorization is shown in **Figure 6-22** (Brayton Point export cable corridor). Detailed information on the transects depicted in **Figure 6-22** can be found in Appendix M. Survey methods, sample locations, and preliminary results are in Appendix M; additional imagery is in Appendix M, Attachment 4. Full survey results will be provided once site-specific surveys have been completed and all have been data validated and analyzed.

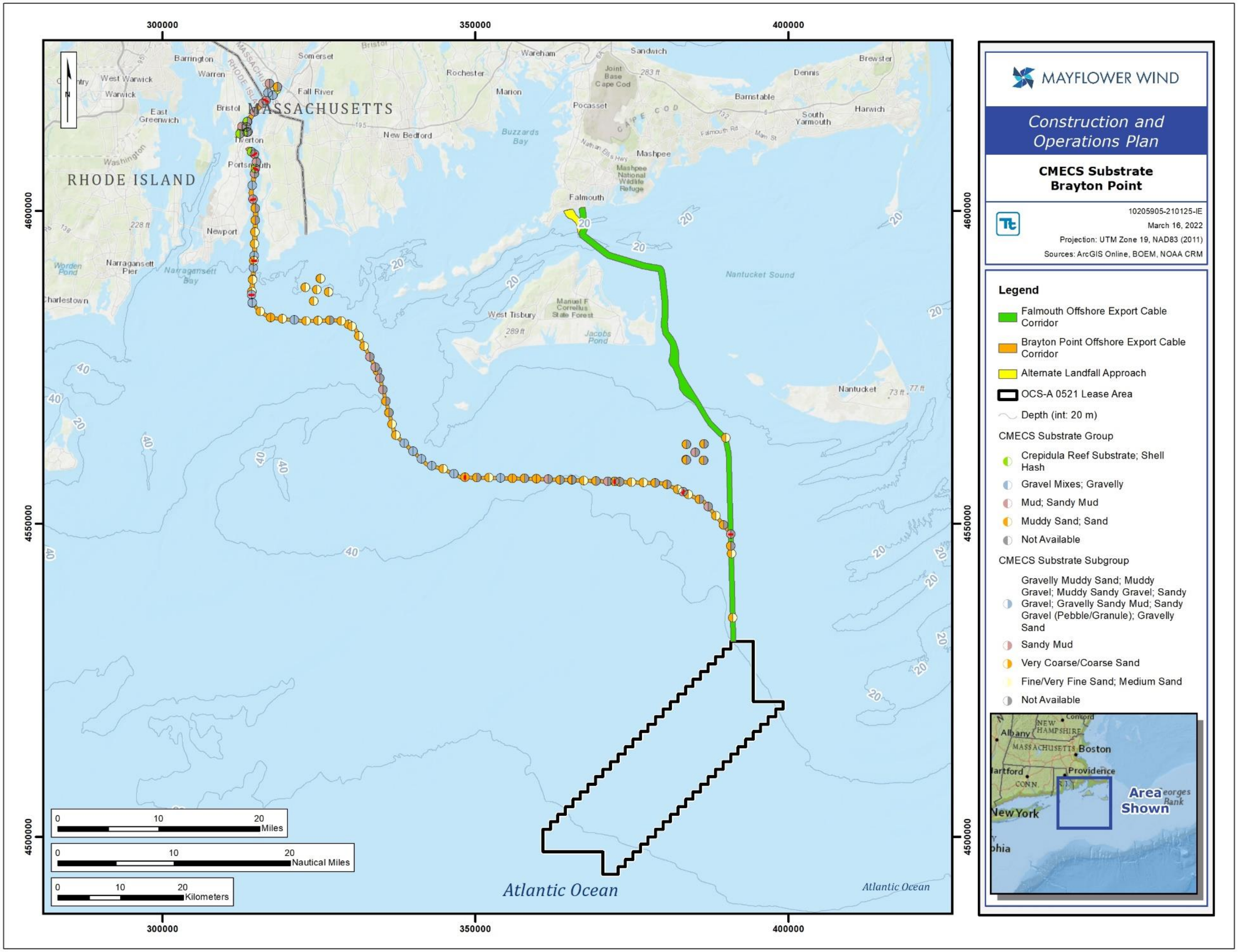


FIGURE 6-22. CMECS SUBSTRATE CLASSIFICATIONS ALONG THE BRAYTON POINT EXPORT CABLE CORRIDOR

6.6.1.7 Benthic Epifauna and Infauna

Benthos, living organisms that inhabit benthic ecosystems, are typically classified either by size or by substratum (Taylor, 2019). These organisms play a role in oxygenating seafloor sediment, nutrient recycling, and decomposing organic matter, which are essential for the ecological health of coastal and offshore ecosystems (Janus et al., 2019). Benthic organisms range in size from microfauna (generally invisible to the human eye), slightly larger meiofauna, macrofauna (visible but difficult to identify without magnification), and megafauna (easily seen in videos and still images). The categorization of these general groups by size varies among researchers, partly determined by the mesh size of the sieve used to collect the organisms (Schlacher and Wooldridge, 1996; Hemery et al., 2017; Ptatscheck et al., 2020). Many invertebrates occur in one group or another as they grow from egg to larva to adult. Benthic organisms can also be classified as epifauna (sessile and mobile invertebrate organisms that live on the seafloor) and infauna (burrowing invertebrate organisms that live within seafloor sediments; NEFSC, 2020a). Epifaunal and infaunal species observed during field surveys, other species typically found in the habitat, and the coinciding benthic substrates are summarized in **Table 6-36** (Lease Area), **Table 6-37** (southern Falmouth export cable corridor), **Table 6-38** (northern Falmouth export cable corridor), and **Table 6-39** (Brayton Point export cable corridor).

6.6.1.7.1 Epifauna

The types of epifauna observed in benthic field surveys in the Spring 2020 and Spring 2021 benthic sampling rounds are illustrated in **Figure 6-23,** and include: macroalgae, sponges, bryozoans, hydroids, barnacles, tunicates, anemones, gastropods, bivalves, nudibranchs, urchins, brittle stars, starfish, sand dollars, crabs, amphipods, isopods, shrimp, and squid (see Appendix M, Benthic and Shellfish Resources Characterization Report). Epifauna observations collected during other seasons of surveys along the Falmouth export cable corridor can be found in Appendix M. The types of epifauna observed in the benthic field surveys of the Brayton Point export cable corridor are illustrated in **Figure 6-24**. Detailed information on the transects depicted in **Figure 6-23** and **Figure 6-24** can be found in Appendix M. Epifauna found in the Lease Area were predominantly mobile crustaceans and mollusks that live on soft sediments. The southern Falmouth export cable corridor contained similar epifauna to the Lease Area due to its similar substrate composition. Suitable habitat for attached, sessile epifauna (i.e., macroalgae, hydroids, bryozoans, sponges) includes hard bottom substrate (gravels, cobbles, shells, man-made objects, etc.); therefore, sessile epifauna were only found along the northern Falmouth export cable corridor and the northernmost area of the southern Falmouth export cable corridor. Sample locations predominately comprised attached epifauna along the Falmouth export cable corridor and were found to be more than 75 percent coarse sediment. Mobile crustaceans that inhabit coarser, mixed substrates and reef made of *Crepidula* shell were also observed along the northern Falmouth export cable corridor.

Spring and Summer 2020 surveys did not extend into the Brayton Point export cable corridor. However, epifaunal species within this corridor are expected to be similar to those in the Falmouth export cable corridor given their geographic proximity and similarities in substrate composition. Sand and Muddy Sand substrates in the offshore portion of the Brayton Point export cable corridor are expected to support mobile taxa common to soft sediments, including the bivalves, crustaceans, echinoderms, gastropods, oligochaetes, and polychaetes observed in the southern Falmouth export cable corridor (**Table 6-37**). The glacial till in Rhode Island Sound and the anthropogenic rock dump area in the Sakonnet River are expected to support attached and encrusted organisms in addition to structure-associated mobile taxa typical of hard substrates, including the bivalves, bryozoans, echinoderms, gastropods, and polychaetes observed in the northern Falmouth export cable corridor (**Table 6-38**). Finally, the Coarse and Mixed Sediments in the Sakonnet River and Mount Hope Bay are expected to support the same taxa observed in the Coarse and Mixed Sediments observed at various locations along the Falmouth export cable corridor (**Table 6-37; Table 6-38**). Prior surveys of benthic macroinvertebrates in portions of the Brayton Point export cable corridor have reported sand dollars, sea stars, American lobster, Jonah crab, and rock crab (Malek et al., 2014; Stokesbury, 2012, 2014, NEFSC 2020a, 2020). A benthic survey was conducted in July 2021 along the Brayton Point export cable corridor to ground-truth existing reports; results are provided in **Table 6-39** and Appendix M.

TABLE 6-36. COMMON SPECIES BY HABITAT TYPE IN THE LEASE AREA

Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/	Other Species Typically Found in the Habitat	References
Coarse Sediment	Bivalvia	None	Jingle shells, discord mussels, Atlantic sea scallop (*Placopecten magellanicus*)	Norden, 2012; Greene et al., 2010
	Echinodermata	None	Green sea urchin (Strongylocentrotus droebachiensis), brittle star (Ophiopholis amphiuridae)	Greene et al., 2010
	Crustacea	None	American lobster (*Homarus americanus*), hermit crabs, lyre crab (*Hyas coartatus*), Aesop shrimp (*Pandalus montagui*), Jonah crab (*Cancer borealis*), Atlantic horseshoe crab (*Limulus polyphemus*)	National Wildlife Federation (NWF), 2021; BOEM, 2020; Greene et al., 2010;
Sand and Muddy Sand	Bivalvia	Subsurface feeder: Atlantic nut clam (*Nucula proxima*). Suspension/filter feeder: Atlantic surf clam, oval spoon clam (*Periplom leanum*), ocean quahog (Artica islandica)	Atlantic sea scallop	Norden, 2012
	Polychaeta	Subsurface feeder polychaetes Polygordius jouinae and Levinsenia gracilis	Sternaspidae Onuphidae	Maurer and Wigley, 1984

Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/	Other Species Typically Found in the Habitat	References
	Oligochaeta	Subsurface feeder: Oligochaeta spp.	—	—
	Crustacea	Tube forming amphipods (*Ampelisca* spp.), hermit crabs (Paguridae), Cancer spp., Atlantic rock crab (*Cancer irroratus*), Phoxocephalidae, *Chiridotea* spp. and Haustoriidae amphipods	Sand shrimp (Crangon septemspinosa), pandalid shrimp (Pandalidae), Jonah crab, Atlantic horseshoe crab	NWF, 2021; BOEM, 2020; Vineyard Wind, 2020; SFWF, 2018
	Echinodermata	Common sand dollars (*Echinarachnius parma*)	Blood star (*Henricia sanguinolenta*); Class Ophiuroidea	SFWF, 2018; Maurer and Wigley, 1984
	Gastropoda	Mud snails (*Nassarius* spp.), channeled whelk (*Busycotypus canaliculatus*)	Northern moon snail (*Lunatia heros*)	SFWF, 2018

Note: "Common" designation based upon desktop analysis of species habitat requirements and geographic distributions
a/ See Appendix M, Benthic and Shellfish Resources Characterization Report, for full list of species observed during 2020 Spring and Summer benthic surveys

TABLE 6-37. COMMON SPECIES BY HABITAT TYPE IN THE SOUTHERN FALMOUTH EXPORT CABLE CORRIDOR

Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/b/	Other Species Typically Found in the Habitat b/	References
Coarse Sediment	Crustacea	Caprellidae spp., Tanaidacea spp., *Ampelisca* spp., attached barnacles, hermit crabs (*Pagurus* spp.)	American lobster, Jonah crab	BOEM, 2020
	Bivalvia	Atlantic nut clam, Atlantic surf clam, chestnut astarte (*Astarte castanea*)	Atlantic sea scallop, jingle shells, discord mussels, blue mussels	BOEM, 2020; Norden, 2012; Greene et al., 2010
	Gastropoda	Threeline mud snail (*Tritia trivitatta*)	Knobbed whelk (*Busycon carica*)	—
	Oligochaeta	Oligochaeta spp.	—	—
	Polychaeta	*Polygordius* spp., Paraonidae , Lumbrineridae, and Nephtyidae.	—	—

Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/b/	Other Species Typically Found in the Habitat b/	References
	Bryozoa/Hydrozoa	Attached bryozoans and hydrozoans	—	—
	Porifera	Attached sponges	—	—
	Echinodermata	Sea urchins – attached, common sand dollar	Brittle star	Greene et al., 2010
Sand and Muddy Sand	Bivalvia	Subsurface feeder: Atlantic nut clam. Suspension/filter feeders: Atlantic surf clam, oval spoon clam (*Periploma leanum*), ocean quahog, chestnut astarte	Atlantic sea scallop, bay scallop (*Argopecten irradians*), *Nuculana* spp., paper clam (*Lyonsia arenos)*	Brand, 2016; Norden, 2012; Greene et al., 2010; Maurer and Wigley, 1984
	Gastropoda	Immaculate moonsnail (*Euspira immaculata*)	Northern moon snails (*Lunatia* spp.), pygmy whelk (*Colus pygmaeus*)	Greene et al., 2010
	Polychaeta	Subsurface feeder polychaetes *Polygordius jouinae* and *Levinsenia gracilis,* Orbiniidae Spionidae, Ampharetidae	Capitellidae	AECOM, 2012
	Oligochaeta	Subsurface feeder: oligochaetes	—	—
	Crustacea	Tube forming amphipods: *Ampelisca* spp.; hermit crabs (Paguridae); *Cancer* spp.; Atlantic rock crab; Phoxocephaliidae*,* Haustoriidae, Class Chiridotea and *Diastylis* spp., isopod *Edotia triloba*	Sand shrimp, pandalid shrimp (Pandalidae) Jonah crab, Atlantic horseshoe crab	NWF, 2021; Vineyard Wind, 2020; SFWF, 2018
	Echinodermata	Common sand dollars	Blood star, Amphioplus spp., Amphilimna olivacea	SFWF, 2018; Maurer and Wigley, 1984
	Gastropoda	Mud snails, channeled whelk	Northern moon snail	SFWF, 2018

Note: "Common" designation based upon desktop analysis of species habitat requirements and geographic distributions
a/ Appendix M, Benthic and Shellfish Resources Characterization Report, for full list of species observed during 2020 Spring and Summer benthic surveys
b/ Species also expected to be observed in Brayton Point export cable corridor

TABLE 6-38. COMMON SPECIES BY HABITAT TYPE IN THE NORTHERN FALMOUTH EXPORT CABLE CORRIDOR

Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/b/	Other Species Typically Found in the Habitat b/	References
Coarse Sediment	Crustacea	Hermit crabs (Paguridae), Caprellidae; tube-forming amphipods (*Cymadusa compta* and *Ampelisca* spp.), portly spider crab (*Libinia emarginata*), attached barnacles.	American lobster, green crab (*Carcinus maenus*), Jonah crab	Greene et al., 2010
	Bivalvia	Atlantic nut clam, Atlantic surf clam, blue mussel *(Mytilus edulis)*, razor clam *(Ensis leei)*, soft-shelled clam *(Mya arenaria)*	Atlantic sea scallop, egg cockle (*Laevicardium mortoni*), Eastern oyster (*Crassostrea virginica*)	Norden, 2012
	Gastropoda	Lunar dovesnail (*Astyris lunata*), glassy lyonsia (*Lyonsia hyaline*), *Caecum* spp., sea snail (*Bittium alternatum*), knobbed whelk	—	—
	Polychaeta	Lumbrineridae, Ampharetidae/Terebellidae, Syllidae Paraonidae, Polygordiidae, Cirratulidae and Glyceridae; Spionidae, and large tube-forming Diopatra	Oweniidae and Scalibregmatidae	AECOM, 2012; Maurer and Wigley, 1984
	Bryozoa/ Hydrozoa	Attached bryozoans and hydrozoans	—	—
	Porifera	Attached sponges	—	—
	Echinodermata	Sea urchins	—	—
Glacial Till	Polychaeta	Scavenger feeder - *Glycera* spp. and subsurface feeders *Polycirrus* spp. and *Polygorduis jouinae*	Polychaetes (Spiophanes kroeyeri)	Greene et al., 2010
	Bryozoa	Attached Bryozoan species	—	—
	Bivalvia	Suspension/filter feeders (Atlantic surf clam and narrow hinged astarte [*Astarte montagui*])	Northern hatchet-shell (*Thyasira gouldii*), little combed crenella (*Crenella pectinula*), black mussel (*Musculus niger*)	Greene et al., 2010
	Echinodermata	Common sand dollar	Holothurians	Theroux and Wigley, 1998
	Gastropoda	Predator feeder *Caecum* spp. and scavenger *Turbonilla* spp.	Chalice bubble snails (*Cylichna gouldi* and *C.*	Greene et al., 2010

Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/b/	Other Species Typically Found in the Habitat b/	References
			alba)	
Mixed Sediments	Bivalvia	Jingle shells, transverse ark clam (*Anadara transversa)*	—	—
	Polychaeta	Nereidae, Syllidae, Pectinaridae and Sabellidae	—	—
	Crustacea	Hermit crabs (Paguridae), *Cancer* spp. Crabs, Atlantic mud crab (*Panopeus herbstii*); tube-forming amphipods (*Cymadusa. compta),* Caprellidae	—	—
	Echinoidermata	Starfish	Echinoidea	Theroux and Wigley, 1998
	Gastropoda	Mud snails, common slipper shells (*Crepidula* spp.); sea snail *Bittiolum alternatum;* lunar dovesnail	Atlantic sea scallop, bay scallop	—
Sand and Muddy Sand	Bivalvia	Subsurface feeder: Atlantic nut clam Suspension/filter feeders: Atlantic surf clam, oval spoon clam, ocean quahog	Maldanidae, *Scalibregma inflatum*; Syllidae, Cirratulidae and Glyceridae	Brand, 2016; Norden, 2012
	Polychaeta	Subsurface feeder polychaetes *Polygordius jouinae* and *Levinsenia gracilis*	—	AECOM, 2012; Maurer and Wigley, 1984
	Oligochaeta	Subsurface feeder: Oligochaetes	Sand shrimp, pandalid shrimp (Pandalidae), Jonah crab, Atlantic horseshoe crab	—
	Crustacea	Tube-forming amphipods (*Ampelisca* spp.), hermit crabs (Paguridae), *Cancer* spp., Atlantic rock crab, Phoxocephaliidae, Haustoriidae, Class Chiridotea amphipods	Blood star, Ophiuroideans and Holothuroideans	NWF, 2021; BOEM, 2020; Vineyard Wind, 2020; SFWF, 2018
	Echinodermata	Common sand dollars	Northern moon snail, knobbed whelk	SFWF, 2018; Maurer and Wigley, 1984
	Gastropoda	Mud snails, channeled whelk	Atlantic sea scallop, bay scallop	SFWF, 2018

Notes: "Common" designation based upon desktop analysis of species habitat requirements and geographic distributions
a/ See Appendix M, Benthic and Shellfish Resources Characterization Report, for full list of species observed during 2020 Spring and Summer benthic surveys
b/ Species also expected to be observed in Brayton Point export cable corridor

TABLE 6-39. COMMON SPECIES BY HABITAT TYPE IN THE BRAYTON POINT EXPORT CABLE CORRIDOR (SUMMER 2021 SURVEY)

Substrate Class Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/	Other Species Typically Found in the Habitat	References
Coarse/Very Coarse Sand	Bryozoa/ Hydrozoa	Attached bryozoans and hydrozoans	--	—
	Polychaeta	Lumbrineridae, Ampharetidae/Terebellidae, Syllidae Paraonidae, Polygordiidae, Cirratulidae and Glyceridae; Spionidae, and large tube-forming Diopatra	Oweniidae and Scalibregmatidae	AECOM, 2012; Maurer and Wigley, 1984
	Crustacea	Hermit crabs (Paguridae), Caprellidae; tube-forming amphipods (*Cymadusa compta* and *Ampelisca* spp.), attached barnacles.	American lobster, green crab (*Carcinus maenus*), Jonah crab	Greene et al., 2010
	Bivalvia	Atlantic nut clam*,* Atlantic surf clam*,* blue mussel *(Mytilus edulis),* razor clam *(Ensis leei)*	Atlantic sea scallop, egg cockle (*Laevicardium mortoni*), Eastern oyster (*Crassostrea virginica*)	Norden, 2012
	Gastropoda	Glassy lyonsia (*Lyonsia hyalina*), knobbed whelk; moon snail eggs; mud snail	*Crepidula*	Shumchenia et al., 2016
	Echinodermata	Sea urchins	—	—
	Porifera	Attached sponges	—	—
	Chordata	Ascidian: sea grape (*Molgula manhattensis*)		
Sand (fine/very fine sand to medium and muddy sand)	Oligochaeta	Subsurface feeder: Oligochaetes	Sand shrimp, pandalid shrimp (Pandalidae), Jonah crab, Atlantic horseshoe crab	—
	Polychaeta	Subsurface feeder polychaetes *Polygordius jouinae* and *Levinsenia gracilis*	—	AECOM, 2012; Maurer and Wigley, 1984
	Crustacea	Tube-forming amphipods (*Ampelisca* spp., *Byblis serrata*), Cumacea (*Diastylis sculpta*); hermit crabs (Paguridae), *Cancer* spp., Haustoriidae, Class Chiridotea amphipods	Blood star, Ophiuroideans and Holothuroideans	NWF, 2021; BOEM, 2020; Vineyard Wind, 2020; SFWF, 2018
	Bivalvia	Subsurface feeder: Atlantic nut clam; *Ameritella agilis* (tellenid)	Maldanidae, *Scalibregma inflatum*; Syllidae, Cirratulidae and Glyceridae	Brand, 2016; Norden, 2012

Substrate Class Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/	Other Species Typically Found in the Habitat	References
	Gastropoda	Mud snails, whelk	Atlantic sea scallop, bay scallop, whelks	SFWF, 2018; Greene et al. 2010
	Echinodermata	Common sand dollar (*Echinarachnius parma*)	Northern moon snail, knobbed whelk	SFWF, 2018; Maurer and Wigley, 1984
	Chordata	Ascidian: sea grape (*Molgula manhattensis*)	—	—
Gravelly or Gravel Mixes	Polychaeta	Polygordiidae; Capitellidae; Scavenger feeder - *Glycera* spp. and subsurface feeders *Polycirrus* spp. and *Polygorduis jouinae*	—	—
	Crustacea	Tube-forming amphipods *(Ampelisca* spp.*),* amphipods *Unciola* spp. and *Ericthonius* spp.	—	—
	Bivalve	Nut clam (*Nucula proxima*); northern horsemussel (*Modiolus modiolus*); soft-shelled clam *(Mya arenaria)*; suspension feeding *Astarte undata*	Hard clam (*Mercenaria mercenaria*)	Anderson et al. 2010
	Gastropoda	*Crepidula fornicata*, whelks, sessile gastropods	—	—
	Cnidaria	Burrowing anemone (*Edwardsia elegans*)	Attached sponges (Porifera)	
	Chordata	Attached tunicates (Lumbrineridae)	—	—
Glacial Till (and Artificial Hardbottom)	Bryozoa	Attached bryozoan species	Boring sponge (*Cliona celata*)	Schweitzer and Stevens 2019
	Polychaeta	Scavenger feeder - *Glycera* spp. and subsurface feeders *Polycirrus* spp. and *Polygorduis jouinae*	Polychaetes (*Spiophanes kroeyeri*)	Greene et al., 2010
	Crustacea	Barnacles; American lobster; *Cancer* crabs	—	—
	Bivalvia	Suspension/filter feeders (Atlantic surf clam and narrow hinged astarte [*Astarte montagui*])	Northern hatchet-shell (*Thyasira gouldii*), little combed crenella (*Crenella pectinula*), black mussel (*Musculus niger*), blue mussel	Greene et al., 2010; Schweitzer and Stevens 2019

Substrate Class Substrate Classification	Phylum or Class	Selected Species Found in SPI/PV Images, Video and Grab Samples a/	Other Species Typically Found in the Habitat	References
			(*Mytilus edulis*)	
	Gastropoda	Moonsnail egg cases	Chalice bubble snails (*Cylichna gouldi* and *C. alba*)	Greene et al., 2010
	Echinodermata	Common sand dollar; sea star (*Asteria* spp.)	Holothurians	Theroux and Wigley, 1998
	Cnideria	Attached anemones (*Metridium*)	—	—
	Porifera	Attached sponges	Boring sponge	—
	Chordata	Attached tunicates (Lumbrineridae, *Didemnum*)	Polychaetes, crabs	Guarinello and Carey 2020

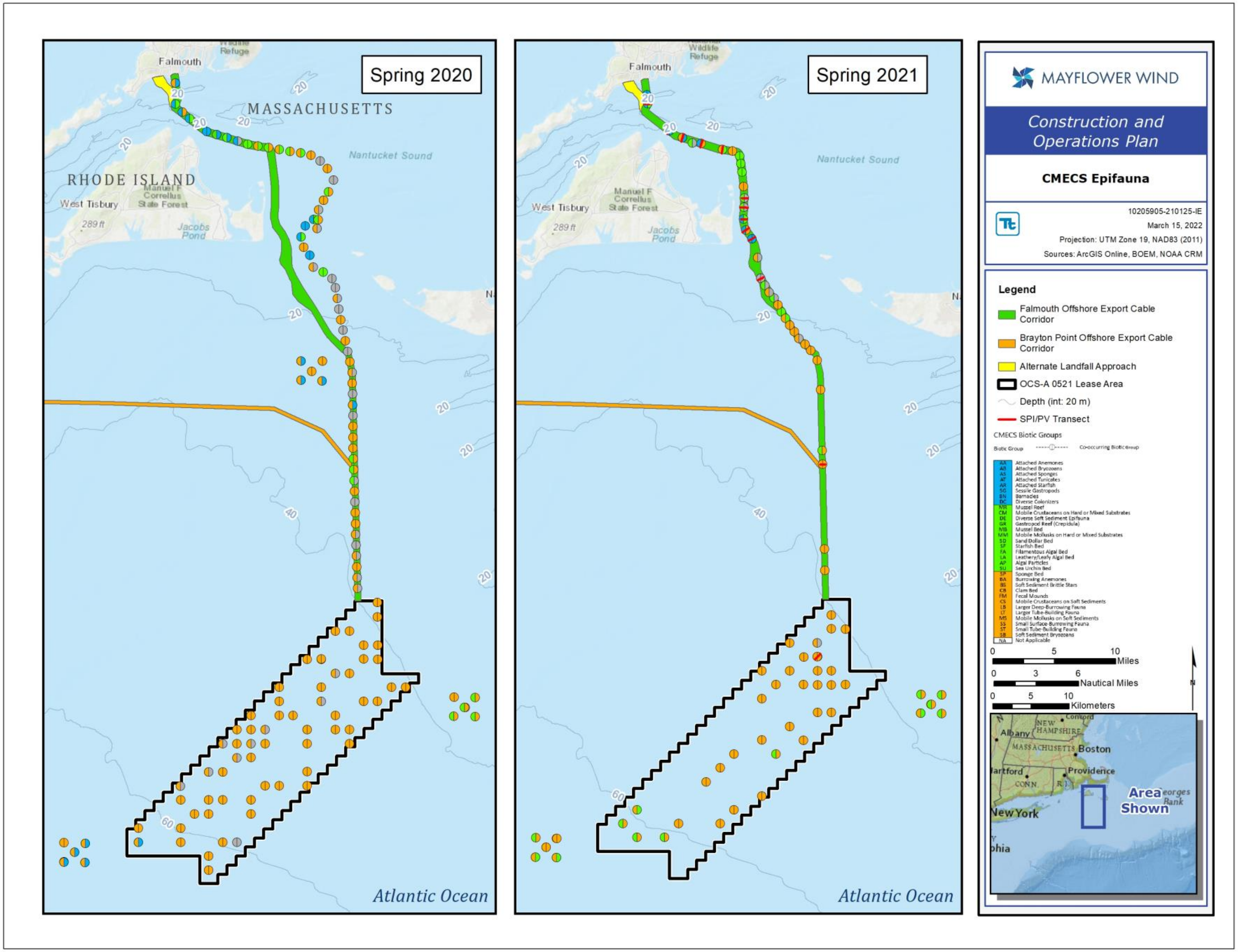


FIGURE 6-23. CMECS EPIFAUNA CLASSIFICATIONS FALMOUTH EXPORT CABLE CORRIDOR (APPENDIX M)

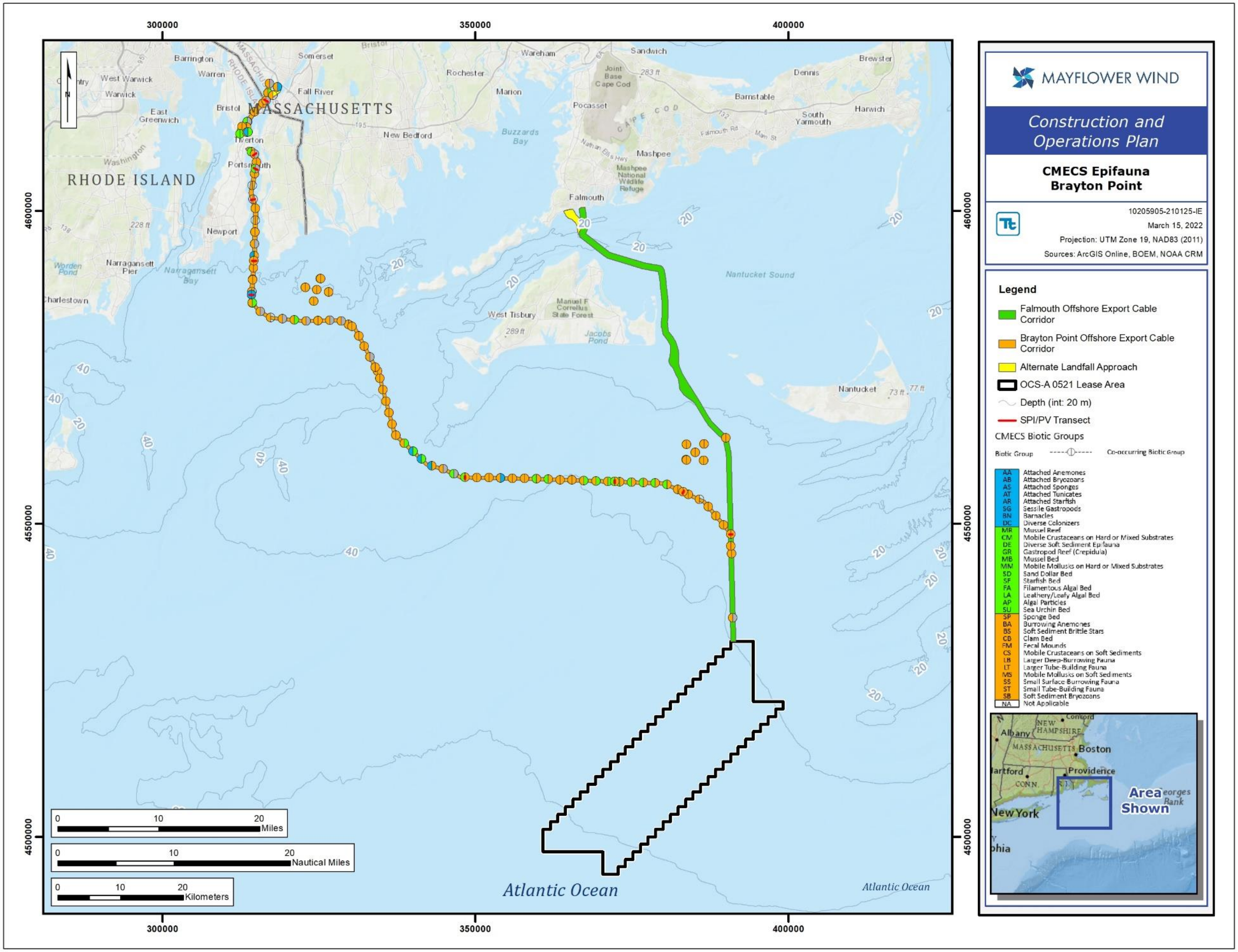


FIGURE 6-24. CMECS EPIFAUNA CLASSIFICATIONS BRAYTON POINT EXPORT CABLE CORRIDOR (APPENDIX M)

6.6.1.7.2 Infauna

Infaunal organisms observed during the benthic surveys are depicted on **Figure 6-25** and **Figure 6-27** and included clams, burrowing anemones, polychaetes, and small burrowing crustaceans. **Figure 6-26** shows infauna organism observations during Spring 2020 and Spring 2021 benthic surveys. Infauna organism observations collected during other seasons of surveys along the Falmouth export cable corridor can be found in Appendix M. The Lease Area mostly comprises all soft-sediment burrowing infauna. The eastern portion of the Lease Area contained clam (*Nucula* spp.) beds, beds of the tube-building *Ampelisca*, and one small surface-burrowing polychaete (Paraonidae). The western portion contained *Ampelisca* beds and two small surface-burrowing infaunal taxa (Paraonidae beds and Cossuridae beds).

Biotic groups in the southern Falmouth export cable corridor were similar to those in the eastern section of the Lease Area. Several clam beds were identified along the corridor with some large tube-building infauna and soft sediment bryozoans. The northern Falmouth export cable corridor supports a heterogeneous assemblage of epifaunal and infaunal species. Typical infaunal organisms reported in the northern Falmouth export cable corridor included soft-sediment bryozoans and mobile burrowing crustaceans on soft sediment.

Resident infaunal species in the Brayton Point export cable corridor are expected to be similar to those in the Falmouth export cable corridor given their proximity and similarities in substrate composition. Soft-sediment burrowing infauna are expected to be found within portions of the Brayton Point export cable corridor containing unconsolidated soft bottom substrates, particularly in Mount Hope Bay and the offshore portion of the corridor by the Lease Area. A seasonal benthic survey has been conducted along the Brayton Point export cable corridor to ground-truth available literature and reports, and results are provided in Appendix M.

6.6.1.8 Substrate and Biota—Integrated Habitat Classification

Substrate and biota classifications discussed in the previous sections were reviewed along with the geophysical data to describe benthic habitat and biotic communities within the Lease Area. Three distinct sections of the Project Area were identified based on results of Spring and Summer 2020 surveys: Lease Area, southern Falmouth export cable corridor, and northern Falmouth export cable corridor. Additional details are provided in Appendix M, Benthic and Shellfish Resources Characterization Report. Summaries of select sample stations representative of the Lease Area, southern Falmouth export cable corridor, and northern Falmouth export cable corridor are provided in the following sections; examples of benthos imagery collected from these three areas are provided in **Figure 6-27** through **Figure 6-31.** A seasonal benthic survey has been conducted along the Brayton Point export cable corridor to ground-truth available literature and reports, and results are provided in Appendix M.

6.6.1.8.1 Lease Area Stations 074, 077, and 078

Stations 074, 077, and 078 (Appendix M, Benthic and Shellfish Resources Characterization Report) are situated in the northeastern portion of the Lease Area and run in a north/south transect covering approximately 4.35 miles (7 km) in water depths of 46 to 48 m (**Figure 6-27**). The simplified Folk classification for these stations is Sand and Muddy Sand. The morphology for the three stations shows Low Density Mounds and Small-Scale Pitting. The observed epifauna included Small Tube-Building and Larger Deep-Burrowing Fauna, Mobile Mollusks, and Clam Beds. Other fauna that might be found in this habitat include sea cucumbers (*Pentamera calcigera*), slender armed star (*Leptasterias tenera*), acorn worm (*Stereobalanus canadensis*), bivalves (*Thyasira* spp., wavy astarte [*Astarte undata*]), cumaceans, caprellids, isopods, and amphipods (Greene et al., 2010).

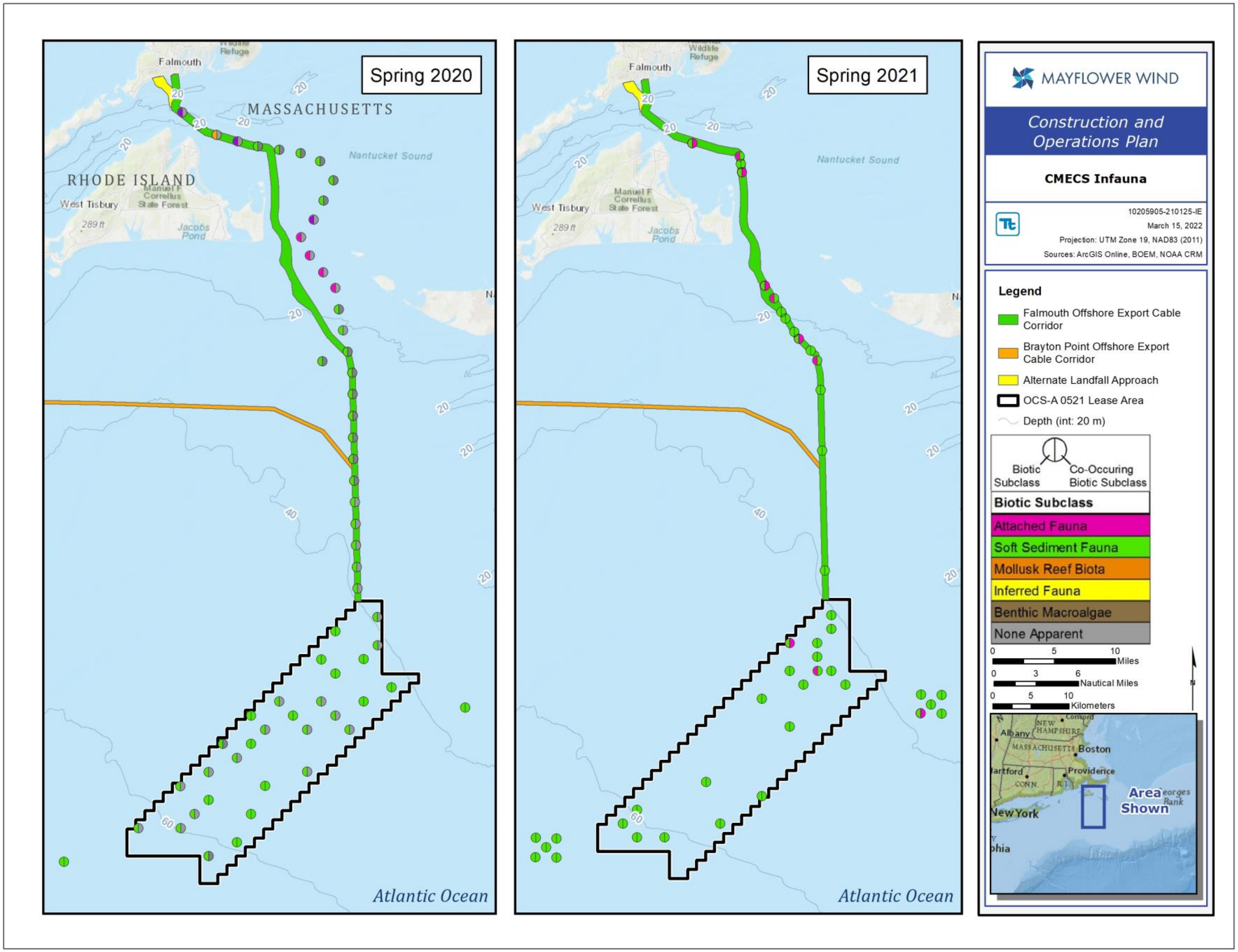


FIGURE 6-25. CMECS INFAUNA CLASSIFICATIONS FALMOUTH EXPORT CABLE CORRIDOR

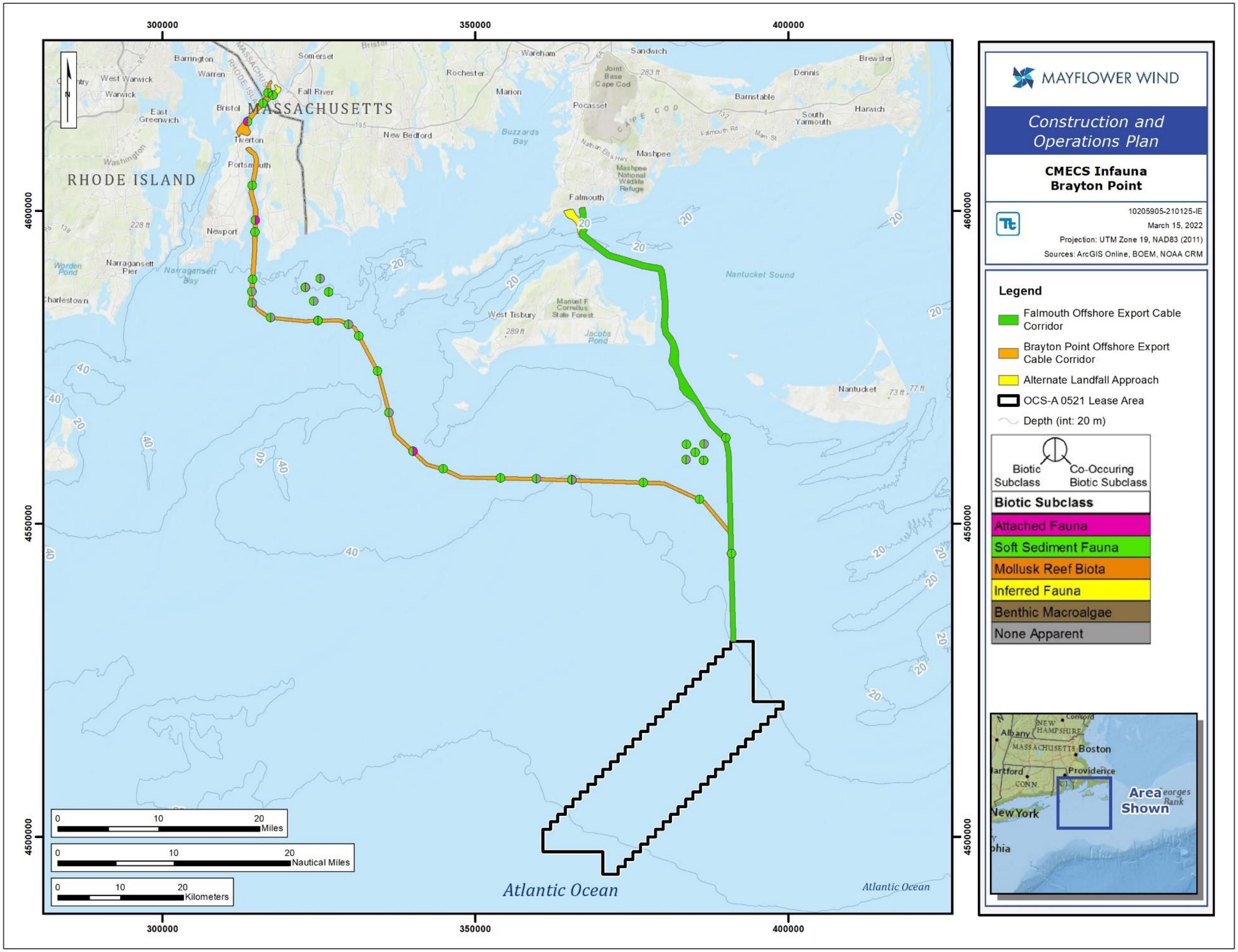
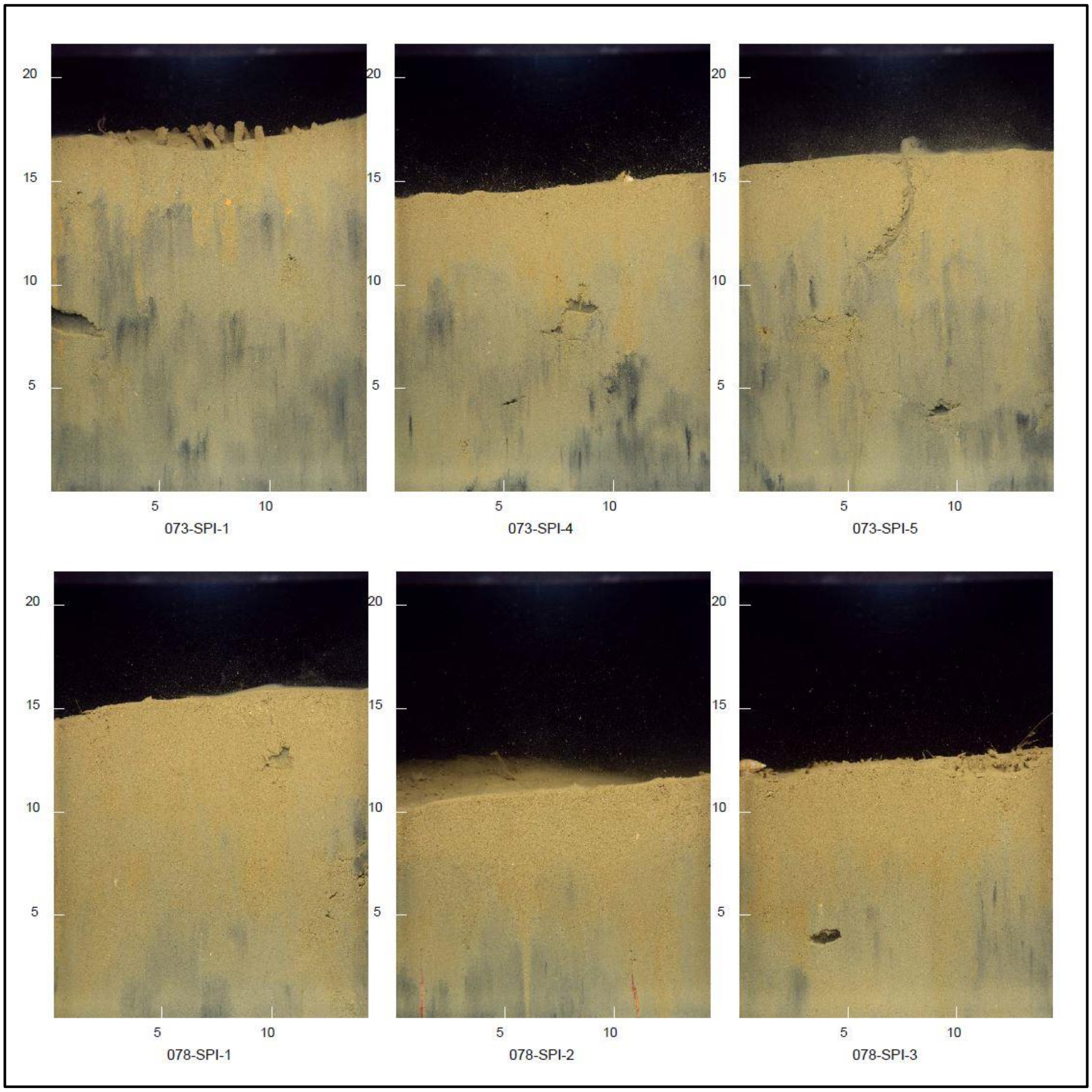
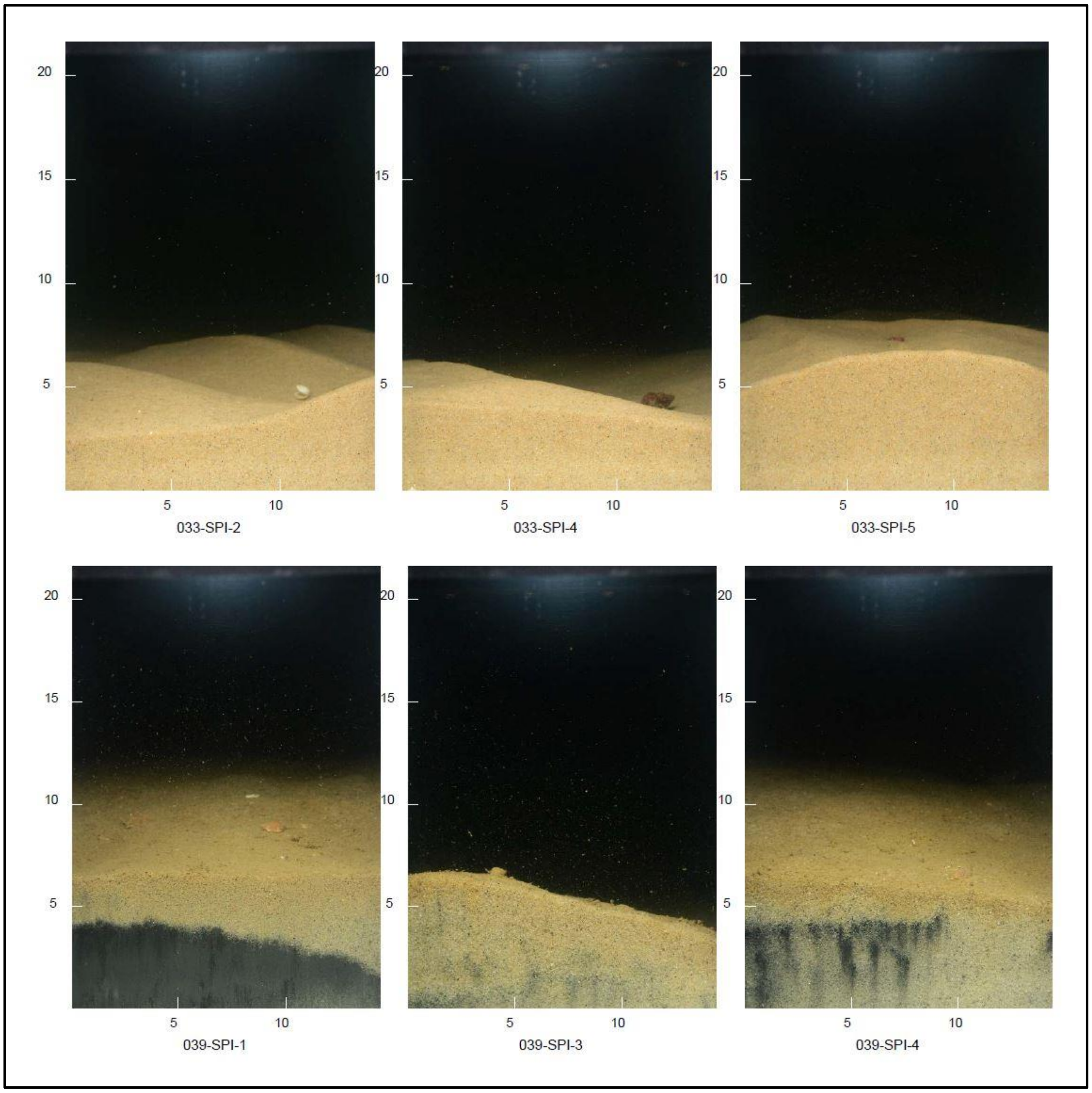


FIGURE 6-26. CMECS INFAUNA CLASSIFICATIONS BRAYTON POINT EXPORT CABLE CORRIDOR



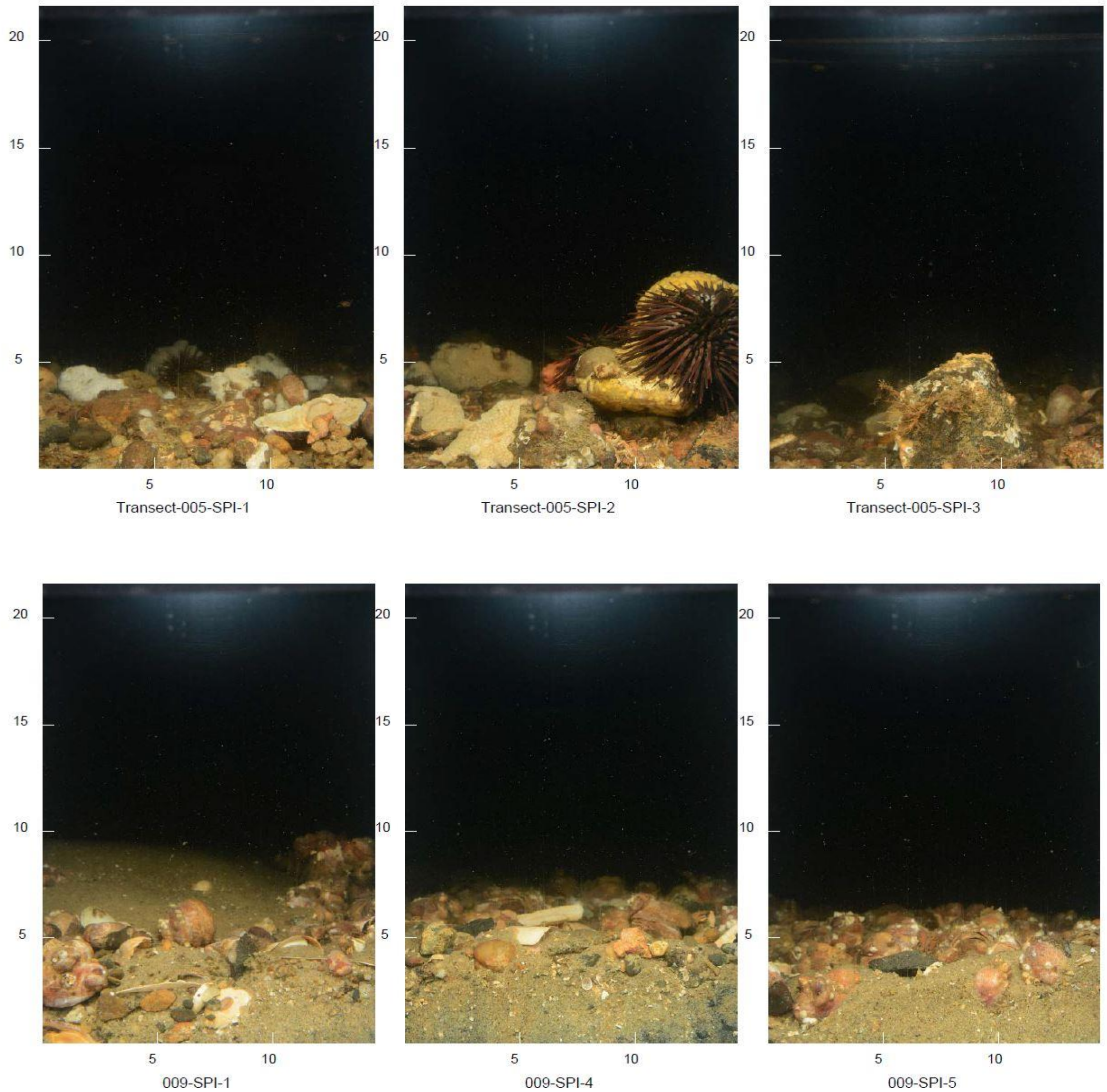
Source: Integral Consulting, Inc., 2020b. ***Pictured above, left to right:*** *Ampelisca tubes; Hermit Crab; None*
Pictured below, left to right: *None; Worms; Snail*

FIGURE 6-27. SPI IMAGES OF BENTHOS OBSERVED IN THE LEASE AREA, SUMMER 2020



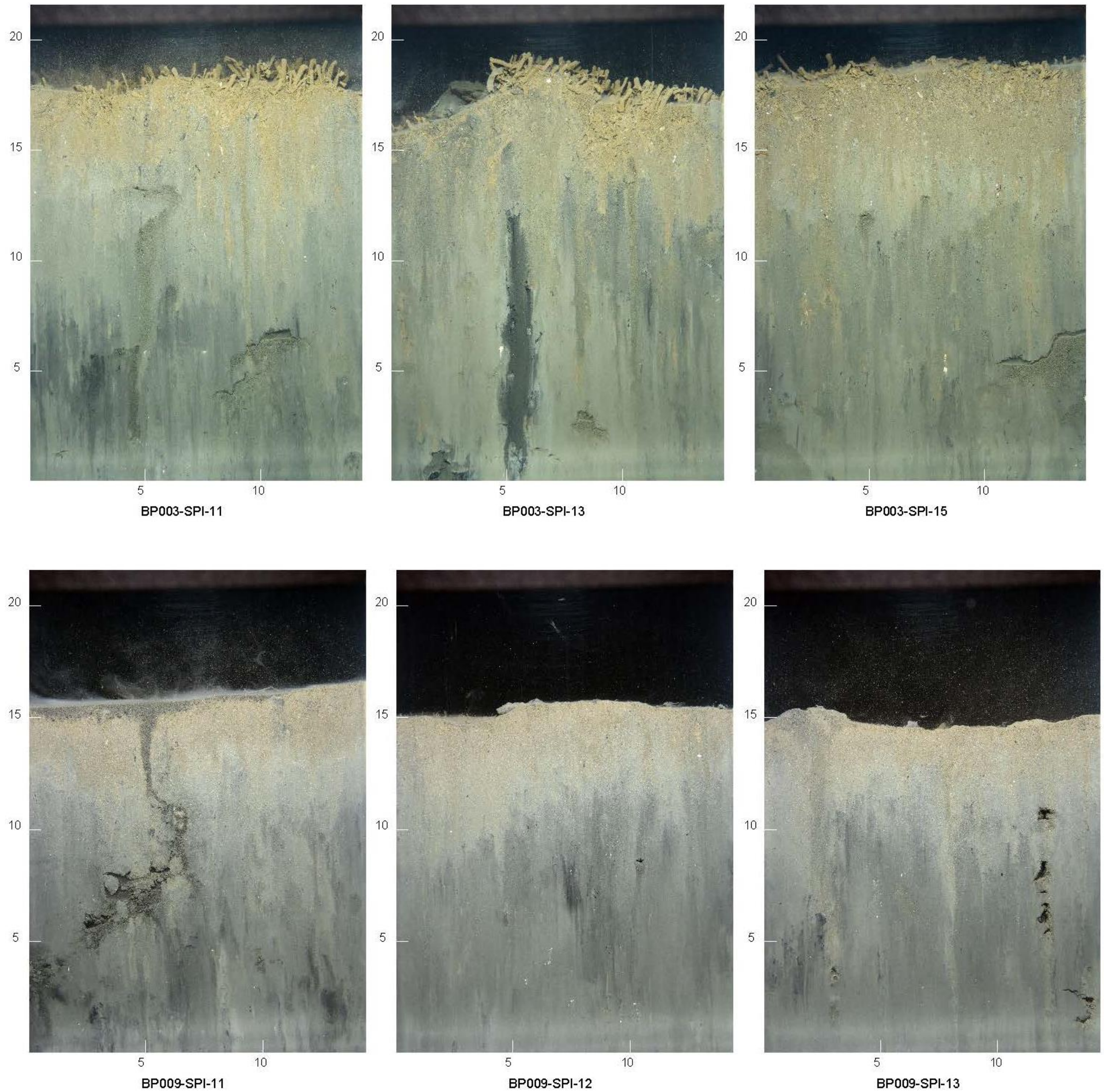
Source: Integral Consulting, Inc., 2020b. ***Pictured above, left to right:*** *None; Hermit Crab; Sand Dollar*
Pictured below, left to right: *Sand Dollar; Nassarius Snail; Nassarius Snail*

FIGURE 6-28. SPI IMAGES OF BENTHOS OBSERVED IN THE SOUTHERN FALMOUTH EXPORT CABLE CORRIDOR, SUMMER 2020



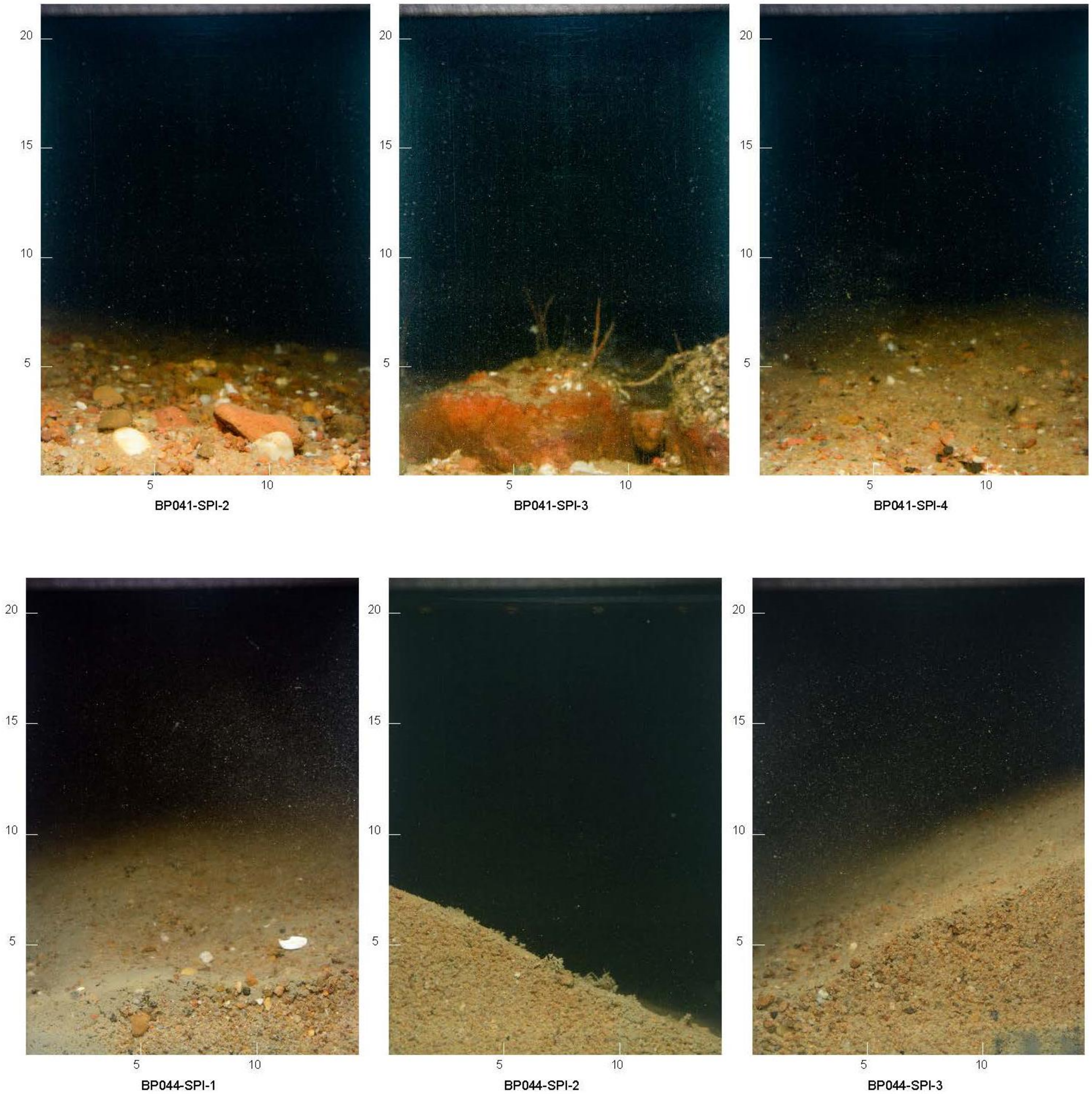
Source: Integral Consulting, Inc., 2020b. ***Pictured above, left to right:*** *SPI-1: Bryozoans, Sponges, Urchin, Hermit crabs, Snails, Chitons; SPI-2: Sponges, Urchin, Chitons, Bryozoans; SPI-3: Sponge, Chitons, Bryozoans, Urchin.* ***Pictured below, left to right:*** *SPI-1: Crepidula, Barnacles, Snail, Byrozoans; SPI-4: Crepidula, Barnacles, Hydroid, Sponge; SPI-5: Crepidula, Barnacles, Bryozoan, Sand dollar*

FIGURE 6-29. SPI IMAGES OF BENTHOS OBSERVED IN THE NORTHERN FALMOUTH EXPORT CABLE CORRIDOR, SUMMER 2020



Source: Integral Consulting, Inc., 2021. ***Pictured above, left to right:*** *Ampelisca tube mat; Ampelisca tube mat; Ampelisca tube mat****. Pictured below, left to right:*** *None; None; None*

FIGURE 6-30. SPI IMAGES OF BENTHOS OBSERVED IN THE NORTHERN BRAYTON POINT EXPORT CABLE CORRIDOR, SUMMER 2021



Source: Integral Consulting, Inc., 2021. ***Pictured above, left to right:*** *None; None; None*
Pictured below, left to right: *None; None; None*

FIGURE 6-31. SPI IMAGES OF BENTHOS OBSERVED IN THE SOUTHERN BRAYTON POINT EXPORT CABLE CORRIDOR, 2021

6.6.1.8.2 Southern Falmouth Export Cable Corridor Stations 045, 046, and 047

A set of stations along the southern Falmouth export cable corridor (045, 046, and 047) was selected to show the sediment/fauna overlay along a 1.9-mi (3-km) stretch in water depths of 105 to 108 ft (32 to 33 m; **Figure 6-28**). No SPI/PV transects were collected south of station 124. This reach of the southern Falmouth export cable corridor is fairly homogeneous and is more similar to the Lease Area than it is to the northern Falmouth export cable corridor. The Folk classification shows that there are areas of both Coarse Sediment and Sand and Muddy Sand, where the hillshade and morphology swaths show areas of Sand and Muddy Sand along with areas of Wave Generated Ripples indicative of a dynamic environment. The epifauna observed here included a Sand Dollar Bed, Small and Larger Tube-Building Fauna, and Mobile Mollusks. Other fauna that might be found in this type of habitat include rag worms (*Nereis zonata),* the polychaete *Capitella capitata*, lady crabs (*Ovalipes ocellatus*), and Atlantic rock crab (Greene et al. 2010). These Soft Sediment Fauna are generally well adapted to disturbance within their habitats, due to frequent sediment mobility prevalent in sandy environments.

6.6.1.8.3 Northern Falmouth Export Cable Corridor Transect 005

Transect 005 (**Figure 6-29**) was collected in water depths of approximately 79 ft (24 m) in an area approximately 1.6 mi (2.5 km) off the coast of Tisbury, Martha's Vineyard. The transect was collected northeast to southwest perpendicular to the centerline. The Folk classification is Coarse Sediment, consistent with the morphology noted in the three southwestern and northeastern most portions of the transect. The areas immediately northeast, southwest, and along the centerline were identified as a Glacial Till Outcrop. The images along the transect showed Diverse Colonizers (mollusks, sponges, and tunicates) as the primary biotic group classification; the co-located groups included Mobile Mollusks and Mobile Crustaceans, as well as Chitons, which are typical of coarse sediment environments.

6.6.1.8.4 Brayton Point/Mount Hope Bay to Aquidneck Island (KP 0- 10)

Substrates in the upper section of the Brayton Point export cable corridor are predominantly gravelly Mud, with some grab samples or SPI-PV imagery stations classified as Mud, muddy Sand, and sandy Muds. See CMECS Substrate Maps (Appendix M) for more details. Several outcrops of bedrock were observed near KP 9 in the southern section of Mount Hope Bay, where seafloor morphology is broadly smooth other than surface furrowing left by relict and active trawl and dredge fisheries. Where Mount Hope Bay constricts and focuses tidal currents, several bedforms were observed (Appendix E). CMECS Biotic Groups observed in grab, video, and SPI-PV samples were dominated by Large Tube Building Fauna and isolated *Crepidula* reefs. Isolated occurrences of algae, sessile gastropods, and large deep-burrowing fauna were also reported, as shown in the CMECS Epifauna and Infauna Maps in Appendix M.

6.6.1.8.5 Land Crossing over Aquidneck Island (KP 10 to 15)

Details for the overland portion of this proposed route are in Appendix J, Terrestrial Vegetation and Wildlife.

6.6.1.8.6 Sakonnet River to State/Federal Water Boundary of Rhode Island Sound (KP 15 to 41)

The mapped section of the Sakonnet River is mostly soft sediments (Mud, gravelly Mud, muddy Sand, and Sand). Some gravelly sand and isolated Gravel Mixes (muddy sandy Gravel and sandy Gravels) occur intermittently from KP 32 to 40. The route crosses isolated patches of outcropping glacial till/moraine interspersed with gravels at the most offshore portion of this route, near KP 39 and 40 (Appendix E, MSIR). See Appendix M for more details. Sakonnet River morphology is largely smooth, with interspersed rippled bedforms related to tidal currents and isolated mounds associated with *Crepidula* reefs and some backfill and rock debris over pipelines. A newly mapped area of submerged aquatic vegetation was interpreted from geophysical data around KP 15 near the Aquidneck Island landfall (Appendix E, MSIR). CMECS Biotic groups were characterized as Large Deep Burrowing Fauna, *Crepidula* Reefs, Tracks and Trails, Mobile Mollusks and Crustaceans on Soft Sediments, and Small Surface-Burrowing Fauna. See Appendix M for more details.

6.6.1.8.7 Federal Waters of Rhode Island Sound to South of Nomans Land (KP 41 to 90)

Substrates along this corridor section are varied, with broad bands of Mud to muddy Sand and Sand. See Appendix M for more details. Glacial moraines and outcropping glacial till/moraine deposits occur with Gravels and Gravel Mixes at KP 57 and 58 (Buzzards Bay Moraine). Scattered surface boulders occur throughout the route, with noted boulder fields near KP 72-73. The route crosses Martha's Vineyard Moraine from KP 77 to 85. Bands of gravel occur at KP 89.5, 91, 92.5, and 94. These and other moraine features are described in the MSIR (Appendix E). Wave-generated rippled sands and gravels, rippled scour depressions, and low-density aggregations of mounds occur on mud to muddy sand substrates in this part of the route; the mounds are formed seasonally, probably by tube-building polychaetes. More details on bedforms are in Appendix E.2. CMECS Biotic groups include Tracks and Trails, Small Tube Building Fauna, Sand Dollar Beds, and Mobile Crustaceans on Soft Sediments, with less common areas of Large Deep-Burrowing Fauna, Mobile Mollusks on Mixed Substrates, Mobile Crustaceans on Soft Sediments, and Diverse Colonizers (on boulders, cobbles, and other harder substrates, as shown in Appendix E, MSIR). CMECS Infaunal groups were identified as Large Tube Building Fauna, Small Tube Building Fauna, and Clam Beds. See Appendix M for more information.

6.6.1.8.8 Waters South of Martha's Vineyard to Intersection of Falmouth ECC (KP 90 to 135)

South of Martha's Vineyard, substrates along with route are mostly Sand with patches of Mud to muddy Sand and isolated patches of Gravel Mixes and associated outcropping Glacial Till near the western portion of this section (KP 92-100 south of Nomans Land Island) (Appendix E, MSIR). See Appendix M for more details. Wave-generated Ripples and Rippled scour depressions are also common along this section of the route, and aggregations of tube-building worm mounds in mud to muddy sands become more common. CMECS Epifauna Biotic groups include Tracks and Trails, Sand Dollar Beds, Mobile Mollusks on Mixed Substrates, and Small Tube-Building Fauna, with a few areas of Burrowing Anemones and Mobile Crustaceans on Soft Sediments. Diverse Soft Sediment Epifauna and Attached Sponges and Tunicates occur on boulders and cobbles near KP 92 and 95. Infauna are characterized as Small Surface Burrowing Fauna and Clam Beds. See Appendix M for more information.

6.6.1.8.9 Waters South from Intersection of Falmouth ECC to Lease Area (KP 135 to 153)

This section of the route was sampled extensively in 2020 and 2021 during the Benthic Sampling Program that targeted the Falmouth ECC and the Lease Area. Water depths increase as the route approaches the Lease Area, and substrates are largely Mud to muddy Sand, with isolated patches of

Sand. See Appendix M for more details. Dominant surface morphologies are wave generated Ripples, with increased occurrences of low-density aggregations of tube-building worm mounds on mud to muddy sand substrates where sediments are smooth and cohesive (Appendix E, MSIR). The dominant CMECS Biotic groups were Tracks and Trails and Mobile Crustaceans on Soft Sediments. Less common were Mobile Mollusks on Soft Sediments and isolated occurrences of Sand Dollar Bed, Sponge Bed, Small Tube Building Fauna, and Fecal Mounds. Two areas of Clam Beds were noted along this portion of the route.

6.6.1.9 Shellfish Resources in the Offshore Project Area

Benthic macrofauna in the Project Area also includes shellfish species; see Section 11 and Appendix V, Commercial and Recreational Fisheries Technical Report for additional information on shellfish occurrence and commercial activity. A review of benthic trawl and grab surveys conducted by the NEFSC and the Massachusetts Division of Marine Fisheries (MA DMF) indicate that several commercially important shellfish are known to occur in or near both export cable corridors and preferred and alternate landfall sites (NEFSC, 2020b; King et al., 2010). Although not generally considered a benthic species, the longfin squid (*Doryteuthis pealeii*) is also an economically important species that has a benthic life stage in the Offshore Project Area. The longfin squid are demersal but lay sessile clusters of eggs on the seafloor that attach to boulders on sand or sand with mobile gravelly habitats (Jacobson, 2005; Macy and Brodziak, 2001). An overview of shellfish species of economic and ecological importance with preferred seafloor habitat similar to those in the Offshore Project Area is summarized in **Table 6-40**.

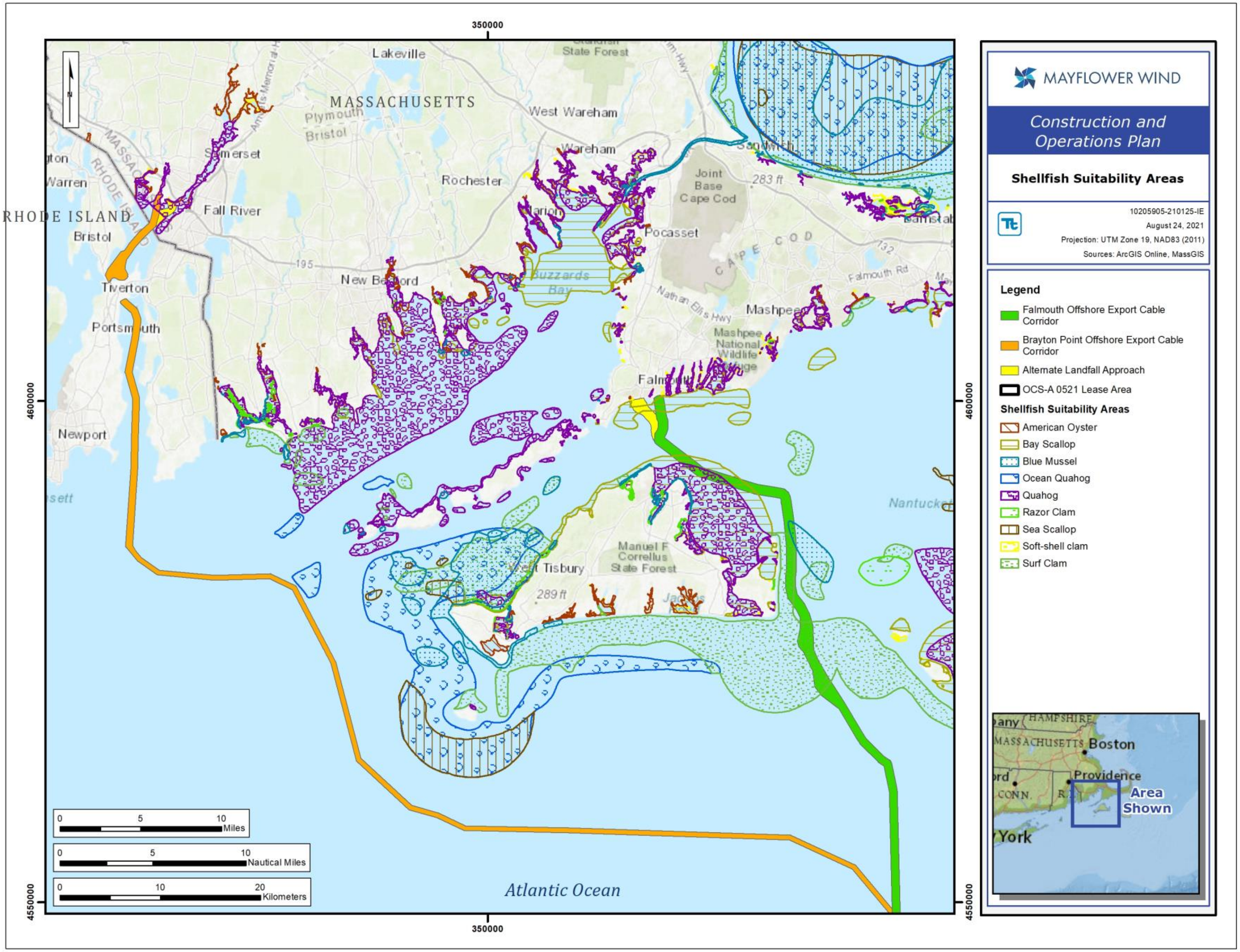
TABLE 6-40. TYPICAL SHELLFISH SPECIES IN SIMILAR HABITAT TO THE MAYFLOWER WIND OFFSHORE PROJECT AREA

Shellfish Species	Preferred Habitat	References
American lobster	Rocky, mixed bottom substrates	Collie & King, 2016
Eastern oyster (*Crassostrea virginica*)	Hard bottom substrates (rocks, shells, man-made objects)	NOAA Fisheries, 2021b
Atlantic deep-sea red crab (*Chaceon quinquedens*)	Mud, sand, and hard bottom substrates along the continental shelf	Wigley et al., 1975
Atlantic horseshoe crab	Shallow embayment and deep offshore waters; sand, muddy-sand, gravel, and shell substrates	Shuster, 1990; Botton et al., 1988; Shuster, 1982
Atlantic rock crab	Rocky and gravelly substrate, but also occurs in sand	Gendron et al., 2001
Atlantic sea scallop	Sand, gravel, shell, and rocky substrates	Hart, 2004
Atlantic surf clam	Medium, fine, silty-fine sand	Cargnelli, 1999a
Bay scallop	Shallow sediments	MacKenzie, 2008
Channeled whelk	Fine sand and other fine-grained sediments	Nelson et al., 2018
Blue mussel	Rocky, hard bottom substrates	Newell, R. I., 1989

Shellfish Species	Preferred Habitat	References
European oyster (Ostrea edulis)	Muddy sand or muddy/rocky/ gravelly/shell sediments with hard bottom substrates	Massachusetts Office of Coastal Zone Management, 2020
Jonah crab	Diverse sediments types in shallower waters	Atlantic States Marine Fisheries Commission, 2018
Knobbed whelk	Shallow shelf waters, oyster reefs, and clam beds;	Anderson, 2005; Magalhaes 1948
Longfin squid	Larvae laid on sand and hard bottom substrates; hatchlings are demersal then migrate offshore	Jacobson, 2005; Macy and Brodziak, 2001
Ocean quahog	Medium to fine sand	Morton, 2011; Cargnelli, 1999b
Northern quahog (Mercenaria mercenaria)	Mud, sandy, and mixed bottom sediments	Marinelli & Woodin, 2004; Bricelj, 1993
Razor clam	Mainly coarse, subtidal areas, but have been observed in muddy sediments	Schwemmer et al., 2019; Leavitt, 2011
Soft-shelled clam	Sand or sand/mud/clay mixture sediments	Abraham and Dillon, 1986

Shellfish suitability areas mapped in the Offshore Project Area by the MA DMF are depicted in **Figure 6-32.** During the Mayflower Wind benthic surveys, a few commercially important shellfish were observed in the Lease Area and Falmouth export cable corridor during benthic grab sampling (Appendix M, Benthic and Shellfish Resources Characterization Report). Ocean quahog was the most abundant shellfish identified in the Lease Area; individuals were observed at 22 out of 63 benthic grab survey stations in May 2020 and 12 out of 43 benthic grab survey stations in August 2020. Atlantic surf clam was the most abundant shellfish in the Falmouth export cable corridor; Atlantic surf clam was observed at 15 out of 53 benthic grab survey stations in May 2020 and at 12 out of 43 benthic grab survey stations in August 2020. **Figure 6-32** identifies suitable habitat for commercial and recreational shellfish species in the Offshore Project Area (MA DMF, 2011).

According to the Rhode Island Shellfish Management Plan, the Sakonnet River portion of the Brayton Point export cable corridor is home to several commercially valuable shellfish, including the bay scallop (*Agropected irradians*), ocean quahog, and soft-shelled clam (URI Coastal Resources Center 2014). Ocean quahogs have also been observed in Mount Hope Bay, alongside channeled and knobbed whelks. Historic abundances of these species have been reduced by water quality degradation and habitat loss. Currently, the Sakonnet River is protected as a Shellfish Management Area by RIDEM (Rhode Island General Law [RIGL] § 20-3-4) for the purposes of shellfish conservation and stock rebuilding. Management strategies employed by RIDEM to achieve these goals include reduced daily harvest limits, no harvest, limited access time, and rotational harvest (URI Coastal Resources Center 2014). A benthic survey has been conducted along the Brayton Point export cable corridor to determine presence and abundances of these and other shellfish species; results are provided in Appendix M.



Source: MA DMF, 2011

FIGURE 6-32. SHELLFISH SUITABILITY AREAS

6.6.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects. Each of the IPFs discussed in the following sections is fully explained for the Project in Section 3.4, Summary of Impact Producing Factors.

This section identifies and describes the IPFs that may be associated with construction, operations, and decommissioning. The IPFs identified in **Table 6-41** may result from proposed Project activities that may behaviorally or physically disturb or harm benthic and shellfish species. Based on the best available science, the sections also include analyses of whether, and to what extent, benthic and shellfish resources may be affected if exposed to one or more of these identified IPFs. **Table 6-41** through **Table 6-47**. provide summaries and relevant information for these assessments.

TABLE 6-41. IPFS AND POTENTIAL EFFECTS ON BENTHIC/SHELLFISH RESOURCES IN THE OFFSHORE PROJECT AREA

IPF	Potential Effect		Period of Potential Effect		
	Project Component		Project Phase		
	Lease Area	Offshore Export Cable Corridors	Construct.	O&M	Decomm.
Introduced Sound into the Environment (in-air or underwater)	Behavioral disturbance	Behavioral disturbance	X	—	X
Seabed (or ground) Disturbance	Harassment/ mortality	Harassment/ mortality	X	—	X
Actions that may displace biological resources, cultural resources, or human uses–Habitat Disturbance and Modification	Reduced prey availability/ habitat loss and artificial reef effect due to presence of structures	Reduced prey availability/ habitat loss and artificial reef effect due to presence of structures	X	X	X
Change in Ambient EMFs	Displacement/ harassment	Displacement/ harassment	—	X	—
Planned Discharges	Harassment/ mortality	Harassment/ mortality	X	X	X
Accidental Events	Harassment/ mortality	Harassment/ mortality	X	X	X

6.6.2.1 Introduced Sound into the Environment (In-Air or Underwater)

TABLE 6-42. FINDINGS SUMMARY – INTRODUCED SOUND INTO THE ENVIRONMENT (IN-AIR- OR UNDERWATER)

Sources of Introduced Sound	Summary
Construction	
Pile driving noise Inter-array cable installation Increased vessel traffic Export cable installation	• Physiological effects are not expected • Behavioral effects may occur (e.g., avoidance behaviors/stress response) but would be temporary and reversible
Operations & Maintenance	
Above-water noise from WTGs Increased vessel traffic	• Physiological effects are not expected • Behavioral effects are not expected
Decommissioning	
Foundation removal Increased vessel traffic	• Physiological effects are not expected • Behavioral effects may occur (e.g., avoidance behaviors, stress response) but would be temporary and reversible

6.6.2.1.1 Background

Potential sources of introduced sound throughout the life of the Project include pile driving, inter-array and export cable installation, increased vessel traffic, and foundation removal (**Table 6-42**). Because benthic species and shellfish lack gas-filled organs, they are considered likely to be less sensitive than finfish and marine mammals to underwater noise (Edmonds et al., 2016; Normandeau Associates, Inc., 2012). While there is some evidence of sound production detection in some invertebrates, including snapping shrimp (*Athanas nitescens*), cephalopods, and some bivalves, the role of sound in the ecology of marine invertebrates remains unclear (Coquereau et al., 2016). Sessile invertebrates may be affected by sound exposure (Dannheim et al., 2019) and additional research is underway studying sound speed and attenuation in sediments and the effects on tube-dwelling and burrowing marine infaunal organisms (Dorgan et al., 2020).

Physiological effects to benthic species from introduced sound are not expected; however, increased underwater noise may lead to temporary behavioral changes, resulting in an increased potential for predation and potential interruption of communication. For example, a study examining the effects of pile driving on blue mussels found that mussel clearance rates (e.g., filter-feeding rate) significantly increased when exposed to pile driving (Spiga et al., 2016). Although not definitive, the study proposed that this increase in clearance rates could be a stress response elicited by blue mussels. André et al. (2011) observed that exposure to low-frequency sound (50-400 Hertz [Hz]) resulted in the formation of lesions on the statocyst epithelia of four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Illex coindetii*), resulting in acute, permanent damage to sensory hair cells that increased with prolonged noise exposure. The study notes, however, that further investigation is required to understand how low-frequency sounds caused such lesions in cephalopods and whether the source of the acoustic trauma arose from particle motion, acoustic pressure, or a combination of both (André et al., 2011). Another study assessing the effects of pile driving noises and the associated sediment vibrations on blue mussels and hermit crabs (*Pagurus bernhardus*) found that low-frequency sounds (5-410 Hz) may cause behavioral changes in benthic species (Roberts et al., 2016). The blue mussels exhibited significant variations in valve gaping and oxygen uptake when exposed to pile driving; however, the hermit crabs did not exhibit any significant behavioral responses.

Appendix U2, Underwater Acoustic Assessment, includes sound modeling to assess predicted sound that will be introduced into the marine environment by pile driving activities. Based on the assessment results and available scientific literature, behavioral disturbance is likely to occur for some benthic species, but physical injury from pile driving noise is not anticipated.

Mobile epifaunal species are expected to exhibit behavioral responses to introduced sound; deep-burrowing infaunal species are not expected to exhibit behavioral responses. Potential short-term behavioral changes include area avoidance by mobile epifaunal species and an increase in behaviors that may indicate a stress response in invertebrate organisms. The introduced sound expected during each phase of the proposed Project and its potential effects on benthic and shellfish species are further discussed below.

6.6.2.1.2 Construction

Introduced sound in the Lease Area is expected to be generated by pile driving, installation of the inter-array cables, and increased vessel traffic during construction. Noise generated by trenching and dredging during cable-laying activities is expected to occur along the export cable corridors during construction. Based on the discussion in Section 6.6.2.1, noise associated with these proposed Project activities may result in effects to benthic and shellfish resources, but substantial effects are not expected.

6.6.2.1.3 Operations and Maintenance

During O&M, increased Project-related vessel traffic will introduce noise similar to that of routine commercial traffic in the Lease Area and export cable corridors. In-air noise generated by WTG gears, generators, and blades would enter the water column and may be detectable by some marine species. However, operational WTG noise would be within the range of naturally occurring background noise and is not expected to cause physiological or behavioral impacts to marine species.

6.6.2.1.4 Decommissioning

Introduced sound during decommissioning is expected to be similar to introduced sound during the construction phase; however, no pile driving will take place during the decommissioning phase. Consequently, introduced sound effects on benthic and shellfish resources during decommissioning are anticipated to be similar to those during construction.

6.6.2.2 Disturbance of Softbottom Habitat and Species

TABLE 6-43. FINDINGS SUMMARY – SEABED DISTURBANCE

Sources of Seabed Disturbance	Summary
Construction	
Seafloor preparation Pile driving Foundation and scour protection installation Inter-array cable installation Export cable installation Vessel anchoring (including spuds)	• Physiological and behavioral effects may occur (e.g., avoidance behavior, stress response, mortality, displacement) • Sessile and/or attached epifauna likely to have lowest tolerance and highest mortality rates to seabed disturbance • Disturbance effects and recolonization/recovery rates will likely vary by species group (mobile benthos vs. sessile/attached benthos) • Effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures
Operations & Maintenance	
Introduction of hard bottom habitat (presence of structures)	• Foundation areas (and potentially some areas along the export cable corridors) will be converted from sand/gravel habitat to hard bottom habitat • Increased hard bottom substrates will lead to habitat loss or habitat gain for benthic communities
Decommissioning	
Seafloor preparation Foundation and scour protection removal Vessel anchoring (including spuds	• Physiological and behavioral effects may occur (e.g., avoidance behavior, stress response, mortality, displacement) • Sessile and/or attached epifauna likely to have lowest tolerance and highest mortality rates to seabed disturbance • Disturbance effects and recolonization/recovery rates will likely vary by species group (mobile benthos vs sessile/attached benthos) • Effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures

6.6.2.2.1 Background

Seabed disturbance (and resulting sediment dispersion and re-sedimentation) is known to have physiological and behavioral effects on benthic and shellfish resources, with varying levels of tolerance depending on species sedimentation preferences. Sediment dispersion could smother benthos that are unable to unbury themselves once the excess sediment has settled back on the seafloor. Research has shown that sessile and attached epifaunal organisms have the lowest tolerance and highest mortality rate from sedimentation, with effects becoming more pronounced in areas with harder substrates (Hiddink et al., 2017; Gates & Jones, 2012). Mobile epifauna or infauna that burrow or feed in subsurface sediments are less sensitive to sediment burial as they can unbury themselves. Benthic suspension feeders are also sensitive to deposition because increased turbidity (caused by disturbances that result in sediment particles remaining suspended in the water column for days) can interfere with feeding and development (Topçu et al., 2019; Smit et al., 2008). Benthic egg and larval organisms (such as longfin squid eggs) are especially susceptible to smothering through sedimentation. Some smaller benthic organisms may be more affected than larger organisms because they have greater difficulty extending above the redistributed sediment for respiration and feeding (BOEM, 2021; BERR, 2008).

The shellfish species most sensitive to anthropogenic sedimentation are those that are sessile and/or attached, such as mussels, clams, and oysters (Volety et al., 2006). Softbottom benthic communities are typically able to recolonize disturbed areas following bottom trawling, dredging, or other anthropogenic activities (Hiddink et al., 2017; Gates & Jones, 2012; Dernie et al., 2003). Benthic communities are expected to recolonize the Offshore Project Area after construction activities have concluded within months to years following disturbance (HDR, 2020b; Hutchison, 2020b; Guarinello et al., 2017; BERR, 2008). Recolonization rates of benthic habitats are driven by the types of benthic communities inhabiting the area surrounding the affected region. Communities well-adapted to disturbance within their habitats (e.g., sand sheets) are expected to quickly recolonize a disturbed area, while communities not well adapted to frequent disturbance (e.g., deep boulder epifaunal communities) may take upwards of a year to begin recolonization. Potential effects to benthic resources will be limited to the area of direct disturbance. Benthos in the coarse sediment and hardbottom areas of the export cable corridors are expected to recover slower than the flatter, noncomplex areas in the Lease Area and soft bottom portions of the export cable corridors.

Seabed recovery is defined here as the natural infilling of sediment in construction trenches and associated recolonization of benthic infaunal and epifaunal communities to support pre-disturbance ecological function. Recovery varies by region, species, and nature of disturbance. Surveys following cable installations in softbottom habitats at shelf depths similar to that of the Lease Area indicate that recovery begins immediately. Availability of mobile sediments and intensity of anthropogenic disturbance both influence recovery time. Full recovery of sediments and benthic communities following sand mining on the U.S. Atlantic coast and in the Gulf of Mexico has been observed within 3 months to 2.5 years (Brooks et al. 2006; Normandeau 2014; Kraus and Carter 2018). Surveys of similar wind farm construction activities (e.g., Block Island Wind Farm) have not identified substantial differences in benthic macrofaunal communities or ecological function in the Lease Area within two years of installation (HDR 2019).

To assess the potential impacts from cable placement (including the HDD exit pit), Scour Modeling and a Sediment Plume Impact Model were conducted for this Project (Appendix F1, Sediment Plume Impacts from Construction Activities and Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment). The modeling calculated both plume dispersion (total suspended solids mg/L in the water column) and areas of accretion where suspended sediments are redeposited.

Sediment deposition varies based on the installation method and region of the Offshore Project Area. Areas are quantified in Section 3.4, Summary of Impact Producing Factors, and discussed in Appendix M, Benthic and Shellfish Resources Characterization Report.

Increased sediment suspension and deposition could result in mortality of benthic organisms through smothering, irritation to respiratory structures, and reduction in feeding success. In all simulated scenarios the maximum total suspended solids level dropped below 10 mg/L within two hours and below 1 mg/L after less than four hours. These effects are expected to be temporary, short-term, and localized.

The seabed disturbance expected during each phase of the proposed Project and its potential effects on benthic and shellfish species are further discussed in the subsections below.

6.6.2.2.2 Construction

The Project construction activities in the Lease Area are expected to result in temporary effects to benthic and shellfish species, including mortality or displacement of benthic species within the Offshore Project Area due to seafloor preparation, pile driving, foundation and scour protection installation, cable installation, and vessel anchoring (**Table 6-43**). The effects of seafloor disturbance on benthos in the southern Falmouth export cable corridor are expected to be similar to the Lease Area due to their similar benthic characterizations. Recolonization of benthic organisms in the complex habitat area of the northern Falmouth export cable corridor (beginning in the Muskeget channel) are expected to occur over a longer period of time; thus, the effects of seafloor disturbance within this area are expected to be longer-lasting (Guarinello et al., 2017; Appendix M, Benthic and Shellfish Resources Characterization Report). Similarly, the complex glacial moraine habitat in the Rhode Island Sound portion of the Brayton Point export cable corridor will likely be recolonized more slowly than the soft bottom areas of the northern Brayton Point export cable corridor and Lease Area.

Offshore export cable installation methods are still under evaluation. Mayflower Wind anticipates the use of HDD for the installation of the export cable in the shallower areas closer to shore to substantially reduce effects of sediment disturbance on benthic and shellfish resources in the nearshore area.

Seabed disturbance will also be caused by vessel anchoring, spud cans, and anchor chain sweeps; the areas of impacts are quantified in Section 3.4, Summary of Impact Producing Factors. The level of habitat disturbance effects for benthos will likely vary by species group. Slow-moving or sessile species such as mollusks, sea scallops, surf clams, sea stars, sand dollars and sessile benthos such as tube-dwelling polychaetes within the Offshore Project Area may experience lethal or sub-lethal effects from incidental sweeps by spud cans, anchor, or anchor chains.

6.6.2.2.3 Operations and Maintenance

Following completion of construction activities in the export cable corridors, the seabed is expected to return to nearly pre-construction conditions where the cable is buried, allowing continued use by benthic species and recovery for sessile, attached benthos that may have been affected by construction activities.

The presence of the WTG and OSP foundations and associated scour protection will result in conversion of the existing benthic habitat; however, less than 1.5 percent of the Lease Area benthos will be converted to WTG and OSP foundations (see **Table 6-43**). This conversion to hardbottom habitat will result in some effects to species that occur in softbottom habitat due to loss of habitat; however, benthic communities could develop on the hard substrates. Anchoring of maintenance vessels are expected to minimal and short term during the operational phase.

Seafloor disturbance during O&M in the export cable corridors and Lease Area will primarily involve vessel anchoring, with excavation where needed. Potential effects on benthic resources from these activities are expected to be localized and short term.

6.6.2.2.4 Decommissioning

During the decommissioning phase of the proposed Project, seabed disturbance effects are expected to be similar to those during the construction phase of the proposed Project.

6.6.2.3 Introduction of Novel Hardbottom Habitat

TABLE 6-44. FINDINGS SUMMARY – HABITAT DISTURBANCE AND MODIFICATION

Sources of Habitat Disturbance and Modification	Summary
Construction	
Foundation and scour protection installation Export cable installation	• Physiological and behavioral effects may occur (e.g., avoidance behavior, stress response, mortality, displacement) • Less than one percent of soft-bottom habitat loss in Lease Area expected due to foundation and scour protection installation • Disturbance effects and recolonization/recovery rates will likely vary by species group (mobile benthos vs. sessile/attached benthos)
Operations & Maintenance	
Introduction of hard bottom habitat	• Foundation areas (and potentially some areas along the export cable corridors) will be converted from sand/gravel habitat to hard bottom habitat • Increased hard bottom substrates will lead to habitat loss or habitat gain for benthic communities • Scour protection in previously soft-sediment habitat may support more heterogeneous, biodiverse benthic communities
Decommissioning	
Foundation and scour protection removal	• Physiological and behavioral effects may occur (e.g., avoidance behavior, stress response, mortality, displacement) • Loss of hardbottom substrates will likely cause the benthic communities in the Lease Area to return to pre-construction conditions

6.6.2.3.1 Background

The installation of the WTG and OSP foundations and associated scour protection will alter a small proportion of the benthic habitat in the Offshore Project Area for the life of the proposed Project. Mortality and displacement effects during construction are expected to be variable and may result in temporarily decreased sediment and benthos abundance and heterogeneity in the Offshore Project Area following decommissioning (Gates & Jones, 2012; Hewitt et al., 2010). However, scour protection also has the potential to turn biodiversity-poor, soft-sediment habitat into heterogeneous, biodiverse benthic communities (Coolen, 2020; HDR, 2019; Langhamer, 2012). Under ideal environmental conditions and sufficient availability of benthic larvae, colonization of scour protection areas will occur with organisms abundant in the water mass or nearby hard bottom habitat. Scour protection has shown to be typically colonized by epifaunal species inhabiting rocky substrata, e.g., crabs, lobsters, barnacles, and sponges (Coolen, 2020; Langhamer, 2012).

Benthic substrates in the Lease Area, southern Falmouth export cable corridor, and northern Brayton Point export cable corridor are generally classified as Fine Unconsolidated sand material, which denotes rapid recovery for benthos that preferred soft-sediment characterization (Dernie et al., 2003). Export cable installation will temporarily alter the seabed habitat, resulting in some effects associated with mortality and displacement during construction and some effects associated with recovery time from the areas affected by their placement. The northernmost portions of the southern Falmouth export cable corridor and the northern Falmouth export cable corridor were characterized by more heterogeneous habitats. Similarly, the glacial moraine area in the Rhode Island Sound portion of the Brayton Point export cable corridor and the anthropogenic rock dumps in the Sakonnet River were characterized by more heterogeneous habitats. Disturbance of the benthic communities in these areas are expected to require a longer period (estimated one to three years) to recover.

6.6.2.3.2 Construction

The installation of the WTG and OSP foundations as well as placement of scour protection (rock material) in the Lease Area will result in direct mortality of sessile epifaunal species and shellfish in the foundation and scour protection footprint. Due to the homogeneous habitat observed in the Lease Area and much of the export cable corridors, recolonization rates in these areas are expected to be reversed in a relatively short period of time. Soft-bottom habitat loss due to WTG installation typically occurs on less than one percent of an offshore wind farm’s total area (Glarou et al., 2020; English et al., 2017). The four foundations types under consideration– monopiles, piled jackets, suction bucket jackets, and gravity-based structures – will take up various amounts of seabed area (see Appendix F2, Scour Potential Impacts from Operational Phase and Post-Construction Infrastructure). Furthermore, because this habitat is widely available in the Lease Area, the loss of soft-sediment habitat is expected to be relatively insubstantial and the addition of new hard substrate may be beneficial to benthic communities (Hemery, 2020; Rastelli et al., 2020; see Section 6.6.2.3.3). See **Section 3**, Description of Proposed Activities, for a description of the total disturbance footprint for each foundation type, including scour protection and seafloor preparation.

6.6.2.3.3 Operations and Maintenance

The installation of WTGs and OSPs in the Lease Area introduces structures that provide a source of new hard substrate for the life of the proposed Project. The Lease Area has a very limited amount of hard bottom habitat; therefore, the presence of WTG and OSP foundations are anticipated to directly affect the benthic habitat in the Lease Area during the operations phase. Epifaunal organisms that may settle on WTG foundations include algae, sponges, tunicates, anemones, hydroids, bryozoans, barnacles, and mussels (Hemery, 2020; ICF Incorporated, LLC., 2020; Kramer et al., 2015; Wehkamp and Fischer, 2013; Joschko et al., 2008). These organisms are known to occur on other hard bottom substrate areas in Nantucket Sound in association with man-made substrates such as navigation buoys and pier pilings. Benthos including polychaetes, gastropods, nudibranchs, and crustaceans are expected to be present on or near the WTGs and OSPs as growth of fouling organisms develops.

Beginning in 2016, BOEM’s Real-time Opportunity for Development Environmental Observations (RODEO) program has collected three years of benthic habitat data from the Block Island Wind Farm to assess the temporal and spatial changes in substrate characterization and benthos abundance and distribution near the WTG foundations during operations (HDR, 2020b). Epifaunal monitoring data was collected using video analysis and benthic grab sampling from three of the five WTGs at various distances from the WTG foundations. Results of the RODEO program found that by year 2 of epifaunal monitoring, the foundations were primarily colonized by dense blue mussel aggregations; approximately 61-88 percent of epifauna observed were blue mussels (Hutchison et al., 2020a, b). The epifaunal and sediment characteristics varied between WTGs and between survey years. These results are expected to be similar to those that may be observed during the operations phase of the proposed Project due to its close proximity to Block Island Wind Farm (located approximately 56.3 miles [90.6 km] southeast of the Block Island Wind Farm).

The installation of the offshore export cable will temporarily alter the bottom habitat but is not expected to cause long-term habitat disturbance to the seafloor; however, the long-term recovery time of sessile, epifaunal benthos expected to occur along the export cable corridors (particularly in the complex, hard bottom portions) may cause a temporary shift in the benthic community composition, which could have permanent effects on the benthic habitat. The offshore export cable may not be completely submerged during installation; a concrete mattress 1 feet (0.3 m) thick will cover parts of the offshore export cables that are placed on the seafloor (Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). Additionally, scour protection may be implemented for necessary areas of the offshore export cables. This concrete mattress along with scour protection areas on the offshore export cables could provide hard substrate for epifaunal colonization.

6.6.2.3.4 Decommissioning

Decommissioning could involve removal of substructures or leaving them in place; if removed, effects would be similar to substructure construction. If left in place, effects would be similar to operation phase effects. For more detailed information on Project decommissioning activities, see Section 3.3.19, Conceptual Decommissioning. These proposed Project activities are expected to cause effects to the benthic communities that were established during the operations phase of the proposed Project, particularly attached epifauna that colonize the WTG and OSP foundations. The loss of hard bottom substrates will likely cause the benthic communities in the Lease Area to return to pre-construction conditions.

The proposed Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there will be no effects from decommissioning. If cable removal is required, effects from removing the cables will be localized to the export cable corridors; cable removal would disturb benthic habitats, including any hardbottom communities that had become established since the cables were installed. Consequently, habitat disturbance and modification effects on benthic and shellfish resources during decommissioning are anticipated to be similar to those during construction.

6.6.2.4 Change in Ambient EMF

TABLE 6-45. FINDINGS SUMMARY – CHANGE IN AMBIENT EMF

Sources of EMFs	Summary
Construction	
N/A	• Physiological and behavioral effects are not expected
O&M	
Introduced magnetic fields from export cables	• Physiological and behavioral effects are not expected • Industry export cable sheathing and burial methods will likely substantially decrease EMF detection by EMF-sensitive marine species
Decommissioning	
N/A	• Physiological and behavioral effects are not expected

6.6.2.4.1 Background

Compared to finfish and elasmobranchs, little research has been conducted on the effects of EMF on benthic invertebrates; however, there is research showing that some invertebrate species are able to detect changes in EMF (Hutchison et al., 2018; Love et al., 2017; Normandeau Associates, Inc., 2011). Various lobster and crab species have been observed to use geomagnetic fields for orientation and migration, signifying that this group of invertebrates may be capable of detecting static magnetic fields (Scott et al., 2019; Hutchison et al., 2018; Lohmann & Ernst, 2013; Boles and Lohmann, 2003). The use of geomagnetic fields for orientation and migration, however, is likely integrated with other environmental cues such as seabed slope, light, currents, and water temperature. Research has shown that undersea cables could cause disorientation in invertebrate species as they encounter magnetic fields emitted from the cable and may redirect locomotion in response to the changes in the magnetic environment (Gill et al., 2005).

Mayflower Wind conducted an offshore EMF analysis of the Offshore Project Area, encompassing several different modeled offshore export cable burial depths and cable spacings to represent both likely submarine cable conditions as well as worst-case conditions following cable installation (Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). Mayflower Wind's analysis found that magnetic field levels in the water column above the seafloor will be substantially less than the modeled levels at the seafloor surface. Magnetic fields decrease as a function of distance above the cable at the same rate at which magnetic fields decrease as a function of lateral distance from the subsea cable. As indicated in Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project, the subsea cables are expected to contain approximately 60 Hz alternating current magnetic fields, which, according to CSA Ocean Sciences, Inc. (2019), are well outside the typical EMF detection range of magnetosensitive and electrosensitive marine species. Some marine species sensitive to EMF are expected to be able to detect magnetic fields when in the immediate vicinity of the subsea cable, but direct effects of EMF on the species are unlikely.

6.6.2.4.2 Operations and Maintenance

WTGs do not generate EMFs. EMFs will be generated by inter-array cables in the Lease Area and from the offshore export cables in the export cable corridors. The offshore export cables will be shielded and buried, likely at a depth of approximately 6.6 feet (2 m) beneath the seafloor, which is expected to substantially decrease EMF detection by EMF-sensitive marine species (Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). Potential exposure to EMFs will be short- or long-term, depending on the proximity of the species to the cables. Sessile benthos are expected to be exposed to potential EMFs more than mobile benthos. Mobile, epifaunal species are most likely to be exposed to potential EMFs when passing through the export cable corridors, whereas benthic species in the Lease Area will be potentially exposed to EMFs for the duration of the energized inter-array cables in the Lease Area.

Overall, additional EMFs from the proposed Project are not expected to affect benthic communities in the Offshore Project Area.

6.6.2.5 Planned Discharges

TABLE 6-46. FINDINGS SUMMARY – PLANNED DISCHARGES

Sources of Planned Discharges	Summary
Construction, Operations & Maintenance, Decommissioning	
Planned vessel discharges	• Vessels may release bilge water, engine cooling water, deck drainage, and ballast water. • Due to the expected and controlled dispersion and dilution of planned discharges, potential effects to benthic resources will likely be insubstantial. • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of planned discharges.

6.6.2.5.1 Background

The planned discharges IPF is evaluated in Section 3.4, Summary of Impact Producing Factors. Vessels used during offshore construction activities routinely and by design conduct planned discharges of bilge water, engine cooling water, deck drainage, and/or ballast water. Such releases are temporary and will be immediately dispersed and diluted. Due to the expected and controlled dispersion and dilution of planned discharges, potential effects to benthic resources are expected to be insubstantial. Alternately, vessels may discharge unplanned contaminants such as oil, solid waste, or other materials. See Section 3.3.14, Vessels, Vehicles, and Environmental Protections, for more information on proposed Project vessel operations. Project vessels and offshore activities will comply with the regulatory requirements related to the prevention and control of discharges and spills, consistent with International Convention for the Prevention of Pollution from Ships (MARPOL) regulations as documented in Appendix AA, Oil Spill Response Plan.

6.6.2.5.2 Construction

Increased vessel traffic in construction areas and at ports utilized by these vessels may increase the likelihood of planned discharges while transiting through the Offshore Project Area. Such planned discharges will likely have an insubstantial effect on the benthic resources in the Offshore Project Area.

6.6.2.5.3 Operations and Maintenance

Planned vessel discharges during the operations phase of the proposed Project are not expected to have a substantial effect on the benthic resources in the Offshore Project Area.

6.6.2.5.4 Decommissioning

Effects associated with planned discharges in the Offshore Project Area during decommissioning are expected to be similar to those described in the construction phase of the proposed Project and are considered to be insubstantial to benthic resources.

6.6.2.6 Accidental Events

TABLE 6-47. FINDINGS SUMMARY – ACCIDENTAL EVENTS

Sources of Accidental Events	Summary
Construction, O&M, Decommissioning	
Unplanned vessel and Project discharges	• Potential effects of unplanned discharges to benthic and shellfish resources will likely be insubstantial. • In the unlikely event the proposed Project generates unplanned discharges, the discharges would be removed in compliance with all regulatory requirements. • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of discharges and spills.

6.6.2.6.1 Background

Unplanned discharges from proposed Project activities that may affect benthic and shellfish resources are most likely to occur from Project vessels (Appendix M, Benthic and Shellfish Resources Characterization Report). Vessels may spill unplanned discharges such as oil, solid waste, or other materials. Accidental spills and unplanned discharges are not expected to be produced by the proposed Project during the construction, O&M, or decommissioning phases.

6.6.2.6.2 Construction

Increased vessel traffic in the area of construction and at nearby ports may increase the likelihood of unplanned releases. Should the rare occurrence of an unplanned vessel discharge during the construction phase of the proposed Project happen, it is not expected to have a substantial effect on benthic and shellfish resources in the Offshore Project Area. In the unlikely event unplanned discharges occur in the Offshore Project Area, Mayflower Wind will comply with the regulatory requirements related to the prevention and control of discharges and spills, consistent with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

6.6.2.6.3 Operations and Maintenance

Unplanned vessel discharges during the O&M phase of the proposed Project are not expected to have a substantial effect on benthic and shellfish resources in the Offshore Project Area. In the unlikely event unplanned discharges occur in the Offshore Project Area, Mayflower Wind will comply with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

6.6.2.6.4 Decommissioning

Effects associated with unplanned discharges in the Offshore Project Area during decommissioning are expected to be similar to the effects described in the construction phase of the proposed Project and are considered insubstantial to benthic resources.

6.6.3 Conclusion

An assessment of the physical and biological characteristics of the seafloor to determine the benthic and shellfish composition of the Lease Area and export cable corridors was completed based on results of a review of published scientific literature, publicly available reports, and field surveys conducted within the Lease Area and export cable corridors. Benthic substrate in the southern Falmouth export cable corridor and Lease Area are primarily classified as fine unconsolidated material, dominated by sand. Complex habitat (gravelly) was observed at a few stations along the southern Falmouth export cable corridor. No other complex habitat features were noted in the southern Falmouth export cable corridor or the Lease Area. Benthic organisms observed during surveys in the Lease Area and a majority of the southern Falmouth export cable corridor were predominantly infaunal tube-building and surface-burrowing species that prefer the soft, sandy sediment with some mobile, epifaunal species (e.g., sand dollars, crabs, gastropods) also observed. These infaunal species are also expected to occur in unconsolidated soft sediments near the Lease Area and within portions of the southern Falmouth export cable corridor. The northern Falmouth export cable corridor substrate was primarily classified as coarse unconsolidated material. Areas of complex habitat were noted at many stations along the northern Falmouth export cable corridor. CMECS characterization of fauna along the northern Falmouth export cable corridor was heterogenous, including soft sediment and attached fauna (i.e., macroalgae, hydroids, bryozoans, sponges), with reef biota observed at two stations (008 and 019).

The substrate along the Brayton Point export cable corridor was generally classified as fine unconsolidated material, with sand and muddy sand throughout the corridor. Isolated pockets of coarse unconsolidated material occur, with gravelly and gravel mixes at locations along the export cable corridor, specifically near the 3 nm (5.6 km) limit of Rhode Island state waters, and in the glacial moraines off Martha's Vineyard. The CMECS characterization of fauna along the Brayton Point export cable corridor was heterogeneous, reflecting the wide variation in substrate types. In Mount Hope Bay, large tube building fauna and some gastropod reefs dominated the fauna. Through the Sakonnet River to federal waters, large deep burrowing fauna and gastropod reefs were observed. Fauna on soft sediments included mobile mollusks, mobile crustaceans and the areas of complex habitats had attached fauna and diverse colonizers.

Benthic and shellfish resources have the potential to be exposed to various IPFs in the Offshore Project Area during all phases of the proposed Project, such as introduced sound, seabed disturbance, habitat disturbance and modification, EMFs, planned discharges, and accidental events. Depending on the IPF, potential effects are expected to vary from insubstantial to notable but will primarily be temporary and reversible behavioral and physiological effects. Benthic communities well adapted to disturbance within their habitats (e.g., sand sheets) are expected to quickly recolonize, and it is anticipated that recolonization of homogenous benthic habitat in the Lease Area and export cable corridors will occur relatively quickly following construction disturbances (Hutchison, 2020b; Grabowski et al., 2014). Communities not well adapted to frequent disturbance (e.g., deep-boulder, hard-bottom epifaunal communities) may take longer than a year to begin recolonization after Project disturbance. Recolonization of the more heterogenous areas may take longer following construction disturbance (estimated one to three years) in the hard bottom portions of the export cable corridors. Effects on benthic species within the Lease Area, southern Falmouth export cable corridor, and much of the Brayton Point export cable corridor are expected to be low, localized, and short-term. Recolonization of the complex habitats in the northern Falmouth export cable corridor and isolated segments of the Brayton Point export cable corridor, is expected to occur over periods of 1 to 3 years; recovery of benthic communities in the sandier sediments of the Lease Area, the southern Falmouth export cable corridor and most of the Brayton Point export cable corridor would likely occur within a year of disturbance. Effects to the benthic resources in the complex habitats found in the northern Falmouth export cable corridor and isolated segments of the Brayton Point export cable corridor are considered temporary, short-term, and indirect. Installation of foundations and scour protection in the Lease Area would result in conversion of soft bottom habitat to hard bottom habitat within the footprint of the WTGs and OSPs. This conversion is predicted to have some beneficial effects to some species through introduction of habitat diversity to a largely homogenous sand plain. Along the Falmouth and Brayton Point export cable corridors and within the Lease Area outside of the footprints of WTGs and OSPs, the substrates are expected to return to conditions similar to conditions seen before construction. The time and nature of recovery of the benthic habitat following removal of offshore facilities during decommissioning at the end of the Project is likely to be similar to the recovery following construction.

6.7 Finfish and Invertebrates

This section describes the finfish and invertebrate species that occur in the Offshore Project Area and includes an evaluation of potential Project-related effects (i.e., from IPFs), as well as proposed avoidance, minimization, and mitigation measures. For this section, the Offshore Project Area is defined as the Lease Area and the proposed offshore export cable corridors. One proposed export cable corridor extends from the Lease Area through Muskeget Channel and ends) in Falmouth, Massachusetts (preferred landfall at Worcester Avenue with alternate sites at Shore Street and Central Park). The other proposed export cable corridor extends from the Lease Area through Rhode Island Sound, the Sakonnet River, and Mount Hope Bay. It ends in Somerset, Massachusetts (eastern and western landfall locations at Brayton Point). This evaluation is based on a review of published scientific literature, publicly available reports, and finfish and invertebrate-specific monitoring reports conducted in the MA/RI WEA and the Offshore Project Area, including Project-generated reports (listed below). Results of the essential fish habitat (EFH) assessment, which is described in detail in Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment, are also discussed.

Technical appendices relating to finfish and invertebrates include:

- Appendix N, Essential Fish Habitat Assessment and Protection Fish Species Assessment

6.7.1 Affected Environment

Mayflower Wind evaluated the best available literature, government databases and site-specific analyses conducted for the proposed Project. **Table 6-48** summarizes the published literature, guidelines, reports, and other data sources used to identify finfish and invertebrate physiological thresholds, habitat descriptions, and species occurrence in the Offshore Project Area.

TABLE 6-48. FINFISH AND INVERTEBRATE LITERATURE, GUIDELINES, REPORTS, AND DATA SOURCES

Author	Source Title	Citations
American National Standards Institute	Sound Exposure Guidelines for Fishes and Sea Turtles	Popper et al., 2014
BOEM	South Fork Wind Farm Draft Environmental Impact Statement	BOEM, 2021
BOEM	Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations	ICF Incorporated, LLC., 2020
BOEM	National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf	BOEM, 2019a
BOEM	Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts. Revised Environmental Assessment	BOEM, 2014
BOEM	Effects of EMFs from Undersea Power Cables on Elasmobranch and Other Marine Species	Normandeau Associates, 2011
U.K. Department for Business Enterprise	Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry	BERR, 2008

Author	Source Title	Citations
and Regulatory Reform		
ESS Group, Inc. and Battelle	Cape Wind Energy Project. Appendix 3.8-B: Draft Fisheries Report	ESS Group, Inc. and Battelle, 2006
NMFS's Greater Atlantic Regional Fisheries Office (GARFO)	The Greater Atlantic Region ESA Section 7 Mapper	GARFO, 2019a
GARFO	GARFO Acoustic Tool: Analyzing the effects of pile driving on ESA-listed species in the Greater Atlantic Region	GARFO, 2016
MA DMF	Shellfish Suitability Areas	Massachusetts Division of Marine Fisheries, 2020
MassWildlife	Natural Heritage & Endangered Species Program	MassWildlife, 2015a; 2015b
NMFS	2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing	NMFS, 2018
NMFS	Recommendations for Mapping Fish Habitat	NMFS, 2020
NOAA	Species Directory	NOAA, 2020d
NOAA National Geophysical Data Center	Bathymetry data from the U.S. Coastal Relief Model Vol.1-Northeast Atlantic	NOAA NGDC, 1999
NOAA	Fisheries Management Plans	NOAA, 2020d-j
NOAA	Essential Habitat Mapper	NOAA, 2020c
NEFSC	Northeast Region Stock Assessment Database	NEFSC, 2020a
NEFSC	Ecology of the Northeast US Continental Shelf (Species richness and biomass bottom trawl surveys)	NEFSC, 2020b
Northeast Regional Ocean Council	Northeast Ocean Data Portal	Northeast Regional Ocean Council, 2020b
Epsilon Associates, Inc.	Vineyard Wind Draft Construction and Operations Plan Volume III: Environmental Information	Epsilon Associates, Inc., 2020
Related COP Appendices		
AECOM	Essential Fish Habitat and Protected Fish Species Assessment	Appendix N
AECOM	Benthic Resource Characterization Report	Appendix M
AECOM	Seagrass and Macroalgae Characterization Report	Appendix K
AECOM	Emergency Response Plan/OSRP	Appendix AA
Fugro	Sediment Plume Impacts from Construction Activities	Appendix F1
IES & Swanson Environmental	Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment	Appendix F3
Gradient	EMF Assessment for the Proposed Mayflower Wind Project	Appendix P1
JASCO Applied Sciences	Mayflower Wind Underwater Acoustics Technical Report: Underwater Acoustic Modeling and Animal Exposure Estimation for Mayflower Wind Energy, LLC.	Appendix U2

Different types of finfish and invertebrate populations that may occur in the Offshore Project Area, including federal- and/or state-listed species and species of importance to commercial and recreational fishing, are evaluated in the subsections below.

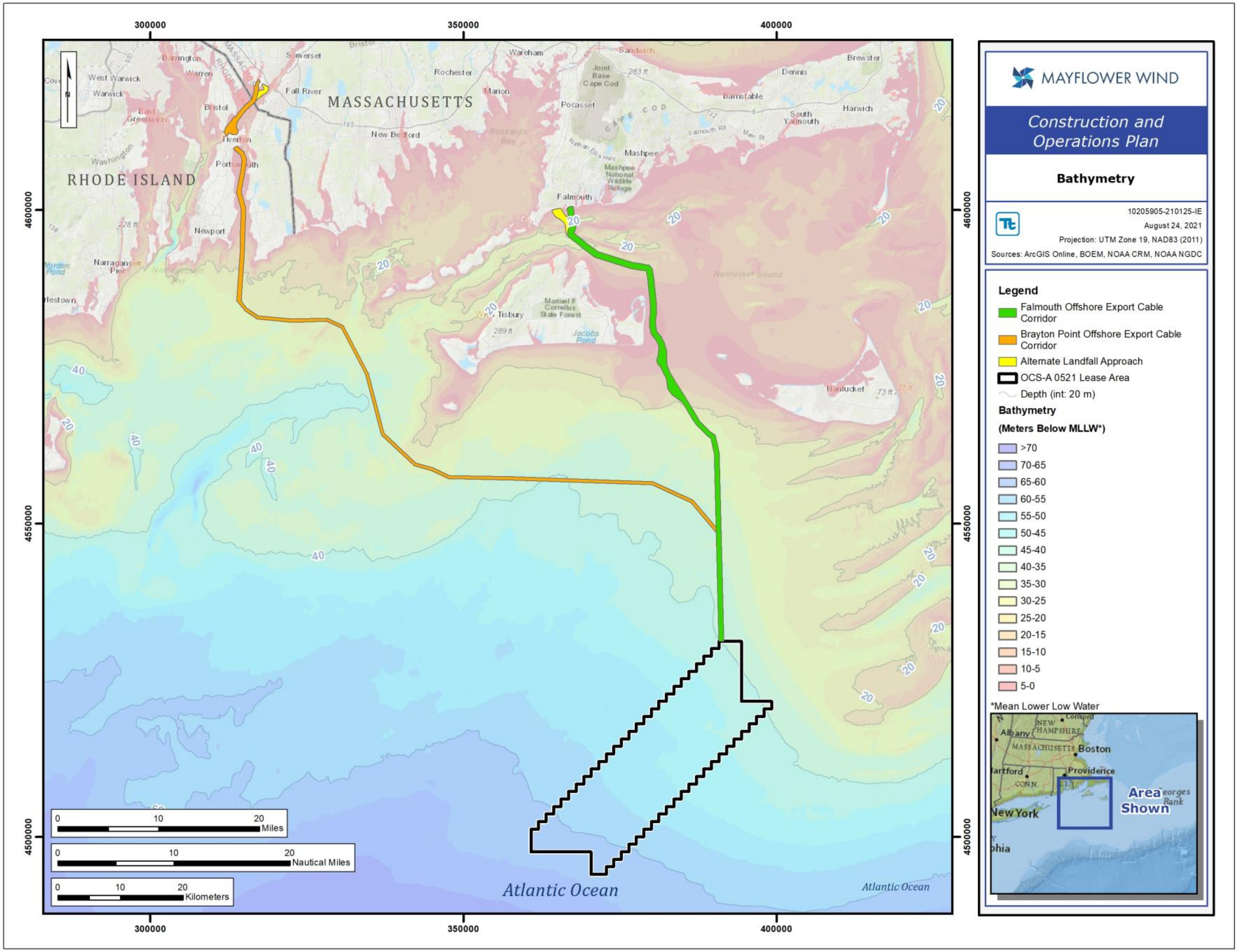
6.7.1.1 Regional Overview

The northwest Atlantic Ocean is comprised of diverse benthic habitats that are defined by their temperature, salinity, pH, seafloor characteristics, biotic structure, depth, and currents. Each benthic habitat structure supports a community of finfish species that rely on these habitats to survive and which directly affect spatial and temporal patterns of finfish species (discussed in further detail in Sections 6.7.2.2 and 6.7.3.1). The results of Mayflower Wind's benthic habitat surveys indicate that the Lease Area seafloor is generally flat with slopes ranging from very gentle (less than 1 degree) to gentle (1.0 to 4.9 degrees) (Appendix E, Marine Site Investigation Report). The water depths, in relation to MLLW, within the Lease Area range from 121.7 feet (37.1 m) to 208.3 feet (63.5 m), with deeper waters in its southwestern portion (**Figure 6-33**). The average depth is 164.0 feet (50.0 m).

6.7.1.1.1 Offshore Project Area Overview

Offshore Project Area substrates are consistent with sediments of the Mid-Atlantic Bight and include unconsolidated sediments composed of clay (smaller than 4 micrometers [µm], silt (4 to 62.5 µm), sand (62.5 µm to 2 mm, and gravel (larger than 2 mm) (Stokesbury, 2012, 2014; Williams et al., 2006). The central section of the Lease Area is comprised of ridges with moderate slopes (5.0 to 9.9 degrees) that are characterized by shallow channels. The substrates found in deeper shelf waters of the Lease Area are predominantly rippled sand and silt-clay. Similar to the Lease Area, the southern portion of the Falmouth export cable corridor is predominantly rippled sand and silt-clay. As this Falmouth export cable corridor moves northward toward the Nantucket Shoals and Muskeget Channel, surface sediment becomes coarser (sand with gravel) and hard bottoms (i.e., pavement) are common. This provides ideal habitat for various invertebrate and shellfish species and early life stage fish species.

The offshore portion of the Brayton Point export cable corridor ranges from slightly gravelly sand to sandy gravel (Stokesbury, 2012, 2014). An area of glacial moraines (marking the maximum extent of the Laurentian Ice Sheet) in the offshore portion of the Brayton Point export cable corridor; this glacial till provides heterogeneous and hardbottom substrates in the form of gravel and boulders (Stokesbury, 2014; CRMC, 2010). In the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable, sediment grain size generally decreases to sandy gravel and slightly gravelly mud. In the Sakonnet River, anthropogenic rock dumps associated with the former Stone and Railroad Bridges provide additional hardbottom habitat. Hardbottom substrates support complex communities of attaching and encrusting organisms that provide secondary habitat for benthic and demersal species. As such, hardbottom habitat is identified as a Special, Sensitive, or Unique Resource in the Massachusetts Ocean Management Plan (MA CZM, 2015) and a sensitive habitat in the Rhode Island Ocean Special Area Management Plan (CRMC, 2010).



Source: Fugro, 2022; NOAA NGDC, 2008; NOAA NGDC, 1999

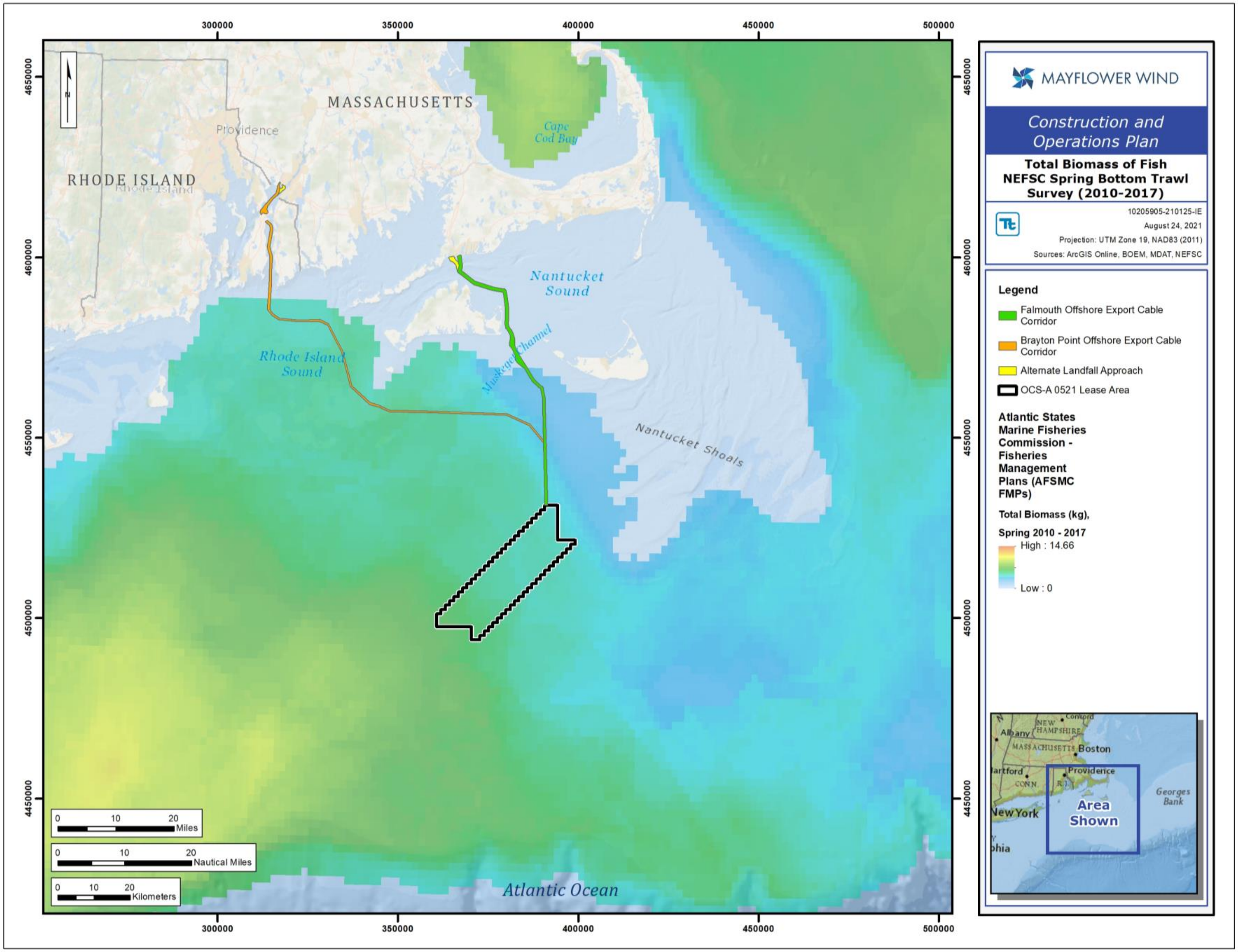
FIGURE 6-33. BATHYMETRY OF THE OFFSHORE PROJECT AREA

Section 6.6 (and Appendix M, Benthic and Shellfish Resource Characterization Report) uses benthic habitat characterization (e.g., geomorphological, substrate, and SAV characteristics) to assess the abundance and distribution of benthic invertebrate species in the Offshore Project Area. Due to the interlinked relationships between benthic habitat characteristics and the occurrence of invertebrate and finfish species, information from Section 6.6 is integrated into the sections below to assess finfish and invertebrate abundance, distribution and their potential exposure to Project-related IPFs.

6.7.2 Species in the MA/RI WEA and the Offshore Project Area

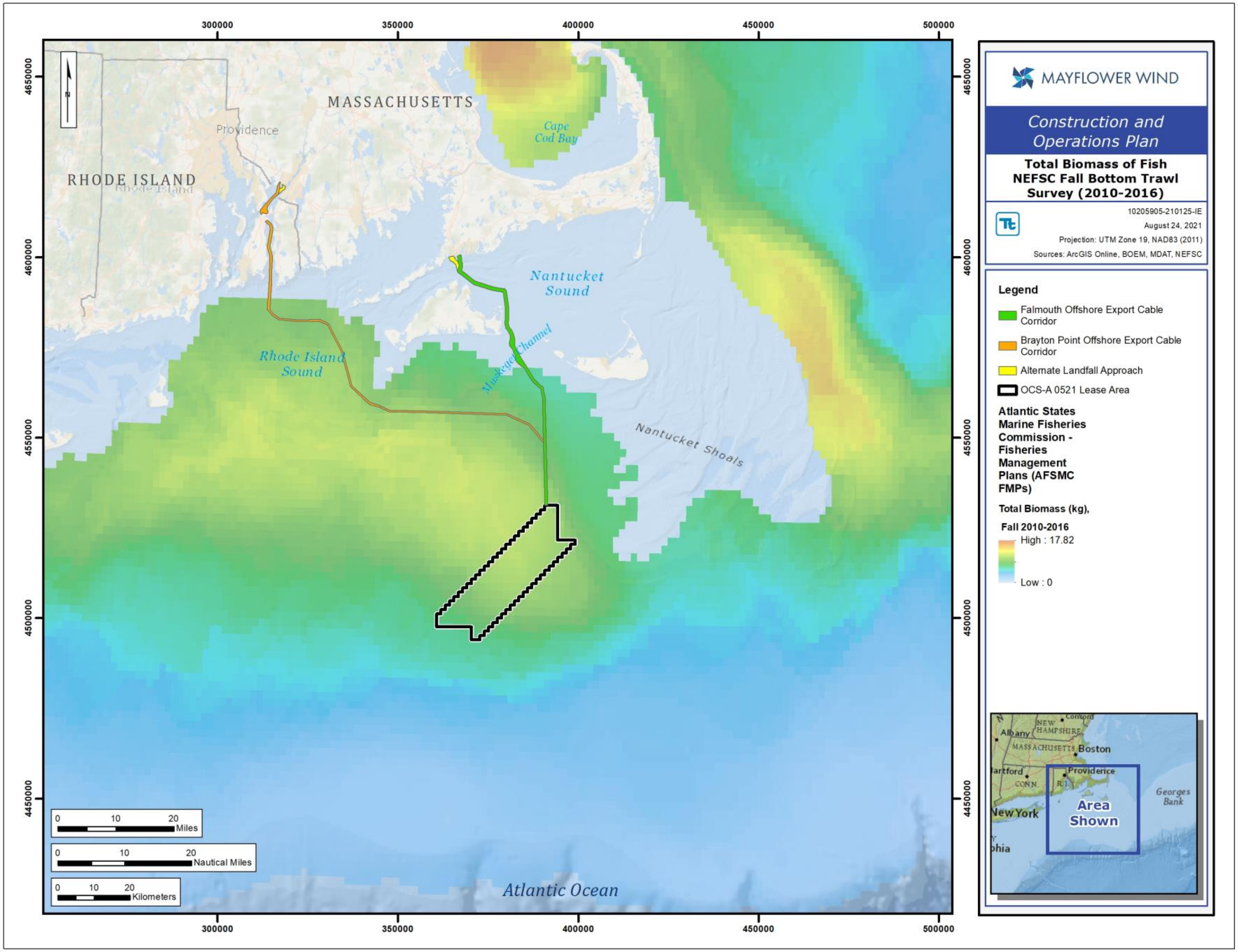
Based on their migratory nature and habitat preferences, marine finfish are broadly classified into the following three guilds: pelagic, demersal, and highly migratory species. Pelagic finfish species spend most of their lives swimming in the water column rather than occurring on or near the seafloor (NEFSC, 2020b). Pelagic species migrate north and south along the Atlantic Coast, depending on sea surface temperatures. They use the highly productive coastal waters during the summer months for feeding and then move to deeper and/or more distant waters for the remainder of the year. Coastal pelagic species also rely on coastal wetlands, seagrass habitats, and estuaries to provide habitat for their early life stages. Demersal fish, or groundfish, are finfish species that inhabit benthic or benthopelagic (near-benthic) habitats (Bergstad, 2009). Many demersal finfish species have either pelagic eggs or larvae that are carried long distances by oceanic surface currents, or eggs that adhere to the various benthic substrates. Highly migratory finfish species often migrate from southern portions of the Atlantic Ocean to as far north as the Gulf of Maine and are expected to be present in the Offshore Project Area during the warmer summer months. Based on bottom trawl data conducted by NMFS NEFSC, the MA/RI WEA has low finfish biomass, but high species richness, when compared to neighboring waters around Cape Cod (NEFSC, 2020b; see **Figure 6-34** through **Figure 6-37**). Finfish species abundance and distribution in the MA/RI WEA is seasonal and varies throughout the year (NEFSC, 2020b).

Many foraging or spawning finfish species that frequent Nantucket Sound, a nursery area where warmer, nutrient-rich waters promote faster growth, are likely to occur along the northern portion of the Falmouth export cable corridor (through the Muskeget Channel towards landfall). These species may also transit to and from Nantucket Sound through the Lease Area and the southern portion of the Falmouth export cable corridor (located between the Lease Area and the opening of the Muskeget Channel). A total of 122 species were recorded in a dataset from the bi-annual resource trawl surveys conducted in Nantucket Sound between 1978 and 2004 (ESS Group, Inc. and Battelle, 2006). During the winter months, finfish biodiversity decreases. However, in the spring, the arrival of anadromous species increases diversity by connecting nutrient transport between freshwater and saltwater ecosystems and catalyzing cascading tropic interactions (Mattocks et al., 2017; Schtickzelle and Quinn, 2007). Biodiversity in the spring and summer months is further increased by seasonal and highly migratory finfish species that may use the Offshore Project Area for spawning and foraging as the local water temperatures increase. Finfish species that rely on structured, hardbottom coastal habitat for spawning are more likely to occur along the northern portion of the Falmouth export cable corridor and near the proposed landfall locations in Falmouth. Alternatively, finfish species that prefer deeper, pelagic waters are more likely to occur along the southern portion of the Falmouth export cable corridor and in the Lease Area.



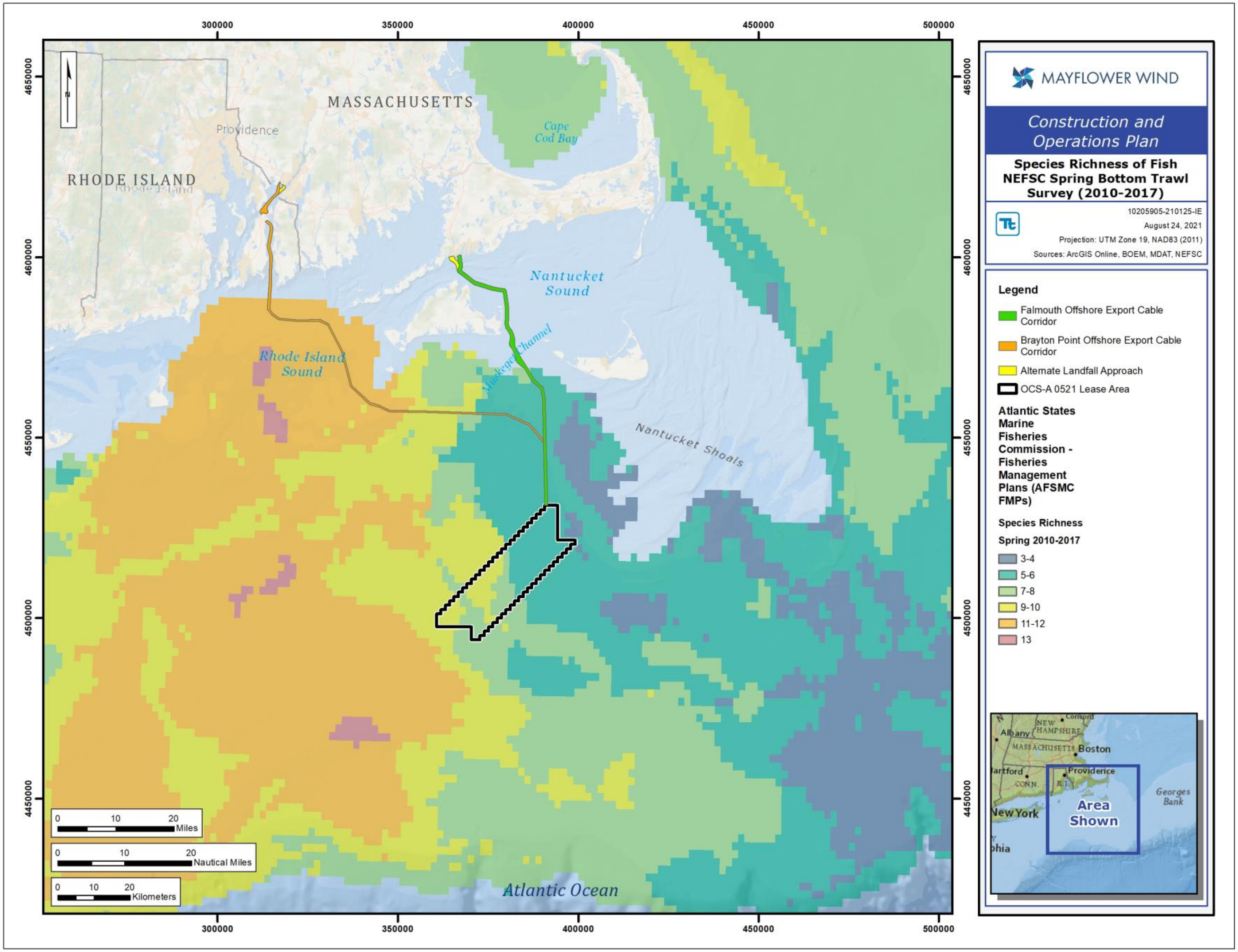
Source: NEFSC, 2020b

FIGURE 6-34. TOTAL BIOMASS (KG) RESULTS OF NEFSC SPRING BOTTOM TRAWL SURVEYS (2010 – 2017)



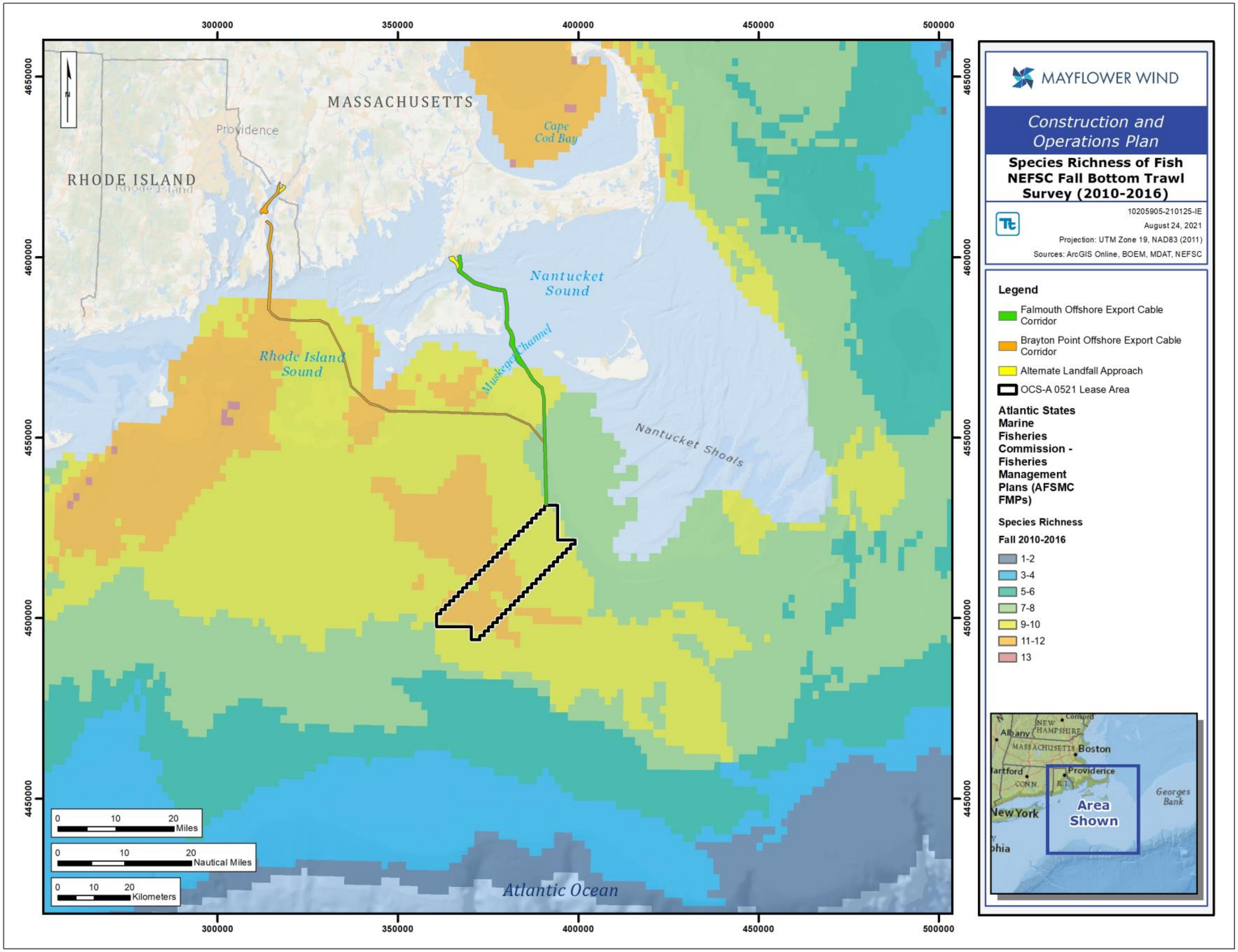
Source: NEFSC, 2020b

FIGURE 6-35. TOTAL BIOMASS (KG) RESULTS OF NEFSC FALL BOTTOM TRAWL SURVEYS (2010 – 2016)



Source: NEFSC, 2020b

FIGURE 6-36. SPECIES RICHNESS RESULTS OF NEFSC SPRING BOTTOM TRAWL SURVEYS (2010 – 2017)



Source: NEFSC, 2020b

FIGURE 6-37. SPECIES RICHNESS RESULTS OF NEFSC FALL BOTTOM TRAWL SURVEYS (2010 – 2016)

Similar to Nantucket Sound, Rhode Island Sound is a nursery area that provides important linkages between nearshore and offshore systems, including nutrient fluxes, larval transport, and juvenile and adult migrations (Malek et al., 2014). A total of 101 species were recorded in a multiyear fishery-independent survey (2009 to 2012) in Rhode Island and Block Island Sounds (Malek et al., 2014). As with Nantucket Sound, biodiversity decreased in Rhode Island Sound during the winter and increased during summer and fall, with an influx of anadromous species, including alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), and striped bass (*Morone saxatilis*) (Evans et al., 2015; Malek et al., 2014). Overall, finfish abundance was higher in Block Island Sound than in Rhode Island Sound, potentially due to higher levels of primary productivity in Block Island Sound (Malek et al., 2014). In the Sakonnet River/Mount Hope Bayportion of the Brayton Point export cable corridor, there has been a recent community shift from year-round resident species to summer migrants (such as summer flounder [*Paralichthys dentatus*], black sea bass [*Centropristis striata*], scup [*Stenotomus chrysops*], and butterfish [*Peprilus triacanthus*]) (Rhode Island Sea Grant, 2018; Evans et al., 2015).

An overview of the finfish species listed under the ESA and MESA that may occur in the Offshore Project Area is provided in the subsections below. Species of Greatest Conservation Need under the Rhode Island Natural Heritage Program and the Rhode Island Wildlife Action Plan are also described in these subsections. Finally, designated EFH for managed species intersecting the Offshore Project Area is provided. For further discussion of other commercially and recreationally important finfish species occurrence in the Offshore Project Area, see Section 11.

6.7.2.1 Endangered and Threatened Finfish

There are two federally and/or state-listed finfish species known to occur in the Offshore Project Area: Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus)* and shortnose sturgeon (*Acipenser brevirostrum*) (Greater Atlantic Regional Fisheries Office, 2019). Additional information regarding each of these species is provided in the subsections below.

6.7.2.1.1 Atlantic Sturgeon

The Atlantic sturgeon is listed as endangered under both the ESA and MESA. It is also a Species of Greatest Conservation Need under the Rhode Island Wildlife Action Plan (NOAA, 2020a, MassWildlife, 2015a, RI DEM DFW, 2015). The species spends most of its life in salt and brackish waters, but returns to freshwater habitat periodically to spawn (Atlantic States Marine Fisheries Commission, 2017). Eggs are deposited on hard-bottom substrates (Greene et al., 2009) and after hatching, the developing larvae move to the estuarine portion of the spawning river, where they will reside as juveniles for years. Sub-adults and adults travel within the marine environment, typically in waters less than 164 feet (50 m) in depth. Atlantic sturgeon are long-lived, slow-growing, and late-maturing finfish that have been recorded to reach up to 14 feet (4.3 m) in length and weigh up to 800 pounds (363 kilograms) (NOAA, 2020). The species can live up to 60 years and their range extends from Newfoundland to the Gulf of Mexico (Sulak et al., 2002). Atlantic sturgeon are bottom feeders with diets consisting of invertebrates (e.g., crustaceans, worms), mollusks, and bottom-dwelling finfish (NOAA, 2020).

Due to its preference for inshore coastal water depths and gravelly and sand substrates (Stein et al., 2004) Atlantic sturgeon may be present within the Project's export cable corridors and near the preferred and alternate landfall locations throughout the year. This species is likely to be more prevalent in the warmer months of the year, when individual adult Atlantic sturgeon migrate to coastal rivers and streams for spawning (Dunton et al., 2010).

6.7.2.1.2 Shortnose Sturgeon

The shortnose sturgeon is listed as endangered under both ESA and MESA and as a Species of Greatest Conservation Need under the Rhode Island Wildlife Action Plan (NOAA, 2020b, MassWildlife, 2015b, RI DEM DFW, 2015). It is an anadromous finfish species found mainly in large freshwater rivers and coastal estuaries located along the east coast of North America, from New Brunswick to Florida. Based on its habitat preferences, shortnose sturgeon may occur in the nearshore export cable corridors and landfall locations. However, the species is unlikely to occur because of its preference to inhabit estuarine waters and river and bay habitats (GARFO, 2019b).

6.7.2.2 Finfish, Skates and Sharks in the Offshore Project Area

Habitat that is essential to sustain finfish and invertebrate populations is identified and regulated by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), also known as the Sustainable Fisheries Act. The MSA oversees a 200-nautical mile fishery conservation zone withing the exclusive economic zone, or EFH, in U.S. waters to prevent overfishing, rebuild depleted finfish stocks, minimize by-catch, enhance research, improve monitoring, and protect finfish habitat. The EFH is defined as "those waters and substrate necessary to finfish for spawning, breeding, feeding, or growth to maturity", and "fish" is defined in the MSA as "finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds" (MSA 16 U.S.C. § 1802). The EFH regulations also define "waters" as including all aquatic areas and their biological, chemical, and physical properties, while "substrate" includes the associated biological communities that make these areas suitable habitats. In addition to EFH designations, habitat areas of particular concern (HAPCs) are subsets of designated EFH that are ecologically significant to a species and are vulnerable to degradation. HAPCs are identified to provide additional focus for conservation efforts. However, they do not confer additional protections or restrictions on designated areas.

The MSA requires that federal agencies consult with NMFS on activities that may adversely affect EFH. Adverse effects are defined as "any impact which reduces quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR § 600.810).

Review of NOAA's *Essential Fish Habitat Mapper* and Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment, determined that the proposed Project is located within EFH for 46 species of finfish and invertebrates at various life stages (NOAA, 2020c). An overview of each of these species, and the occurrence of their EFH in the Offshore Project Area is provided in **Table 6-49**. Life stages discussed vary by species (e.g., skates/sharks do not have egg or larval EFH designations due to lack of knowledge on the egg stages and because individuals emerge from eggs as fully developed juveniles). A review of preferred habitat for finfish and invertebrate species in the Lease Area, export cable corridors, landfall locations and the coinciding presence of EFH is discussed in the subsections below.

6.7.2.2.1 Finfish

Table 6-49 provides an overview of the fishery status and preferred habitats of finfish species with known EFH in the Offshore Project Area.

TABLE 6-49. FINFISH SPECIES WITH MAPPED EFH IN THE OFFSHORE PROJECT AREA

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Albacore tuna	*Thunnus alalunga*	• EFH for juvenile and adult life stages in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor • EFH for juvenile life stage only in Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
American plaice	*Hippoglossoides platessoides*	• Larval life stage EFH in the Lease Area
Butterfish	*Peprilus triacanthus*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile and adult life stages only at the Falmouth landfalls
Atlantic cod	*Gadus morhua*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for egg, larval, and juvenile life stages only at the Falmouth landfalls
Atlantic herring	*Clupea harengus*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor • EFH for larval, juvenile, and adult life stages only in Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile life stage only at Falmouth landfalls
Atlantic mackerel	*Scomber scombrus*	• EFH for all life stages in the Lease Area and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for egg, larval, and juvenile life stages only in Falmouth export cable corridor and offshore portion of the Brayton Point export cable corridor • EFH for juvenile life stage only in Falmouth landfall
Atlantic wolffish	*Anarhichas lupus*	• EFH for all life stages in the offshore portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and at Falmouth landfalls
Black sea bass	*Centropristis striata*	• EFH for juvenile and adult life stages in the Falmouth export cable corridor, Falmouth landfall, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile life stage only in the Lease Area

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Bluefin tuna	*Thunnus thynnus*	• Juvenile and adult life stage EFH in the Lease Area, Falmouth export cable corridor, Falmouth landfalls, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
Bluefish	*Pomatomus saltatrix*	• EFH for juvenile and adult life stages in the offshore portion of the Brayton Point export cable corridor and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for adult life stage only in the Lease Area and Falmouth export cable corridor
Haddock	*Melanogrammus aeglefinus*	• EFH for all life stages in Lease Area • EFH for egg, larval, and juvenile life stages only in the offshore portion of the Brayton Point export cable corridor and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for egg life stage only in the Falmouth export cable corridor
Monkfish	*Lophius americanus*	• EFH for all life stages in the Lease Area and offshore portion of the Brayton Point export cable corridor • EFH for egg and larval life stages only in the Falmouth export cable corridor
Ocean pout	*Macrozoarces americanus*	• EFH for egg, juvenile, and adult life stages in the Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for egg and adult life stages only in the Lease Area
Offshore hake	*Merluccius albidus*	• Larval life stage EFH in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor
Pollock	*Pollachius pollachius and P. virens*	• EFH for egg, larval, and juvenile life stages in the offshore portion of the Brayton Point export cable corridor • EFH for egg and larval life stages only in the Lease Area • EFH for larval life stage only in the Falmouth export cable corridor and Falmouth landfalls • EFH for juvenile life stage only in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
Red hake	*Urophycis chuss*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for egg, larval, and juvenile life stages only at the Falmouth landfalls
Scup	*Stenotomus chrysops*	• EFH for all life stages in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile and adult life stages only in the Lease Area, offshore portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Silver hake	*Merluccius bilinearis*	• EFH for all life stages in the Lease Area • EFH for egg, larval, and adult life stages only in the offshore portion of the Brayton Point export cable corridor and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for egg and larval life stages only in the Falmouth export cable corridor and Falmouth landfalls
Skipjack tuna	*Katsuwonus pelamis*	• EFH for juvenile and adult life stages in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor • EFH for adult life stage only at the Falmouth landfalls and the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
Summer flounder	*Paralichthys dentatus*	• EFH for all life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfall • EFH for larval, juvenile, and adult life stages only in the Sakonnet River/Mount Hope Bay portion of the export cable corridor
White hake	*Urophycis tenuis*	• EFH for juvenile and adult life stages only in the Lease Area • EFH for larval and juvenile life stages only in the Falmouth export cable corridor and offshore portion of the Brayton Point export cable corridor • EFH for juvenile life stage only at the Falmouth landfalls
Windowpane flounder	*Scophthalmus aquosus*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile and adult life stages only at the Falmouth landfalls
Winter flounder	*Pseudopleuronectes americanus*	• EFH for all life stages in the Falmouth export cable corridor, Falmouth landfall, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for larval, juvenile, and adult life stages only in the Lease Area and offshore portion of the Brayton Point export cable corridor
Witch flounder	*Glyptocephalus cynoglossus*	• EFH for all life stages in the Lease Area • EFH for egg, larval, and adult life stages only in the offshore portion of the Brayton Point export cable corridor • EFH for larval and adult life stages only in the Falmouth export cable corridor
Yellowfin tuna	*Thunnus albacares*	• EFH for juvenile and adult life stages in the offshore portion of the Brayton Point export cable corridor • EFH for juvenile life stage only in the Lease Area, Falmouth export cable corridor, Falmouth landfalls, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Yellowtail flounder	*Pleuronectes ferruginea*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile life stage only at the Falmouth landfalls

6.7.2.2.1.1 Lease Area

Finfish with EFH located within the Lease Area are typically pelagic species that prefer offshore, open waters and soft-sediment substrates; such as butterfish, red hake (*Urophycis chuss*), summer flounder, witch flounder (*Glyptocephalus cynoglossus*), and highly migratory tuna species (**Table 6-49**). EFH occurrence also depends on habitat and substrate preferences of certain species life stages, likely due to the presence of benthic prey associated with offshore soft-sediment habitat (for more information on benthic resources, see Section 6.6). For example, witch flounder primarily feed on worms during its juvenile life stage and on both worms and crustaceans during its adult life stage; both of which commonly occur in the Lease Area (see Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment, for further details). Fish eggs that do not require attachment to hard-bottom substrates, such as buoyant monkfish (Lophius americanus) eggs, can typically be found in the Lease Area. Results of a seagrass and macroalgae evaluation of the Offshore Project Area found no SAV in the Lease Area (Appendix K, Seagrass and Macroalgae Report). Finfish species with a strong preference for vegetated habitats, such as juvenile winter flounder (*Pseudopleuronectes americanus*), are expected to occur in lower abundance in the Lease Area, compared with nearshore areas of the export cable corridors and landfall locations.

6.7.2.2.1.2 Export Cable Corridors

EFH has been designated for several species of fish and invertebrate fish within the Falmouth export cable corridor (Appendix M, Benthic and Shellfish Resources Characterization Report). The section of the Falmouth export cable corridor located between the Lease Area and the mouth of the Muskeget Channel is comprised of unvegetated, soft-sediment, benthic habitat similar to that of the Lease Area (Appendix K, Seagrass and Macroalgae Report; Appendix M, Benthic and Shellfish Resources Characterization Report). However, the northern part of the Falmouth export cable corridor from the Muskeget Channel to the landfall locations has coarser sediment and harder bottom, including more gravel and rock. The seagrass and macroalgae characterization surveys did not identify SAV in the southern portion of the Falmouth export cable corridor, but macroalgae was identified in approximately two-thirds of the survey locations during benthic grabs of the northern section of the Falmouth export cable corridor (Appendix K, Seagrass and Macroalgae Report; Appendix M, Benthic and Shellfish Resources Characterization Report).

A finfish species that primarily occupies the Falmouth export cable corridor is the ocean pout (*Macrozoarces americanus*) (**Table 6-49**). Ocean pout have known EFH for all its life stages within the Falmouth export cable corridor, and egg and adult life stages in the Lease Area, but none near the proposed landfall locations. This coincides with the species' preference for hard bottom habitat and its occurrence in more offshore waters (NEFMC and NMFS, 2017).

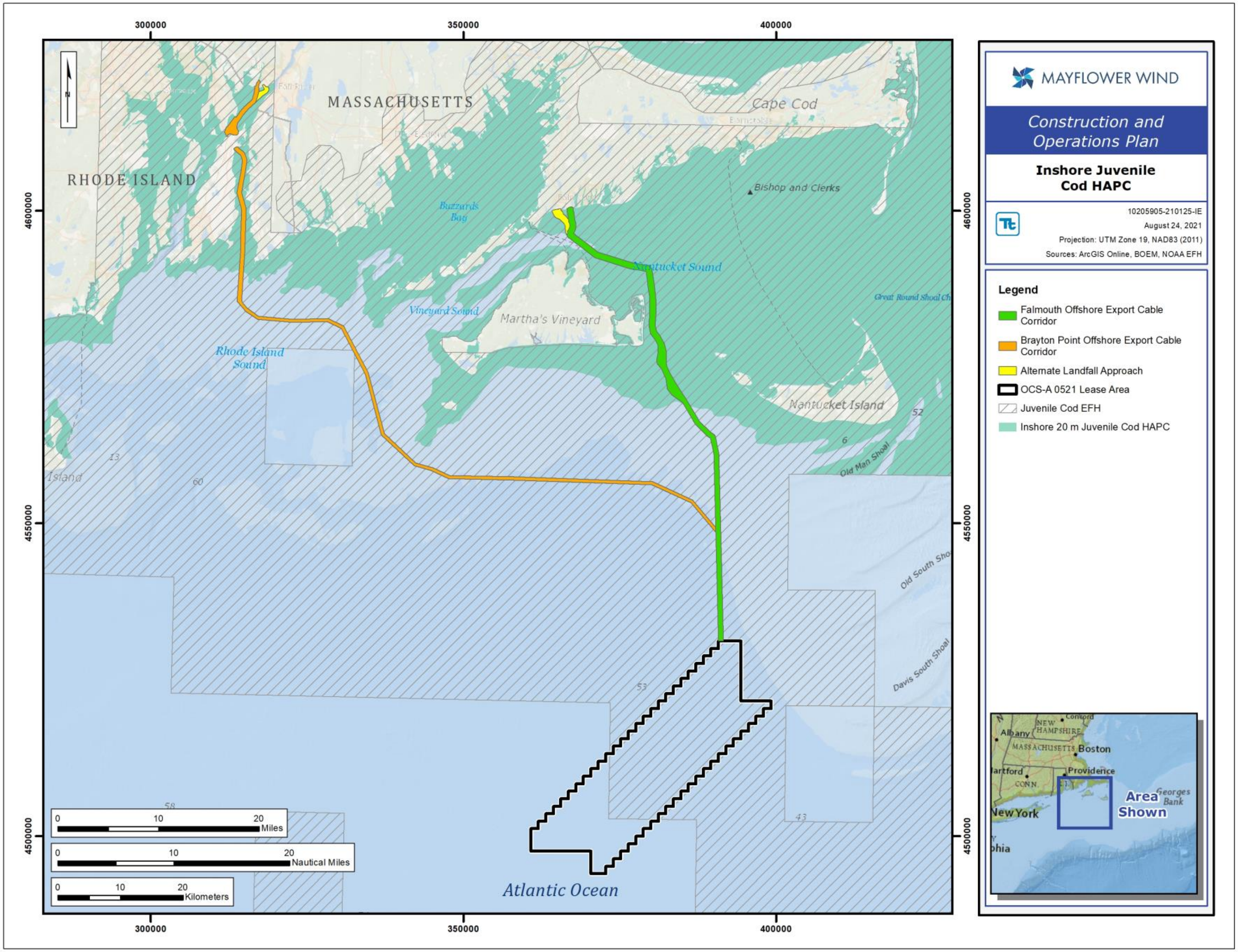
Similarly, finfish EFH in the Brayton Point export cable corridor also belongs to several species that have various habitat and substrate preferences due to the heterogeneous substrates in the area. The offshore portion of the Brayton Point export cable corridor approaching Rhode Island Sound is characterized by sand and gravel mixes, and includes sections of hardbottom in the glacial moraine region located southwest of Martha's Vineyard. Therefore, both unconsolidated softbottom-associated and hardbottom-associated species are known to reside in this area.

Commercially valuable species that have been observed along the Brayton Point export cable corridor include red and silver hake (*Merluccius bilinearis*), summer and winter flounder, and scup (Malek et al., 2014; Stokesbury, 2012, 2014). Grain size decreases to form sand and mud mixes in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor.

Demersal residents in these nearshore areas include winter flounder, American eel (*Anguilla rostrata*), Atlantic tomcod (*Microgadus tomcod*), and white perch (*Morone americana*) (Evans et al., 2015). In recent years, there has been a shift in this inshore community structure from year-round residents to summer migrants, such as summer flounder, black sea bass, scup, and butterfish (Rhode Island Sea Grant, 2018; Evans et al., 2015).

Eelgrass (*Zostera marina*) is found in Narragansett Bay, however, according to Rhode Island and Massachusetts state mapping there are no records of eelgrass in the proposed Brayton Point export cable corridor and at the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island and at Brayton Point (CRMC, 2016 and MA DEP, 2021).

Inshore, coastal areas from the Gulf of Maine to southern New England have been identified by NEFMC as significant habitat (i.e., HAPC) for juvenile Atlantic cod (NEFMC, 2017). Suitable benthic habitat for juvenile cod HAPC includes structurally complex, rocky-bottom substrates that support biodiverse benthos and adjacent sand sediments. The complex, hardbottom habitats are essential to the developmental success of juvenile cod because they provide protection from predation while the adjacent sandy habitat provides suitable foraging habitat. The NEFMC designated HAPC for juvenile cod in the inshore areas of the Gulf of Maine and southern New England between 0 and 66 feet (0 and 20 m; relative to mean high water) (NEFMC, 2017). The only HAPC designated in the Offshore Project Area is for juvenile Atlantic cod (*Gadus morhua*) in the northern section of the Falmouth export cable corridor, in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, and near the proposed landfall locations (**Figure 6-38**) (Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment).



Source: NEFMC and NOAA NMFS. 2017

FIGURE 6-38. JUVENILE COD HAPC

6.7.2.2.1.3 Landfalls

Finfish EFH found near the landfall locations is typically associated with finfish species and life stages that prefer rocky, hard-bottom benthic habitats, SAV, and shallower waters (**Table 6-49**), (see Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). These hard-bottom substrates are essential for finfish that attach or hide their eggs to hard substrates (e.g., Atlantic wolffish [*Anarhichas lupus*]) or for earlier life stages that use hard substrates for shelter and protection. The landfall locations also contain suitable habitat for various sessile and/or attached epifauna species, which are key prey species for many finfish species (see Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Additionally, HAPC for juvenile Atlantic cod occurs in the proposed landfall locations (**Figure 6-38**), (see Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment).

Adult finfish life stages typically do not occur near landfall, except for some highly migratory species (e.g., Atlantic mackerel [*Scomber scombrus*] and tuna species) and demersal species with a preference for hard-bottom, structured habitats, such as black sea bass. Many flounder species may also occur near landfall due to their preference for nearshore waters.

6.7.2.2.2 Skates

Table 6-50 provides an overview of the fishery status and preferred habitats of skate species with known EFH in the Offshore Project Area.

TABLE 6-50. SKATE SPECIES WITH MAPPED EFH IN THE OFFSHORE PROJECT AREA

Common Name	Species Name	Mapped EFH in the Project Area
Barndoor skate	*Dipturus laevis*	Juvenile and adult life stage EFH in the Lease Area
Little skate	*Leucoraja erinacea*	Juvenile and adult life stage EFH in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls
Winter skate	*Leucoraja ocellata*	Juvenile and adult life stage EFH in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls

6.7.2.2.2.1 Lease Area

Skates are demersal species with a broad variety of substrate and benthic prey preferences. The three skate species known to occur in the Offshore Project Area include: barndoor (*Dipturus laevis*), little (*Leucoraja* erinacea), and winter (*Leucoraja ocellata*) skates. These can occur in sand, mud, and gravel substrates and tend to feed on small fish and a variety of benthic organisms, including crustaceans, squid, worms, and mollusks (NOAA, 2020d). All three skate species have known EFH for both juvenile and adult life stages in the Lease Area. However, barndoor skate is expected to occupy the Lease Area in a relatively higher abundance due to its preference for deeper, offshore waters (**Table 6-50**). Juvenile and adult barndoor skates typically occur in water depths of up to 1,310 feet (400 m) and 2,460 feet (750 m) on the continental shelf, respectively, whereas little skates prefer maximum coastal water depths between 260 feet (80 m) and 330 feet (100 m) and winter skates prefer maximum coastal water depths between 295 feet (90 m) and 260 feet (80 m) (NEFMC and NMFS, 2017).

6.7.2.2.2.2 Export Cable Corridors

As previously discussed in Section 6.7.2.2.2.1, all skate species prefer various benthic substrates, but barndoor skates prefer offshore waters; therefore, there is no known EFH for barndoor skate in the Falmouth or Brayton Point export cable corridors. However, there is known EFH for all life stages of little and winter skates (**Table 6-50**). Little and winter skates prefer intertidal and subtidal coastal habitats, including bays and estuaries, with sand and gravel substrates (NEFMC and NMFS, 2017). Therefore, the species are expected to occur throughout the export cable corridors.

6.7.2.2.2.3 Landfalls

Along with EFH occurrence in the export cable corridors, little and winter skates also have EFH near the proposed landfall locations (**Table 6-50**). Both species prefer intertidal and subtidal coastal habitats with sand and gravel substrates, but little skates have a particular preference for pebbly-bottom substrates (NEFMC and NMFS, 2017). Due to the higher availability of pebbly-bottomed substrates near landfall, a relatively higher abundance of little skates is expected to occur near the landfall locations.

6.7.2.2.3 Sharks

Table 6-51 provides an overview of the fishery status and preferred habitats of shark species with known EFH in the Offshore Project Area. A detailed discussion of shark EFH occurrence in the Offshore Project Area is included in the subsections below.

TABLE 6-51. SHARK SPECIES WITH MAPPED EFH IN THE OFFSHORE PROJECT AREA

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Basking shark	*Cetorhinus maximus*	• EFH for all life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, and Falmouth export cable corridor
Blue shark	*Prionace glauca*	• Neonate, juvenile, and adult life stage EFH in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor
Common thresher shark	*Alopias vulpinus*	• EFH for all life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls
Dusky shark	*Carcharhinus obscurus*	• EFH for all life stages in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor
Great white shark	*Carcharodon carcharias*	• EFH for all life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls • EFH for neonate life stage only in Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
Porbeagle shark	*Lamna nasus*	• EFH for all life stages in the Lease Area

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Sand tiger shark	*Carcharias taurus*	• Neonate and juvenile life stage EFH in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls
Sandbar shark	*Carcharhinus plumbeus*	• EFH for juvenile and adult life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor • EFH for juvenile life stage only in the Falmouth export cable corridor
Shortfin mako shark	*Isurus oxyrinchus*	• Neonate, juvenile, and adult life stage EFH in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor
Smoothhound shark (Atlantic Stock)	*Mustelus canis*	• EFH for all life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and Falmouth landfalls
Spiny dogfish	*Squalus acanthias*	• Male and female sub-adult and adult life stage EFH in the Lease Area, offshore portion of the Brayton Point export cable corridor, and Falmouth export cable corridor • EFH for sub-adult female and adult male life stages only in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
Tiger shark	*Galeocerdo cuvier*	• Juvenile and adult life stage EFH in the Lease Area, Falmouth export cable corridor, and offshore portion of the Brayton Point export cable corridor

6.7.2.2.3.1 Lease Area

Due to their highly migratory nature and general preference for deeper ocean waters, all shark species reviewed in **Table 6-51** have EFH in the Lease Area. However, shark species that prefer cold, open ocean water are more likely to use EFH further offshore beyond the OCS, such as blue shark (*Prionace glauca*) and tiger shark (*Galeocerdo cuvier*), (see Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Porbeagle shark (*Lamna nasus*) has a particular preference for cold, deep, waters and therefore, has EFH in the Lease Area only. The majority of the sharks assessed do not have specific benthic substrate preferences for their early life stages (as opposed to finfish species). Consequently, EFH for early life stages of sharks occurs similarly to later life stages in the Lease Area.

6.7.2.2.3.2 Export Cable Corridors

Most shark species reviewed are expected to have EFH within the export cable corridors in similar abundance to Lease Area EFH (**Table 6-51**) (Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Shark species with preferences for hardbottom benthic habitats, such as sand tiger shark (*Carcharias taurus*) and sandbar shark (*Carcharhinus plumbeus*), are expected to have a higher occurrence in the export cable corridors EFH, especially in sections closer inshore that contain more complex benthic substrates and in the glacial moraine area southwest of Martha's Vineyard.

6.7.2.2.3.3 Landfalls

There is minimal shark EFH near landfall locations since they are generally pelagic species (**Table 6-51**). Out of the 12 shark species reviewed, only 4 species have known EFH near the Project's preferred and alternate landfall locations. These include the common thresher shark (*Alopias vulpinus*), great white shark (*Carcharodon carcharias*), sand tiger shark (*Carcharias taurus*), and smoothhound shark (*Mustelus canis*). Common thresher sharks are known to occur in coastal and oceanic habitats and may therefore occur within the Lease Area, export cable corridors, and near the landfall locations (NMFS, 2009). Great white sharks generally prefer open ocean habitat, but are often drawn nearshore while hunting for pinnipeds, which commonly occur in coastal habitats. Sand tiger and smoothhound sharks are primarily coastal sharks that prefer relatively shallow waters. Therefore, these are likely to have the highest occurrence in landfall EFH, as opposed to the other shark species reviewed.

6.7.3 Invertebrates in the Offshore Project Area

Invertebrate species form the foundation of marine ecosystems, providing essential prey resources, protection and shelter, and suitable spawning grounds and nurseries for finfish, marine mammal, and sea turtle species. Marine invertebrates are classified into more than 30 phyla and occupy both benthic and pelagic habitats. Benthic invertebrates can generally be classified into two groups, epifauna and infauna, due to their close associations with benthic geomorphological and sediment characteristics (for more information, see Section 6.6 and Appendix M, Benthic and Shellfish Resources Characterization Report).

The Lease Area and the southern sections of the export cable corridors are predominately characterized by tube-building and surface-burrowing infauna (e.g., clams, amphipods, and polychaete worms) which prefer soft-sediment habitats (NBEP, 2017; Stokesbury, 2012, 2014; Appendix M, Benthic and Shellfish Resources Characterization Report; Appendix N, Essential Fish Habitat and Protected Fish Species Assessment). Epifauna that occur in the southern sections of the export cable corridors and Lease Area predominantly include mobile, surface-dwelling organisms such as sand dollars, Jonah and rock crabs, American lobster, and gastropods (Malek et al., 2014). Beam trawls in the offshore portion of the Brayton Point export cable corridor revealed high abundances of sand dollars, sea stars, and sea scallops in the vicinity of the glacial moraines (Malek et al., 2014).

The northern section of the Falmouth export cable corridor contains attached epifauna such as mollusks, bryozoa, and tunicates, which prefer hard, complex habitats, as well as mobile epifauna such as whelk. Longfin and shortfin squid are common seasonally in both export cable corridors. Despite Mount Hope Bay's extensive history of eutrophication, sediment contamination, and increasing temperatures, recent observations of the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor have revealed healthy beds of *Ampelisca*, a tube-building amphipod, and other high habitat-value shellfish that provide biogenic habitat for a wide range of fishes and invertebrates (NBEP, 2017). Other benthic infauna such as hard clams are known to exist in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, specifically in the Sakonnet River but at lower densities than other portions of Narragansett Bay (Murphy and Erkan, 2006; Mercer, 2013).

Several benthic substrates were identified in the Offshore Project Area that may be suitable habitat for various species of shellfish. Infaunal clams and sea snails, such as ocean quahog (*Arctica islandica*) and channeled whelk (*Busycotypus canaliculatus*) prefer sand substrates with mobile gravel. Boulder and patchy cobble habitat are considered suitable and regionally important for many attached, epifaunal bivalve species and crustaceans, such as the American lobster (*Homarus americanus*) (Collie and King, 2016). Seasonal longfin inshore squid (*Loligo pealeii*) are demersal during the summer months and lay their eggs on hardbottom benthic substrates and in sand with mobile gravel habitats (Macy and Brodziak, 2001).

An overview of economically and ecologically important invertebrate species with known EFH in the Offshore Project Area is included in the subsections below. A more detailed discussion of commercially and recreationally important shellfish species occurrence in the Offshore Project Area is included in Section 11.

6.7.3.1 Invertebrates

Table 6-52 provides an overview of the fishery status and known EFH of invertebrate species in the Offshore Project Area. Additional information on habitat preferences of the species is discussed in Section 6.6.

TABLE 6-52. INVERTEBRATE SPECIES WITH MAPPED EFH IN THE OFFSHORE PROJECT AREA

Common Name	Species Name	Mapped EFH in the Offshore Project Area
Atlantic sea scallop	*Placopecten magellanicus*	Egg, larval, juvenile, and adult life stage EFH in the Lease Area, Falmouth export cable corridor, offshore portion of the Brayton Point export cable corridor, and Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor
Atlantic surfclam	*Spisula solidissima*	Juvenile and adult life stage EFH in the offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and near the Falmouth landfalls
Longfin inshore squid	*Doryteuthis pealeii*	EFH for all life stages in the Lease Area, offshore portion of the Brayton Point export cable corridor, Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and near the Falmouth landfalls
Northern shortfin squid	*Illex illecebrosus*	Adult life stage EFH in the offshore portion of the Brayton Point export cable corridor, Falmouth export cable corridor, and near the Falmouth landfalls
Ocean quahog	*Arctica islandica*	Juvenile and adult life stage EFH in the Lease Area, offshore portion of the Brayton Point export cable corridor, and Falmouth export cable corridor

6.7.3.1.1 Lease Area

Invertebrates with preferences for soft-sediment benthic substrates and pelagic waters have known EFH in the Lease Area, including Atlantic surfclam (*Spisula solidissima*), longfin inshore squid (*Doryteuthis pealeii*), and ocean quahog (*Arctica islandica*) (**Table 6-52**). Atlantic surfclam and ocean quahog are suspension feeding infauna that prefer the Lease Area's fine, soft-sediment sand substrates. For longfin inshore squid, the early life stages are primarily associated with hardbottom substrates, but the species moves further offshore in its later life stages; as an adult the species is highly seasonal, moving inshore during warmer months and offshore in the colder months. There is EFH in the Lease Area for the adult life stage of Atlantic sea scallop (*Placopecten magellanicus*) due to its occurrence in both sand and hardbottom habitats, but the species primarily occurs in more hardbottom benthic habitats.

6.7.3.1.2 Export Cable Corridors

All invertebrate species reviewed in **Table 6-52** have EFH in the export cable corridors due to the presence of a variety of benthic habitat characteristics. Species that prefer soft-sediment substrates will likely occur in the southern portion of the Falmouth export cable corridors, between the Lease Area and the Muskeget Channel (e.g., ocean quahog). Species that prefer hardbottom substrates will likely occur in the northern portion of the Falmouth export cable corridor that occurs in the Muskeget Channel and northwards towards the landfall locations (see Section 6.6). Conversely, species that prefer fine-grained, unconsolidated sediments will likely occur in the Sakonnet River/Mount Hope Bay portion of the Brayton Point export cable corridor. Species that prefer hardbottom substrates will likely occur in the vicinity of the glacial moraines in the offshore portion of the Brayton Point export cable corridor. Invertebrates that prefer SAV presence will also occur in the northern portion of both export cable corridors (Appendix K, Seagrass and Macroalgae Report). The hard substrates, along with SAV, are EFH for the spat (i.e., free-moving larvae) life stage of Atlantic sea scallop, which attach to these surfaces for survival (NEFMC and NMFS, 2017).

6.7.3.1.3 Landfalls

Invertebrate species with a strong preference for hardbottom habitat and SAV will typically occur near the preferred and alternate landfall locations (**Table 6-52**; Appendix M, Benthic and Shellfish Resources Characterization Report). Ocean quahog has EFH near the Brayton Point landfall locations, but does not have EFH near the Falmouth landfall locations due to its preference for soft-sediment substrates. Although Atlantic sea scallop typically prefers hardbottom habitat, the species does not have any known EFH near the proposed Falmouth landfall locations, likely due to a preference for deeper waters near the continental shelf. The egg life stage of longfin inshore squid typically attach to various hard substrates and SAV similar to those near the landfall locations, but may also occur on sand and mud substrates in the Lease Area and export cable corridors.

6.7.4 Potential Effects

Impact-Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019a, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

In this section, Mayflower Wind identifies and describes the IPFs that may be associated with construction, operations, and decommissioning. The IPFs identified in **Table 6-53** result from proposed Project activities that may behaviorally or physically influence, disturb, or harm finfish or invertebrate species. Mayflower Wind also includes an analysis of whether, and to what extent, finfish and invertebrates or coinciding EFH may be affected if exposed to one or more IPFs, which is summarized in **Table 6-54** through **Table 6-60**. The following sections provide detailed explanations, based on the best available science, of the IPFs during each Project phase.

TABLE 6-53. IPFS AND POTENTIAL EFFECTS ON FINFISH AND INVERTEBRATES IN THE OFFSHORE PROJECT AREA

IPF	Potential Effects			Period of Effect		
	Project Components			Project Phase		
	Lease Area	ECCs	Landfalls	Construction	O&M	Decommission
Introduced Sound into the Environment (in-air or underwater)	Behavioral disturbance	Behavioral disturbance	Behavioral disturbance	X	-	X
Seabed (or ground) Disturbance	Harassment/mortality	Harassment/ mortality	Harassment/ mortality	X	X	X
Actions that may displace biological resources, cultural resources, or human uses –Habitat Disturbance and Modification	Reduced prey availability/habitat loss Artificial reef effect	Reduced prey availability/ habitat loss Artificial reef effect	Reduced prey availability/ habitat loss	X	X	X
Change in Ambient Lighting	Displacement/ harassment	Displacement/ harassment	Displacement/ harassment	X	-	X
Change in Ambient EMF	Displacement/ harassment	Displacement/ harassment	Displacement/ harassment	-	X	-
Planned Discharges	Harassment/mortality	Harassment/ mortality	Harassment/ mortality	X	X	X
Accidental Events	Harassment/mortality	Harassment/ mortality	Harassment/ mortality	X	X	X

6.7.4.1 Introduced Sound into the Environment (In-air or Underwater)

TABLE 6-54. FINDINGS SUMMARY – INTRODUCED SOUND INTO THE ENVIRONMENTAL (IN-AIR OR UNDERWATER)

Sources of Introduced Sound	Summary
Construction	
Pile driving Inter-array cable installation Increased vessel traffic Export cable installation	• Potential for physiological effects for finfish (e.g., barotrauma) in close proximity to the pile driving zone • Behavioral effects may occur for finfish and invertebrates (e.g., avoidance behaviors/stress response) but would be temporary and reversible • Effects of introduced sounds will be avoided, minimized, or mitigated by appropriate mitigation measures
Operations & Maintenance	
WTG Noise Increased vessel traffic	• Physiological or behavioral effects may occur for finfish and invertebrate species • Finfish and invertebrate species will likely acclimate to operational WTG and maintenance vessel sounds
Decommissioning	
Foundation removal Increased vessel traffic	• Potential for physiological effects is not expected for finfish and invertebrate species • Behavioral effects may occur for finfish and invertebrates (e.g., avoidance behaviors, stress response) but would be temporary and reversible • Effects of introduced sounds will be avoided, minimized, or mitigated by appropriate mitigation measures

6.7.4.1.1 Background

Sound in water travels about 4.3 times faster than in air and attenuates much less rapidly in water. Excessive increases in sound waves may reach a level high enough to cause barotrauma (via rupturing of swim bladders) and damaged fish tissues, leading to instant or rapid mortality or injury that may reduce the fish's ability to avoid predation (Carlson, 2012). Although finfish have the capability of sight, finfish often rely on hearing to sense predators and prey as well as for navigation. Finfish species hear sounds using pressure and particle motion and detect surrounding water motion (Popper et al., 2008). Finfish with swim bladders are generally more sensitive to pressure motion, as opposed to those that lack swim bladders. Pelagic finfish species more commonly have swim bladders, while demersal species like halibut (*Hippoglossus* spp.), flounders, and soles (*Solea* spp.) tend to lack swim bladders.

Finfish species could experience sublethal or lethal effects when exposed to underwater sound; effects could range from minor behavioral changes to injurious and lethal barotrauma (for detailed information on acoustic thresholds and finfish noise impact assessments, see Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Additionally, an increase in localized noise may alter a fish's behavior, causing further disturbances. Increased sound may also mask other sounds which could be deleterious to the fish's ability to catch prey and avoid predators. A finfish species located in very close proximity to the sound source (e.g., pile driving), may result in instant mortality or serious injury due to above-threshold sound pressure. However, when a finfish is further away from the sound source, the pressure from the sound will dissipate and there is less of a chance of injury or behavioral reaction.

Anatomical and physiological variation among finfish species makes it difficult to generalize the sublethal and lethal noise thresholds for individual species (Thomsen et al., 2006). The effects will vary based on a number of factors, such as finfish hearing sensitivity, source level, physiological composition of an individual species, and noise propagation characteristics in a particular location or benthic substrate among others. Finfish without swim bladders, such as winter flounder and elasmobranchs (sharks, skates, and rays), are known as being the least sensitive to noise, with acoustic thresholds for sublethal and lethal effects ranging between approximately 186 and 207 decibels referenced at one micropascal (dB re 1 µPa) sound pressure level (Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Finfish with swim bladders that are not connected or near inner-ear structures, such as Atlantic sturgeon, have similar thresholds to finfish who use swim bladders for hearing, but may have higher lethal thresholds because they primarily detect noise through particle motion (210 dB re 1 µPa). The most sensitive finfish species are those with swim bladders connected or close to the inner ear, such as Atlantic herring and cod; these species are known to experience sublethal and lethal effects at lower noise levels than other finfish species (Thomsen et al., 2006; Popper et al., 2014).

Because benthic species and shellfish lack gas-filled organs, marine invertebrates are considered likely to be less sensitive than finfish to underwater noise (Edmonds et al., 2016; Normandeau Associates, Inc., 2012). Most invertebrates lack swim bladders and are considered less sensitive to sound, though the research on invertebrates and sound is still limited (Edmonds et al., 2016; Normandeau Associates, Inc., 2012). While there is some evidence of sound detection in some invertebrates, including snapping shrimp (*Athanas nitescens*), cephalopods, and some bivalves, the role of sound in the ecology of marine invertebrates remains unclear (Coquereau et al., 2016). For more detailed information on estimated acoustic thresholds for invertebrates and the observed effects of noise on invertebrates, see Section 6.6 and Appendix M, Benthic and Shellfish Resources Characterization Report.

6.7.4.1.2 Introduced Sound in the Offshore Project Area

The introduced underwater sound sources associated with an offshore wind project most likely to affect finfish and invertebrate species are those derived from pile driving. The driving of steel monopiles may exceed acoustic injury thresholds in close proximity to the activity and may result in some mortality, injury, and behavioral avoidance responses by finfish and invertebrates. The degree to which a finfish or invertebrate species may be affected by pile driving noise is dependent on several factors, including the distance of the species from the pile, species-specific hearing sensitivities, and substrate types. Cod and sole species have been shown to be impacted by pile driving noise, exhibited through increased swimming speeds and other avoidance behaviors (Mueller-Blenkle et al., 2010).

Laboratory pile driving studies showed swim bladder damage in Chinook salmon (*Oncorhynchus tshawytscha*) and documented barotrauma injuries in other finfish species (Halvorsen et al., 2012). Studies examining the effects of pile driving on blue mussels (*Mytilus edulis*) found that mussel clearance rates (e.g., filter-feeding rate) significantly increased when exposed to low-frequency pile driving (5 to 410 Hz), which may act as a stress response elicitation (Spiga et al., 2016; Appendix M, Benthic and Shellfish Resources Characterization Report). André et al., (2011) observed the formation of lesions on the statocyst epithelia of four cephalopod species (*Loligo vulgaris, Sepia officinalis, Octopus* *vulgaris*, and *Illex coindetii*) when the species were exposed to sounds between 50 and 400 Hz, which resulted in acute, permanent damage to sensory hair cells that increased with prolonged noise exposure.

Appendix U2, Underwater Acoustic Assessment, includes sound modeling to model predicted introduced sound energy that will be created from pile driving activities. See Appendix U2, Underwater Acoustic Assessment, for the underwater acoustic modeling results for proposed Project pile driving activities. The assessment concludes that potential injury to finish and invertebrates from pile driving noise is not anticipated. However, that some behavioral disturbance (e.g., avoidance behaviors, increased stress responses) is likely to occur for finfish and invertebrate species expected to occur in the Lease Area (see Sections 6.7.2.2 and 6.7.3.1). Due to their highly migratory nature, tuna and shark species are expected to exhibit avoidance behaviors if in the vicinity of Project pile driving activities. Finfish and invertebrate species that have soft-sediment habitat preferences, such as butterfish, monkfish, and ocean quahog, are also more likely to be exposed to pile driving noise long enough or at sound levels sufficient to cause behavioral effects.

Ship engines and vessel hulls emit continuous sound, with source levels generally ranging from 150 to 200 dB re 1 µPa m at low frequencies below 1,000 Hz, which overlaps with the known and estimated hearing frequencies for finfish and invertebrate species (Erbe et al., 2019; NSF & USGS, 2011). However, introduced sound from vessels and trenching activities are not expected to exceed peak or cumulative auditory thresholds. Research indicates that vessel noise is not expected to cause lethal or sublethal injuries in adult finfish, but has been shown to cause behavioral effects, including auditory masking (Hawkins et al., 2014). Auditory thresholds have been shown to increase up to 40 decibels when finfish are exposed to vessel noise (Codarin et al., 2009; Vasconcelos et al., 2007). Some examples of exhibited behaviors caused by vessel noise include changes in time spent burrowing or time spent defending or tending to nests and eggs, increased intraspecific aggression and territoriality interactions, changes in foraging behavior, vocalization changes, and changes in patterns of movement (Bruintjes and Radford, 2013; Bracciali et al., 2012; Purser and Radford, 2011; Sebastianutto et al., 2011; Picciulin et al., 2010; Buscaino et al., 2009). However, these studies also demonstrated that some of the behavioral changes observed were typically temporary and reversible, likely caused by the finfish habituating to the anthropogenic noises.

6.7.4.1.3 Construction

Sound is expected to be introduced in the Lease Area during pile driving and installation of the inter-array cables, as a result of increased Project vessel traffic (relative to pre-construction levels), and during offshore export cable installation. Trenching and dredging noise during cable-laying activities is expected to occur along the export cable corridors during construction. Noise associated with these proposed Project activities is expected to cause some sublethal and lethal effects on finfish species, if/when these occur close enough to the pile driving zone. However, Mayflower Wind's proposed suite of mitigation measures (e.g., "soft starts" and employment of sound-attenuation measures) is expected to decrease the risk of mortality or injury to finfish and invertebrate species that may occur in the Offshore Project Area (See Section 16).

The temporary avoidance of introduced sound by finfish and mobile invertebrates is expected to occur during construction activities, similar to the avoidance behaviors observed during heavy recreational vessel use, ferry traffic, or heavy fishing activity. Finfish and mobile invertebrates are expected to return to the area after construction is complete.

6.7.4.1.4 Operations and Maintenance

The WTGs may introduce sound into the underwater environment during the O&M phase. A study of three different types of WTGs at wind farms in Denmark and Sweden measured underwater sound energy above ambient levels at frequencies below 500 Hz (Tougaard and Henriksen, 2009). The total sound pressure level ranged between 109 to 127 dB re 1µPa root mean squared, measured at distances within 20 m of the WTG foundations. Finfish species with or without swim bladders have a behavioral disturbance threshold between 158 and 186 dB re 1 µPa (Popper et al., 2014; Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Therefore, it is highly unlikely that the sound levels emitted from operational WTGs will have any significant effects on finfish species (Thomsen, et al., 2006). Invertebrate species are expected to detect operational noise but are not expected to experience physiological or behavioral effects from the introduced sound. Studies have shown that invertebrates are colonizing at WTG foundations in existing wind farm developments, suggesting that the noise levels are not high enough to act as a deterrent (HDR, 2020; Hemery, 2020; ICF Incorporated, LLC., 2020).

There is a potential for behavioral disturbance from sound emitted from Project maintenance vessels. However, effects of vessel noise during O&M are expected to be insignificant, due to generally low traffic levels and the existing acclimation of finfish and invertebrate species to commercial and recreational vessel use in the area. Vessel traffic is expected to be reduced during O&M compared to the construction and decommissioning phases of the proposed Project. This is due to a decrease in vessels transporting construction equipment to and from the Offshore Project Area, and fewer personnel transiting to and from the Offshore Project Area.

Introduced sounds associated with O&M activities are expected to have little to no effect on finfish and invertebrate species.

6.7.4.1.5 Decommissioning

Introduced sound during the Project's decommissioning phase is expected to be similar to or less than introduced sound during the construction phase (see Section 6.7.4.1.3). Decommissioning will involve the use of sound-producing activities, but the sounds are expected to be considerably less than for construction since pile driving will not be required. Consequently, introduced sound effects on finfish species during decommissioning are anticipated to be similar to or less than those during construction.

6.7.4.2 Seabed (or Ground) Disturbance

TABLE 6-55. FINDINGS SUMMARY – SEABED DISTURBANCE

Sources of Seabed Disturbance	Summary
Construction	
Seafloor preparation Pile driving Foundation and scour protection installation Inter-array cable installation Export cable installation Vessel anchoring (including spuds)	• Physiological and behavioral effects may occur for finfish and invertebrate species (e.g., avoidance behavior, stress response, mortality, displacement) • Early-life stage finfish and immobile invertebrates will likely have lowest tolerance and highest mortality rates to seabed disturbance • Disturbance effects and recolonization/recovery rates will likely vary by species group • Effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures
Operations & Maintenance	
Introduction of hard bottom habitat (presence of structures)	• Foundation areas (and potentially some areas along the export cable corridors) will be converted from sand/gravel habitat to hard bottom habitat • Increased hard bottom substrates will lead to increased prey resources
Decommissioning	
Seafloor preparation Foundation and scour protection removal	• Physiological and behavioral effects may occur for finfish and invertebrate species (e.g., avoidance behavior, stress response, mortality, displacement) • Early-life stage finfish and immobile invertebrates will likely have lowest tolerance and highest mortality rates to seabed disturbance • Disturbance effects and recolonization/recovery rates will likely vary by species group • Effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures

6.7.4.2.1 Background

Seabed disturbance (via sediment dispersion and re-sedimentation) is known to have physiological and behavioral effects on finfish and invertebrate species, with varying levels of tolerance depending on species sedimentation preferences. Increased sediment resuspension can impact finfish respiration and other life functions (e.g., feeding, spawning). Common turbidity effects on finfish include gill membrane abrasion, resulting in the inability to collect oxygen, feeding impairment, reduction in available dissolved oxygen, and fatality to benthic/epibenthic early life stages (Wilkens & Suedel, 2017; Wilber & Clarke, 2001; Morgan et al., 1983).

Sediment dispersion could smother benthic invertebrates that are unable to unbury themselves once the excess sediment has settled back on the seafloor (see Section 6.6; Appendix M, Benthic and Shellfish Resources Characterization Report). Research has shown that immobile invertebrates have the lowest tolerance and highest mortality rate from sedimentation, with effects becoming more pronounced in areas with harder substrates (Hiddink et al., 2017; Gates & Jones 2012). Mobile finfish and invertebrates are expected to exhibit avoidance behaviors during seabed disturbance activities. However, some finfish in early life-stages may experience physical effects similar to the effects experienced by immobile invertebrates (i.e., suffocation and/or difficulty feeding when buried in excess sediments).

Proposed Project activities likely to cause seabed disturbance (e.g., produce sedimentation) and affect finfish and invertebrate species in the Offshore Project Area are discussed by Project phase in the subsections below.

6.7.4.2.2 Construction

Seafloor disturbances during construction in the Lease Area will occur during the following activities; seafloor preparation, pile driving, foundation and scour protection installation, WTG and OSP installation, inter-array cable installation, and vessel anchoring (including spuds). Pile driving during WTG and OSP foundation installation and scour protection installation are expected to result in temporary sediment resuspension. Vessel anchoring may likewise result in increased turbidity during foundation installation, the construction of offshore WTGs, and installation of the inter-array cables and offshore export cables.

For more detailed information on proposed Project construction activities, see Section 3.3, Project Components and Project Stages. A Sediment Plume Impact Assessment conducted for the proposed Project (Appendix F1, Sediment Plume Impacts from Construction Activities) estimated that the amount of total suspended solids in the area will be below 10 mg/L (9.59 parts per million) after two hours and below 1 mg/L (0.96 parts per million) after four hours along the Falmouth export cable corridor. Due to higher silt and clay contents, it could take as long as 50 hours for total suspended solids to decrease to below 10 mg/L (9.59 parts per million) in Mount Hope and the Sakonnet River along the Brayton Point export cable corridor, due to resuspension of bottom sediments (Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment). The offshore export cables may not always be completely buried during installation; in which case a 1-foot (0.3-meter) thick concrete mattress will cover parts of the offshore export cables that are placed on the seafloor. This concrete mattress could also provide hard substrate for epifaunal colonization.

Each of these proposed Project activities is expected to result in behavioral effects to finfish species, and potential behavioral and physical effects to benthic life stages, particularly egg and larval stages. Temporary effects to benthic fish life stages include mortality or displacement within the area due to sediment resuspension and deposition.

Benthic EFHs for egg and larval fish life stages and benthic invertebrate communities are expected to recolonize the area after construction activities have concluded. This may occur within months or one to three years following disturbance (HDR, 2020; Guarinello et al., 2017; BOEM, 2014; BERR, 2008; See Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment and Appendix M, Benthic and Shellfish Resources Characterization Report). Recolonization rates of benthic habitats are driven by the benthic communities inhabiting the area surrounding the affected region. Communities well-adapted to disturbance within their habitats (e.g., sand sheets) are expected to quickly recolonize a disturbed area, while communities not well adapted to frequent disturbances (e.g., deep-boulder benthic communities) may take upwards of a year to recolonize. Direct potential effects to benthic resources will be limited to the areas of disturbance for the specific activities noted.

To offset the effects from seabed disturbance activities, Mayflower Wind anticipates the use of horizontal directional drilling for the installation of the offshore export cables in the shallower areas closer to shore. This will substantially reduce effects of sediment disturbance on benthic and epibenthic finfish and invertebrate resources in the nearshore area (for more information on offshore export cable installation, see Section 3.3.5, Offshore Export Cables). Final cable route selection within the export cable corridors will be sited to avoid to the extent practicable, high-value EFH that may be expected to have slower or incomplete recovery to pre-construction conditions.

6.7.4.2.3 Operations and Maintenance

During the O&M phase of the proposed Project, the seabed is expected to return to nearly pre-construction conditions, allowing continued use and recovery by benthic and epibenthic fish species that may have been affected by the construction phase of the proposed Project (Dernie et al., 2003). Operation of the WTGs and the transmission of power along the export cable corridors will not result in further sediment disturbance during normal operations. However, the potential maintenance on the offshore Project components may result in temporary sediment disturbances. The presence of the foundations and inter-array cables in the Lease Area may also result in changes to seafloor substrate conditions, which may affect some EFHs with specific substrate requirements. The presence of the WTG and OSP foundations and associated scour protection is expected to affect benthic organisms by converting the existing sand and mud substrates in the Lease Area to hard bottom habitat (see Appendix M, Benthic and Shellfish Resources Characterization Report). This conversion to hard bottom habitat will result in some effects to species that occur in soft bottom habitat due to loss of habitat. However, benthic species associated with hard bottom habitat are expected to experience beneficial effects due to an increase of suitable habitat. Studies of existing offshore wind farms have shown that sessile invertebrate species (e.g., mussels) and finfish species with a strong preference for structures habitat (e.g., black sea bass) will be some of the first marine species to colonize at the introduced WTG structures (BOEM, 2021; HDR, 2020; see Section 6.6).

During operations, crew transfer vessels will transport personnel to and from WTGs and OSPs for servicing and maintenance activities (see Section 3.3.14, Vessels, Vehicles, and Aircrafts, for more information on Project vessels). If vessels anchor, there may be some temporary disturbance of the seafloor habitat. Potential effects on benthic finfish species and EFHs from these activities include mortality or displacement due to sediment disturbance.

Effects of seabed disturbance on finfish and invertebrates during the O&M phase are expected to be insignificant.

6.7.4.2.4 Decommissioning

During the decommissioning phase of the proposed Project, seabed disturbance effects are expected to be similar to those exhibited during the construction phase (see Section 6.7.4.2.2). The WTGs/OSPs and their foundation components will be removed in adherence to regulatory requirements (see Section 3.3.19, Conceptual Decommissioning).

Effects from removing the cables will be localized to the export cable corridors and similar to those experienced during cable installation. Consequently, seabed disturbance effects on finfish species during decommissioning are anticipated to be similar to or less than those during construction. The Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there will be no effects from decommissioning.

6.7.4.3 Habitat Disturbance and Modification

TABLE 6-56. FINDINGS SUMMARY – HABITAT DISTURBANCE AND MODIFICATION

Sources of Habitat Disturbance and Modification	Summary
Construction	
Foundation and scour protection installation Export cable installation	• Physiological and behavioral effects may occur for early-life stage finfish and immobile invertebrate species (e.g., avoidance behavior, stress response, mortality, displacement) • Increased hard bottom substrates will lead to loss of soft bottom habitat • Less than one percent of soft-bottom habitat loss in Lease Area expected due to foundation and scour protection installation • Disturbance effects and recolonization/recovery rates will likely vary by species group • Cable installation will result in short term increase in suspended sediment (turbidity) above the seabed
Operations & Maintenance	
Introduction of hard bottom habitat	• Foundation areas (and potentially some areas along the export cable corridors) will likely be converted from sand/gravel habitat to hard bottom habitat • Increased hard bottom substrates will lead to habitat gain for benthic communities • Scour protection may cause an artificial reef effect, turning biodiversity-poor, soft-sediment habitat into hardbottom, biodiverse communities
Decommissioning	
Foundation and scour protection removal	• Physiological and behavioral effects may occur for early-life stage finfish and immobile invertebrate species (e.g., avoidance behavior, stress response, mortality, displacement) • Increased hard bottom substrates will lead to loss of soft bottom habitat • Less than one percent of soft-bottom habitat loss in Lease Area expected due to foundation and scour protection installation • Disturbance effects and recolonization/recovery rates will vary by species group

The installation of the WTG and OSP foundations and the associated scour protection (rock material) will permanently alter the benthic habitat in the Offshore Project Area. This will result in effects occurring associated with mortality and displacement during construction, as well as effects associated with recovery time from the areas affected by foundation placement. Scour protection also has the potential to transform soft-sediment, homogenous habitat into hardbottom, biodiverse benthic communities (HDR, 2020; Langhamer, 2012; Appendix M, Benthic and Shellfish Resources Characterization Report; Section 6.6).

Hard benthic substrates onto which invertebrate organisms can attach are often a limiting habitat in the marine environment. Scour protection has shown to be typically colonized by invertebrates inhabiting rocky substrata (e.g., crabs, lobsters, barnacles, and sponges), which may lead to an increase in prey availability for finfish species in the Offshore Project Area (Slavik et al., 2019; Langhamer, 2012). The attraction of finfish to these substructions may result in increased predation on invertebrate resources and may also attract other prey species to the structures (BOEM, 2021). Furthermore, the increased productivity near the Project structures may also indirectly increase the recreational and commercial fishing efforts nearby.

Project activities likely to cause habitat disturbance and modification affecting finfish and invertebrate species in the Offshore Project Area are discussed by Project phase in the subsections below.

6.7.4.3.1 Construction

The installation of the WTG and OSP foundations and the placement of scour protection will result in the direct mortality of sessile, benthic fish life stages (i.e., demersal eggs) in EFH occurring in the Lease Area. For more detailed information on Project substructure and foundation installation, see Section 3.3.1, Substructures.

Finfish and mobile invertebrates may temporarily leave the affected area at the start of construction and will remain displaced during much of the construction period (Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Given the abundance of homogenous, soft-sediment habitat outside the Lease Area, however, this temporary displacement is not expected to affect finfish and invertebrate populations. Furthermore, the total scour protection area for each proposed foundation type (monopile, piled jacket, suction bucket jacket, and gravity-based structure) is estimated to occupy less than one percent of the Lease Area (Fugro, 2020; Section 6.6).

The installation of the offshore export cables will temporarily alter the seabed habitat, resulting in some effects associated with mortality and displacement during construction, and some effects associated with varied recovery times of EFHs affected by offshore export cable placement. For more detailed information on Project offshore export cable installation, see Section 3.3.5, Offshore Export Cables. The portion of Falmouth export cable corridor between the Muskeget Channel and landfall site are characterized by more heterogeneous habitats; disturbance of the benthic early-stage EFH and invertebrate EFH in these areas are expected to require a longer period (a minimum of one to three years) to recover, as opposed to the homogenous portions of the export cable corridors (Section 6.6). Overall benthic species displacement within the export cable corridors will be temporary, and recolonization in some areas will begin soon after construction ends (Dernie et al., 2003).

Sediment disturbance during construction, especially for cable installation and at the HDD exit pit, will result in increased turbidity in water above the seabed. As discussed above in Section 6.7.4.2, elevated turbidity will be short term, on the order of hours.

6.7.4.3.2 Operations and Maintenance

The installation of WTGs and OSPs in the Lease Area introduces a source of new hard substrate that will be present for the life of the proposed Project. The long-term presence of the physical structures occupying the sea floor will displace finfish and invertebrate organisms within the foundation footprint. This displacement will be offset in part by additional vertical relief and habitat created by the scour protection. The Lease Area has a very limited amount of hard bottom habitat. Therefore, the presence of WTG and OSP foundations are considered to directly affect the benthic habitat in the Lease Area during the operations phase, increasing benthic colonization.

Invertebrates likely to colonize the WTGs foundations are attached, filter-feeding invertebrates such as blue mussels (Slavik, 2019). Three years of benthic habitat monitoring data from BOEM's RODEO program was collected from the Block Island Wind Farm to assess the temporal and spatial changes in substrate characterization and benthos abundance and distribution near offshore wind foundations during operations (HDR, 2020). Results of the RODEO program indicate that by year 2 of benthic monitoring, the foundations were primarily colonized by dense blue mussel aggregations and by large populations of black sea bass (Hutchison et al., 2020). The invertebrate colonization and sediment characteristics varied between WTGs and between survey years. These results are expected to be similar to those that may be observed during the operations phase of the proposed Project due to its close proximity (approximately 56.3 miles [90.6 km] southeast) to the Block Island Wind Farm.

Following installation of the offshore export cables, conversion of bottom habitat is not expected to cause long-term habitat disturbance to the seafloor. The long-term recovery time of hard bottom EFHs expected to occur along the export cable corridors (particularly in the northern portion) may cause a temporary shift in the benthic community composition, which could have permanent effects on the benthic habitat (BOEM, 2021).

6.7.4.3.3 Decommissioning

Decommissioning could involve removal of substructures or leaving them in place; if removed, effects would be similar to substructure construction. If left in place, effects would be similar to operation phase effects. For more detailed information on Project decommissioning activities, see Section 3.3.19, Conceptual Decommissioning.

If cable removal is required, effects from removing the cables will be localized to the export cable corridors and similar to those experienced during cable installation. Consequently, habitat disturbance and modification effects on finfish resources and EFHs during decommissioning of the offshore export cables are anticipated to be similar to those during construction. The proposed Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there will be no effects from decommissioning.

6.7.4.4 Change in Ambient Lighting

TABLE 6-57. FINDINGS SUMMARY – CHANGE IN AMBIENT LIGHTING

Sources of Changes to Ambient Lighting	Summary
Construction & Decommissioning	
Lighting of construction activities Project vessel lighting	• Physiological and behavioral effects for finfish and invertebrate species are not expected to occur • Effects of ambient lighting will be avoided, minimized, or mitigated by appropriate mitigation measures

Artificial lighting effects on finfish and invertebrate species are very species-dependent and may include attraction and/or avoidance behaviors (Marchesan et al., 2005). Finfish and invertebrates that prefer shallower waters (e.g., spawning scup [*Stenotomus chrysops*], silver hake, sand tiger shark, and cephalopods) may be more exposed to artificial lighting effects than other species (Bará et al., 2018; Martins and Perez, 2006; Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment). Artificial lighting may disrupt migration patterns of finfish, resulting in a potential change in species richness and EFH composition (Nightingale et al., 2006; Phipps, 2001). Other potential effects include increased risk of predation and changes in predator/prey interactions, resulting in the loss of opportunity for foraging and an effect on survival (Orr et al., 2013). Alternately, studies have shown that artificial lighting may increase the foraging success of finfish species, providing adequate light to locate prey at night (Keenan et al., 2007).

Because artificial lighting use will be restricted to Project structures and vessels relative to the surrounding unlit areas, the overall effects of changes to ambient lighting are expected to be insignificant and temporary for finfish species. Lighting on operational WTGs and OSPs will be executed in accordance with FAA and USCG guidance and regulations (FAA, 2020; USCG, 2015). Changes to ambient lighting during the O&M phase are not expected to affect finfish species and, therefore, are not discussed further in this section.

6.7.4.4.1 Construction

Potential effects of changes to ambient lighting may occur during the construction phase of the proposed Project. However, because of the limited, localized size of the illuminated area during construction and the relatively deeper water depths, changes in ambient lighting during the construction phase of the proposed Project are not expected to affect the EFHs of finfish and invertebrate species.

6.7.4.4.2 Decommissioning

Effects associated with changes to ambient lighting in the Offshore Project Area during decommissioning are expected to be similar to the effects described in the construction phase.

6.7.4.5 Change in Ambient EMF

TABLE 6-58. FINDINGS SUMMARY – CHANGE IN AMBIENT EMF

Sources of EMFs	Summary
Operations & Maintenance	
Introduced magnetic fields from offshore export cables Introduced electric fields from inter-array cables	• Physiological and behavioral effects to finfish and invertebrate species are not expected to occur • Industry offshore export cable sheathing and burial methods will likely significantly decrease EMF detection by EMF-sensitive marine species

Electric and magnetic fields will be generated by the inter-array cables that connect the WTGs in the Lease Area, and from the offshore export cables throughout the export cable corridors. There is limited research on the effect of EMF impacts on finfish. Certain types of finfish, particularly elasmobranchs and ray-finned fishes, use EMF to sense and locate prey (Normandeau Associates, Inc., 2011). In the New

England area, several bony fish (American eel, Atlantic salmon [*Salmo salar*], and Atlantic yellowfin tuna), can sense magnetism (BOEM, 2020b). Experimental testing of three-phase alternating-current (AC) subsea cables exporting power from the Block Island Wind Farm demonstrated that the little skate and American lobster exhibit strong behavioral changes (i.e., increased travel distances, increased movements) when exposed to high EMFs (>52.6 microtesla [μT]) (BOEM, 2020b; Hutchison et al., 2018). However, the EMFs associated with subsea inter-array cables and offshore export cables did not prove to be a barrier to movement. If EMFs generated from the inter-array cables and offshore export cables result in comparable levels at the seafloor, certain elasmobranchs, if present, may experience behavioral effects. Elasmobranch species are present seasonally at relatively low abundances in the Offshore Project Area (Northeast Regional Ocean Council, 2020; Skomal, 2007; Musick et al., 2000).

6.7.4.5.1 EMF Analysis in the Offshore Project Area

Mayflower Wind conducted an EMF analysis of the Offshore Project Area that encompassed several different models of offshore export cable burial depths and cable spacings in order to represent both likely submarine cable installation conditions, as well as worst-case conditions, following cable installation (Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). The analysis focused on magnetic fields because direct electric fields are expected to be shielded by grounded metallic armoring. The target burial depth for the offshore export cables is to be approximately 6.6 feet (2 m), with the modeling assuming a 6.6 feet (2 m) distance from the seafloor to the top of the offshore export cables.

Given the potential that hard bottom seafloor conditions or existing infrastructure may be encountered during the offshore export cable installation, a second worst-case seabed scenario was modeled in which the submarine cable was laid directly on the seafloor and covered with a 1-foot (0.3-m)-thick concrete mattress.

For this scenario, a reduced cable spacing of 82 feet (25 m) was assumed, which allowed for the assessment of any interaction of magnetic fields between adjacent cables at this reduced separation distance. For both scenarios, magnetic field emission predictions were consistent with other submarine cable magnetic field modeling analyses (Normandeau Associates, Inc., 2011). Magnetic field levels in the water column above the seafloor will be substantially less than the modeled levels at the seafloor surface. Magnetic fields decrease at the same rate as the distance increases above the subsea cable into the water column. The subsea cables are expected to emit approximately 60 Hz AC magnetic fields, which are well outside the typical EMF detection range of magnetosensitive and electrosensitive marine species.

Overall, additional EMFs emitted from the proposed Project are not expected to affect benthic communities in the Offshore Project Area. Pelagic magnetosensitive fish species such as Atlantic salmon, Atlantic yellowfin tuna, and sharks typically spend their time in the water column and therefore will only rarely come into contact with EMF from submarine offshore export cables. The effects of submarine cable EMF on bottom-dwelling, demersal skates (the species with the greatest potential for EMF exposure) are expected to be infrequent and very short due to the highly localized area of the cables relative to their overall habitat, and due to the rapid decay of EMF levels with distance from the cables (see Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project and Appendix P2, High Voltage Direct Current Electric and Magnetic Field (EMF) Assessment).

6.7.4.5.2 Operations & Maintenance

Operational WTGs do not generate EMFs. However, the operation of the inter-array cables and offshore export cables will result in EMF generation. Inter-array cables are expected to produce electric fields, while the offshore export cables are expected to produce a magnetic field perpendicular and in a lateral direction around the offshore export cables. The offshore export cables will be shielded and buried at a targeted burial depth of 6.6 feet (2 m) beneath the seafloor, which is expected to significantly decrease EMF detection by EMF-sensitive marine species (Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). Potential exposure to EMFs will depend on the species mobility and the species proximity to the offshore export cables. EFHs of mobile, benthic, and epibenthic finfish and invertebrate life stages are most likely to be exposed to potential EMFs when passing through the northern and southern export cable corridors. Whereas EFHs for benthic/epibenthic finfish life stages and invertebrates in the Lease Area will potentially be exposed to EMFs when the inter-array cables are energized.

EMF exposure will largely depend on the burial depth and configuration of the cables, the cable reinforcement materials placed above them, and the operational loads on those cables. Based on available literature, the EMF will not become a physical barrier to movement of EMF-sensitive finfish and invertebrates (BOEM, 2020b; Hutchison et al., 2018). Depending on the magnitude of EMF detected at and above the seafloor, the behavior of susceptible finfish and invertebrates may be altered in the immediate vicinity of the cables. However, industry standard cable burial and cable sheathing are expected to reduce or eliminate EMF exposure to benthic marine species (See Section 16).

Additional EMFs during the operations phase of the proposed Project are not expected to affect finfish and invertebrate species of EFHs in the Offshore Project Area.

6.7.4.6 Planned Discharges

TABLE 6-59. FINDINGS SUMMARY – PLANNED DISCHARGES

Sources of Planned Discharges	Summary
Construction, Operations & Maintenance, Decommissioning	
Planned vessel discharges	• Vessels may discharge bilge water, engine cooling water, deck drainage, and ballast water • Due to the expected and controlled dispersion and dilution of planned discharges, potential effects to finfish and invertebrates will likely be insignificant • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of planned discharges

Vessels used during offshore construction activities routinely (and by design) conduct planned discharges of bilge water, engine cooling water, deck drainage, and/or ballast water. Such discharges are temporary and will be immediately dispersed and diluted. Due to the expected and controlled dispersion and dilution of planned discharges, potential effects to finfish and invertebrate species are expected to be insignificant. See Section 3.4, Summary of Impact Producing Factors, for an evaluation of planned discharges and Section 3.3.16, Waste Generation and Disposal for more information on proposed Project vessel operations.

6.7.4.6.1 Construction

Increased vessel traffic in construction areas and at ports utilized by these vessels may increase the likelihood of planned discharges while transiting through the Offshore Project Area. Finfish avoidance, along with the rare occurrence of planned discharges, will likely result in insignificant effects on finfish and invertebrates in the Offshore Project Area.

6.7.4.6.2 Operations & Maintenance

Planned vessel discharge during the O&M phase of the proposed Project will not have a significant effect on finfish and invertebrates (or the coinciding EFHs) in the Offshore Project Area.

As described in Section 4.3, Physical Oceanography and Meteorology, and Section 5.2, Water Quality, the use of seawater for the CWIS at the OSPs will be discharged at a higher than ambient temperature and will be treated with sodium hypochlorite, which may have localized impacts to finfish and invertebrates or EFH. Residual chlorine will fall within safe and previously permitted concentrations for other facilities, similar to ballast water treatment under the Vessel General Permit program administered by the EPA (78 FR 21938) and therefore is not expected to have measurable impacts to finfish and invertebrates or EFH once diluted into the mixing zone of the surrounding water column of the OSPs (Anasco et al. 2008; Bass and Heath 1975).

The thermal plume associated with the once-through cooling water discharged from the OSPs will be slightly warmer (temperature change up to 18°F [10°C] at the end of the discharge pipe and 0.3°F [0.2°C] at the edge of the mixing zone) than ambient water temperatures within a mixing zone that will vary in size depending on season, currents, and tidal cycle (see Section 5.2, Water Quality). Alterations in temperature within the thermal plume (if detectible by fishes or invertebrate species) may elicit behavioral or physiological responses in fishes and invertebrates that inhabit waters directly adjacent to the discharge pipe or along a gradient within the mixing zone. Studies have shown that for several species such as summer flounder, Atlantic cod, and pollock, temperature is the primary driver influencing small scale movements or where they are found within the water column (Freitas et al., 2021; Henderson & Fabrizio, 2014). Squid and blue crabs are known to experience increased metabolic and growth rates with increased temperatures (Forsythe, 2004; Leffler, 1972). However, tolerance ranges, temperature thresholds, and overall effects would vary among exposed species. For example, a study on Atlantic cod early life stages indicated that even with a 5°C increase in temperature over multiple time periods (up to 96-hours), the differences between egg mortality and cell asymmetries were not significantly different between control groups incubated and raised in ambient water temperatures and experimental groups raised in higher water temperatures (Puvanendran et al., 2015). The extent of impacts to marine life by thermal pollution from cooling water effluent depends on the volume of the waterbody from which cooling water is withdrawn and returned, rate at which the thermal plume dissipates, other sources of heat, the presence of nearby refugia, and the sensitivity or thermal tolerances of nearby fish species (EPA, 2014). Since the Mayflower Wind OSPs' thermal plume will dissipate rapidly in ocean waters, the impacts to fish or invertebrates are expected to be negligible.

Various lifestages of fish and invertebrates occurring near the OSPs may be subject to impingement (on intake screens) or entrainment (eggs/larvae withdrawn through the intake screens) in the CWIS. The

EPA considers intake velocities of 0.5 ft/s or less, the best technology available to minimize impingement impacts, per 40 CFR 125.84(b)(2). Since the CWIS will meet the 0.5 ft/s velocity compliance option, impingement impacts are not considered further. Entrained eggs and larvae are assumed to experience 100 percent mortality within the CWIS (EPA, 2006, 2014). However, it is difficult to evaluate the nature and magnitude of entrainment impacts at the population level. Entrainment impacts only the egg and larval stages (ichthyoplankton) of broadcast-spawning fishes, which typically have extremely high rates of natural mortality (Barnthouse, 2013). With low probability of survival past egg and larval stages in a natural environment, entrainment losses studied for decades at conventional generation power plant CWIS often result in negligible, if not completely undetectable, impacts to fish populations and communities (Barnthouse, 2013; Perry et al., 2002; White et al., 2010). Results documented for another similar offshore energy facility in Massachusetts (the Northeast Gateway liquified natural gas terminal), which have shown entrainment to have mostly negligible impacts to fish populations (Northeast Gateway, 2012). Notably, the magnitude of cumulative entrainment impacts by U.S. coastal power plants, suggests that population models eliminating impingement mortality and entrainment would only increase abundance of certain species (California American shad, California anchovy, Atlantic cod, Atlantic herring, Atlantic mackerel, pollock, scup, silver hake, summer flounder, and winter flounder) by less than 1 percent (Barnthouse, 2013; Newbold and Iovanna 2007).

Most of the species with overlapping egg or larval stage EFH may be susceptible to entrainment of larvae. American plaice, Atlantic cod, Atlantic herring, Atlantic mackerel, butterfish, haddock, monkfish, pollock, red hake, silver hake, summer flounder, windowpane, witch flounder, and yellowtail flounder all have pelagic egg or larval stages that may be distributed throughout the water column across the depth range of the Offshore Project Area. Several of these species display life history traits that make it more or less likely that the eggs or larvae would occur at depths where they may be entrained. For example, Atlantic herring and ocean pout eggs are demersal, while monkfish eggs float near the surface. Windowpane larvae transition to demersal habitats soon after hatching, and individuals may therefore be less vulnerable to entrainment after settlement (NEFSC, 1999a). Witch flounder typically inhabit and spawn in very deep waters beyond the Offshore Project Area (NEFSC, 1999b). Ocean pout is the only species with overlapping larval EFH that remain demersal after hatching.

The majority of ichthyoplankton species maintain a depth range located within the upper layers of the ocean, even when diel vertical migration, varying depth preferences based on seasonal temperature differences, or different horizontal transport mechanisms are accounted for (Hare & Govoni, 2005; Huebert et al. 2010). Research specifically exploring how ichthyoplankton are distributed by depth suggest that fish larvae abundance dramatically decreases with increased depths (Wang et al., 2021). The depth of withdrawal for the CWIS, at mid-water column depths (ranging from approximately 25 to 115 ft [7.6 to 35.0 m] below the surface), which is a favorable location for avoiding the highest concentrations of ichthyoplankton, and is expected to result in a very low likelihood of entrainment for those species with either buoyant or demersal egg/larval stages.

Atlantic cod is a species of particular commercial, recreational, and conservation interest within the Offshore Project Area. Studies on spawning dynamics have identified primary Southern New England spawning areas in the northeastern region of Georges Bank, with some scattered areas across western George's Bank, Nantucket Shoals, and areas offshore Rhode Island and Southern Massachusetts, such as Cox's Ledge (DeCelles et al, 2017; Zemeckis et al., 2014). There are no known Atlantic cod spawning grounds in the vicinity of the Lease Area, though entrainment of cod eggs and larvae may occur as a result of larval transport to the vicinity of the Offshore Project Area. Near-surface ocean circulation patterns in New England waters are suspected of transporting cod eggs and larvae from spawning sites in both Georges Bank and the Gulf of Maine to waters near the Offshore Project Area (Zemeckis, 2016). Thus, Atlantic cod eggs and larvae that are transported close enough to be drawn into the intake flow of the OSP CWIS are presumably subject to entrainment. However, egg and larval losses are not expected to have population-level implications for the reasons described above.

Mayflower Wind is in the process of applying for a NPDES Permit from EPA Region 1, New England. As part of that permit application, Mayflower Wind is utilizing existing regional ichthyoplankton datasets to characterize the entrainment impacts of the CWIS. The Marine Resources Monitoring, Assessment, and Prediction program (MARMAP) and the Ecosystem Monitoring (EcoMon) program ichthyoplankton density data within a 10-mile (16.1 km) radius of the CWIS were compiled from these surveys from 1997 through 2019, publicly available from USDOC/NOAA/NMFS Northeast Fisheries Science Center (2019). These data are currently being analyzed as part of the NPDES Permit Application and will be utilized to estimate entrainment impacts at the CWIS.

6.7.4.6.3 Decommissioning

Effects associated with planned vessel discharges during the decommissioning phase of the proposed Project are expected to be similar to the effects described in the construction phase.

6.7.4.7 Accidental Events

TABLE 6-60. FINDINGS SUMMARY – ACCIDENTAL EVENTS

Sources of Accidental Events	Summary
Construction, Operations & Maintenance, Decommissioning	
Unplanned vessel and Project discharges	• Potential effects of unplanned discharges to finfish and invertebrates will likely be insignificant • In the unlikely event the proposed Project generates unplanned discharges, the discharges would be removed in compliance with all regulatory requirements • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of discharges and spills

As discussed in Section 3.4, Summary of Impact Producing Factors, accidental spills and unplanned discharges are not expected to be produced by the proposed Project during the construction, O&M, or decommissioning phases. In the event that an unplanned spill does occur in the Offshore Project Area, the proposed Project will comply with the regulatory requirements related to the prevention and control of discharges and spills, consistent with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

Anthropogenically sourced spills have been shown to cause reductions in benthic biodiversity, direct deleterious effects on early life stage finfish EFHs, a depletion of primary food sources, and bioaccumulations of toxins in the tissues of secondary and tertiary finfish species (Price et al., 2019; Borja et al., 2011; McGee et al., 2006; Muxika et al., 2005; Matthiessen & Law, 2002). Bivalve invertebrates are often used as indicator species of benthic habitats due to their high capacity to bioaccumulate and biomagnify chemical contaminants, and therefore are likely to be the most sensitive to unplanned discharges from proposed Project activities (El-Shenawy et al., 2016; Rzymski et al., 2014; Frontalini and Coccioni, 2011; Appendix N, Essential Fish Habitat Assessment and Protected Fish Species Assessment).

6.7.4.7.1 Construction

Increased vessel traffic in the construction area and at nearby ports may increase the likelihood of unplanned releases. Due to the likely rare occurrence of unplanned discharges, unplanned vessel discharges during the construction phase of the Project are not expected to have a significant effect on finfish and invertebrate species located in the Offshore Project Area. In the unlikely event that an unplanned discharge occurs in the Offshore Project Area, Mayflower Wind will comply with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

6.7.4.7.2 Operations and Maintenance

Unplanned vessel discharges during the O&M phase of the proposed Project are not expected to have a significant effect on finfish and invertebrate species in the Offshore Project Area. In the unlikely event that an unplanned discharge occurs in the Offshore Project Area, Mayflower Wind will comply with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

6.7.4.7.3 Decommissioning

Effects associated with unplanned discharges in the Offshore Project Area during decommissioning are expected to be similar to the effects described in the construction phase of the proposed Project.

6.7.5 Conclusion

Finfish and invertebrate species, along with their habitat designated as EFH or HAPC, have the potential to be exposed to various IPFs in the Offshore Project Area during all Project phases. The federally and state-endangered Atlantic sturgeon is identified as potentially co-occurring with Project activities in the nearshore areas of the export cable corridors and landfall locations of the proposed Project (e.g., during offshore export cable installation and removal). During the summer months, shortnose sturgeon are unlikely to occur in the Offshore Project Area because of their preference for estuarine waters and river and bay habitats. Overall, the potential Project effects on finfish and invertebrate species are expected to be temporary and localized.

Due to the heterogeneous habitat noted in the northern portions of the export cable corridors, recolonization of the invertebrates associated with hardbottom substrates is expected to occur over longer periods (approximately one to three years), and therefore, effects to the EFH in this area will be prolonged. Recolonization of benthic habitat in the Lease Area and southern portions of the export cable corridors, however, is expected to occur relatively quickly due to its high tolerance of disturbance (e.g., highly mobile sand sheets) and availability of homogenous habitat adjacent to the Offshore Project Area.

After construction, EFHs in and around the Offshore Project Area is expected to return to pre-Project conditions. Long-term effects (e.g., artificial reef effect during the O&M phase) include introduction of habitat diversity to a largely homogeneous, sandy, benthic habitat at WTG and OSP foundations. This may provide habitat for species such as Atlantic cod, black sea bass, and the egg and larval stages of ocean pout that could use the Lease Area as foraging habitat, and for immobile invertebrates.

When proposed Project activities are considered together with the existing EFHs in the Offshore Project Area, the potential for negative effects associated with the construction, operation, and decommissioning of the proposed Project are quite limited both temporally and spatially. The proposed Project is not expected to cause population level changes to resident, migratory, or protected finfish and invertebrate species, or to significantly affect EFH or HAPC. Avoidance, minimization, and mitigation measures, along with other best management practices are expected to reduce the potential effects to finfish and invertebrate species in the Offshore Project Area (see Section 16).

6.8 Marine Mammals

This section describes marine mammal species with the potential to occur in the Offshore Project Area and includes an evaluation of potential Project-related effects. For this section, Project Area is defined as the Offshore Project Area (i.e., the Lease Area and proposed offshore export cable corridors). This evaluation is based on a review of published scientific literature and publicly available reports, including marine mammal-specific monitoring and vessel-based monitoring reports conducted for other offshore wind facilities in the Massachusetts/Rhode Island WEA located in U.S. federal and state waters of the Northeast Atlantic.

Mayflower Wind evaluated the best available literature, government databases, and site-specific analyses conducted for the proposed Project. **Table 6-61** provides an overview of the published literature, guidelines, reports, and other data sources used to identify marine mammal physiological thresholds, habitat preferences, and species occurrence in the Project Area.

Technical appendices relating to marine mammals include:

- Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan

TABLE 6-61. MARINE MAMMAL LITERATURE, GUIDELINES, REPORTS, AND DATA SOURCES

Author	Source Title	Citations
BOEM	National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf	BOEM, 2019
BOEM	Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts. Revised Environmental Assessment	BOEM, 2013
BOEM	Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles	Kraus et al., 2016
BOEM	Atlantic Marine Assessment Program for Protected Species, 2010-2014	Palka et al., 2017
BOEM	Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales: Summary Report Campaign 5, 2018-2019	O'Brien et al., 2021
Coastal Resources Management Council	Data analysis of marine mammal and sea turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound, and nearby waters	Kenney & Vigness-Raposa, 2010
Department of the Navy	Navy OPAREA Density Estimates for the Northeast OPAREAS: Boston, Narragansett Bay, and Atlantic City	DON, 2007
Aquatic Mammals Journal	Biologically Important Areas for Cetaceans Within U.S. Waters	LaBrecque et al., 2015
Aquatic Mammals Journal	Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects	Southall et al., 2019

Author	Source Title	Citations
Marine-life Data and Analysis Team	Technical report on the methods and development of marine-life data to support regional ocean planning and management Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018	Curtice et al., 2019; Roberts et al., 2018
Massachusetts Division of Fish and Wildlife	Natural Heritage & Endangered Species Program	Retrieved from: https://www.mass.gov/orgs/masswildlifes-natural-heritage-endangered-species-program
NMFS	U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments	Hayes et al., 2020
NMFS	2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing	NMFS, 2018
NMFS	An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve: Chapter 8: Estuarine Habitat of Narragansett Bay	Schwartz, 2021
National Oceanic and Atmospheric Administration	Species Directory	Retrieved from: https://www.fisheries.noaa.gov/species-directory
New England Aquarium	Aerial Survey Data of the Rhode Island-Massachusetts WEA	New England Aquarium, 2020a-m
Northeast Fisheries Science Center & Southeast Fisheries Science Center	Atlantic Marine Assessment Program for Protected Species (AMAPPS), 2011-2018	Northeast Fisheries Science Center & Southeast Fisheries Science Center, 2011-2017; 2018
Environmental Protection Agency	Statutes and Regulations Affecting Marine Debris	Environmental Protection Agency, 2017
Related COP Sections and Appendices		
AECOM	Emergency Response Plan / Oil Spill Response Plan	Appendix AA
A.I.S., Inc.	AIS Protected Species Observer Report	A.I.S., Inc., 2020
JASCO Applied Sciences	Mayflower Wind Underwater Acoustics Technical Report: Underwater Acoustic Modeling and Animal Exposure Estimation for Mayflower Wind Energy, LLC.	Appendix U2
LGL Ecological Research Associates, Inc.	Marine Mammal and Sea Turtle Monitoring and Mitigation Plan	Appendix O
Mayflower Wind	Birds	Section 6.1
Mayflower Wind and APEM	Monthly survey data of the Project Area	Mayflower-APEM, 2020a-l
RPS	Protected Species Observer Reports	RPS, 2019

6.8.1 Affected Environment

Thirty-one species of marine mammals have the potential to occur in the MA/RI WEA and the Project Area, including several that are federally and/or state-listed in Massachusetts and Rhode Island or have been petitioned for listing. The marine mammal species listed in **Table 6-62** have been previously observed and/or recorded during surveys specific to offshore wind development for BOEM-specific assessments, surveys conducted in and around the MA/RI WEA and Project Area as part of long-term population assessments, and in NOAA Marine Mammal Stock Assessment reports of the MA/RI WEA (see **Table 6-61**).

TABLE 6-62. MARINE MAMMAL SPECIES WITH POTENTIAL TO OCCUR IN THE MA/RI WEA AND PROJECT AREA

Common Name	Scientific Name	Stock	ESA/ MMPA Status b/	MA Status b/	RI SGCN b/	Likely Occurrence within Project Area
Baleen whales						
Blue whale	*Balaenoptera musculus*	Western North Atlantic	E/D	E	-	Rare
Fin whale	*Balaenoptera physalus*	Western North Atlantic	E/D	E	SGCN	Common
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	NL/P	E	SGCN	Common
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast	NL/P	NL	-	Common
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic	E/D	E	SGCN	Common
Sei whale	*Balaenoptera borealis*	Nova Scotia	E/D	E	-	Common
Toothed whales						
Atlantic white-sided dolphin	*Lagenohynchus acutus*	Western North Atlantic	NL/P	NL	-	Common
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	NL/P	NL	-	Rare
Blainville's beaked whale	*Mesoplodon densirostris*	Western North Atlantic	NL/P	NL	-	Rare
Common bottlenose dolphin a/	*Tursiops truncatus*	Western North Atlantic	NL/P	NL	-	Common
Cuvier's beaked whale	*Ziphius cavirostris*	Western North Atlantic	NL/P	NL	-	Rare
Dwarf sperm whale	*Kogia sima*	Western North Atlantic	NL/P	NL	-	Rare
Gervais' beaked whale	*Mesoplodon europaeus*	Western North Atlantic	NL/P	NL	-	Rare
Killer whale	*Orcinus orca*	Western North Atlantic	NL/P	NL	-	Rare
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	NL/P	NL	-	Uncommon
Pantropical spotted dolphin	*Stenella attenuata*	Western North Atlantic	NL/P	NL	-	Rare
Pygmy sperm whale	*Kogia breviceps*	Western North Atlantic	NL/P	NL	-	Rare

Common Name	Scientific Name	Stock	ESA/ MMPA Status b/	MA Status b/	RI SGCN b/	Likely Occurrence within Project Area
Risso's dolphin	*Grampus griseus*	Western North Atlantic	NL/P	NL	-	Uncommon
Short-beaked common dolphin	*Delphinus delphis*	Western North Atlantic	NL/P	NL	-	Common
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	NL/P	NL	-	Rare
Sowerby's beaked whale	*Mesoplodon bidens*	Western North Atlantic	NL/P	NL	-	Rare
Sperm whale	*Physeter macrocephalus*	North Atlantic	E/D	E	-	Uncommon
Striped dolphin	*Stenella coeruleoalba*	Western North Atlantic	NL/P	NL	-	Rare
True's beaked whale	*Mesoplodon mirus*	Western North Atlantic	NL/P	NL	-	Rare
White-beaked dolphin	*Lagenorhynchus albirostris*	Western North Atlantic	NL/P	NL	-	Rare
Porpoises						
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy Stock	NL/P	NL	SGCN	Common
Pinnipeds						
Gray seal	*Halichoerus grypus*	Western North Atlantic	NL/P	NL	-	Common
Harp seal	*Pagophilus groenlandicus*	Western North Atlantic	NL/P	NL	-	Uncommon
Harbor seal	*Phoca vitulina*	Western North Atlantic	NL/P	NL	SGCN	Common
Hooded seal	*Crysophora cristata*	Western North Atlantic	NL/P	NL	-	Rare
West Indian Manatee	*Trichechus manatus*	Florida	T/D	NL	-	Rare

Notes:
a/ It is also possible for the common bottlenose dolphin Western North Atlantic North Migratory Coastal Stock to occur in the Project Area, but the boundaries of their range falls just south of the Project Area.
b/ ESA = Endangered Species Act (16 U.S.C §.1531 et seq.); MMPA = Marine Mammal Protection Act (16 U.S.C §.1361 et seq.); MESA = Massachusetts Endangered Species Act (321 CMR 10.00); E = Endangered; T = Threatened; P = Protected; D = Depleted; NL = Not listed.; Rhode Island Wildlife Action Plan Species Profiles, Species of Greatest Conservation Need (SGCN). SGCN species are identified by RIDEM and the Rhode Island Chapter of The Nature Conservancy in the Rhode Island Wildlife Action Plan. It should be noted that SGCN designation does not represent an equivalent to ESA or MESA species listings; rather, this represents a publicly available data source to identify species which Rhode Island considers to be of greatest concern, based on the threat affecting each (RIDEM, 2015).

6.8.1.1 Summary of Marine Mammal Occurrence in the Project Area

This section identifies and describes the different types of marine mammals that may be present in and around the Project Area during construction, operations, and decommissioning activities. Mayflower Wind has also included an analysis of whether, and if so to what extent, marine mammals may co-occur with Project activities and whether these species may be adversely affected.

Mayflower Wind evaluated the best available literature and government databases, marine mammal-specific surveys conducted for the proposed Project, as well as local and regional information regarding habitat use, abundance, and distribution of marine mammal species known to occur in Massachusetts waters. Existing threats (i.e., impact-producing factors as described below) to marine mammal species that may occur in the Project Area are also identified and evaluated in Section 6.8.2. During the construction phase, marine mammals may co-occur with, and be affected by, Project activities in the Lease Area and in the export cable corridors. During the operations phase, marine mammals may co-occur with the WTGs, OSPs, and the proposed export cable corridors, including vessel traffic for maintenance and associated effects. Marine mammal likelihood of co-occurrence with Project activities in specific Project locations is a function of overall occurrence levels that range from “rare” to “common” and seasonality of occurrence as listed in **Table 6-63**.

TABLE 6-63. SEASONALITY OF NON-ESA-LISTED MARINE MAMMALS IN THE PROJECT AREA

Species	Occurrence Level	Seasonality in Project Area	
		Project Components	
		Lease Area	ECCs
Minke whale	Common	Occurrence in the spring, summer, and fall; occasional occurrence in winter	Occurrence in the spring, summer, and fall; occasional occurrence in winter
Atlantic white-sided dolphin	Common	Potential occurrence in the summer and fall	Potential occurrence in the summer and fall
Atlantic spotted dolphin	Rare	Rare occurrence in spring, summer, and fall	Rare occurrence in spring, summer, and fall
Blainville’s, Gervais’, True’s, and Sowerby’s beaked whales	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
Common bottlenose dolphin	Common	Occurrence in the summer and fall; occasional occurrence in the winter and spring	Occurrence in the summer and fall; occasional occurrence in the winter and spring
Cuvier's beaked whale	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
Dwarf and pygmy sperm whale	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
Killer whale	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
Pantropical spotted dolphin	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
Pilot whale (long-finned and short-finned)	Uncommon/ Rare	Potential occurrence in the summer and fall; occasional occurrence in the winter and spring	Potential occurrence in the summer and fall; occasional occurrence in the winter and spring
Risso’s dolphin	Uncommon	Occasional occurrence in the spring, summer, and fall	Occasional occurrence in the spring, summer, and fall
Short-beaked common dolphin	Common	Occurrence in the spring and summer; occasional occurrence	Occurrence in the spring and summer; occasional occurrence

Species	Occurrence Level	Seasonality in Project Area	
		Project Components	
		Lease Area	ECCs
		in fall and winter	in fall and winter
Striped dolphin	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
White-beaked dolphin	Rare	Not determined, based on rare occurrence	Not determined, based on rare occurrence
Harbor porpoise	Common	Occurs year-round; peak abundance in the fall through spring	Occurs year-round; peak abundance in the fall through spring
Gray seal	Common	Occurs year-round	Occurs year-round
Harp seal	Uncommon	Annual vagrants found from January-May	Annual vagrants found from January-May
Harbor seal	Common	Occurs year-round	Occurs year-round
Hooded seal	Rare	Annual vagrants found from January-May	Annual vagrants found from January-May

The MA/RI WEA and Offshore Project Area are located in a foraging and nursery area for marine mammals observed in the region (Executive Office of Energy and Environmental Affairs, 2009); the area also overlaps with the migratory corridor for some marine mammal species. Baleen whales are most frequently observed traveling through the MA/RI WEA in the spring and summer, particularly along the Falmouth export cable corridor, near and within the Muskeget Channel, in the winter and spring while migrating between northern and southern feeding areas (BOEM, 2013). The exception to this seasonal occurrence is the blue whale (*Balaenoptera musculus*), which is considered to be a rare winter migrant in the MA/RI WEA. Toothed whales (e.g., sperm whale [*Physeter macrocephalus*], common bottlenose dolphin [*Tursiops truncatus*], pilot whale [*Globicephala spp.*]) can primarily be found within the Project Area in the summer and fall, and occasionally during the winter and spring seasons (BOEM, 2013). The harbor porpoise (*Phocoena phocoena*) is typically observed in the Project Area year-round, with peak abundance occurring during the winter and spring seasons. Pinniped species are present in the MA/RI WEA year-round with a lower abundance in the summer (DON, 2007).

Marine mammals that have been sighted along the Brayton Point export cable corridor, through the Sakonnet River, include the gray seal (*Halichoerus grypus*), harp seal (*Pagophilus groenlandicus*), hooded seal (*Crysophora cristata*), North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), dwarf sperm whale (*Kogia sima*), long-finned pilot whale (*Globicephala melas*), Risso's dolphin (*Grampus griseus*), Atlantic white-sided dolphin (Lagenohynchus acutus*),* bottlenose dolphin *(Tursiops truncatus),* striped dolphin *(Stenella coeruleoalba),* harbor porpoise (*Phocoena phocoena*), and West Indian manatee (*Trichechus manatus*) (Schwartz, 2021). Note that sightings for most whales and dolphins in Narraganset Bay and nearshore Rhode Island are rare. Harbor seals (*Phoca vitulina)* are routinely sited from fall through spring and several haul-out sites exist at Rome Point, Brenton Point, Citing Rock, Cold Spring Rock, Seal Rock, and Cormorant Cove with the size of the region harbor seal population and number of haul-out sites increasing in recent years (Schwartz, 2021). Humpback whales have also been seen in increasing numbers closer to shore in more recent years (Kenney, 2019).

Although the Northeast Large Pelagic Survey's (NLPS) efforts were directed toward large whales, survey results recorded several small marine mammals in the MA/RI WEA (Kraus et al., 2016). Species commonly identified included the short-beaked common dolphin (*Delphinus delphis*), common bottlenose dolphin (*Tursiops truncatus*), and harbor porpoise (*Phocoena phocoena*). Atlantic white-sided dolphin (*Lagenohynchus acutus*), Risso's dolphin (*Grampus griseus*) and pilot whale (*Globicephala spp.*) were only occasionally recorded in the MA/RI WEA. Gray seal (*Halichoerus grypus*) and harbor seal (*Phoca vitulina)* observations were also recorded. The New England Aquarium (NEAq), funded by the MCEC, has funded North Atlantic right whale (*Eubalaena glacialis*; NARW) surveys in support of offshore wind development in the MA/RI WEA (MCEC, n.d.). In 2020, Massachusetts and Rhode Island developers, in collaboration with MCEC, jointly funded a continuation of these digital aerial surveys starting in 2020 and continuing in 2021. The 2020 survey results included the following marine mammal observations within the MA/RI WEA:

- 2 minke whales and 125 common dolphin observations in June (NEAq, 2020a)
- 1 minke whale, 290 common dolphins, and 153 bottlenose dolphins in July (NEAq, 2020b, 2020c)
- 6 minke whales, 210 bottlenose dolphins, and 555 common dolphins in August (NEAq, 2020d, 2020e)
- 1 minke whale in September (NEAq, 2020f, 2020g)
- 180 common dolphins in October (NEAq, 2020h)
- 60 common dolphins in November (NEAq, 2020j)
- 75 common dolphins in December (NEAq, 2020k-l)

In 2020, the minke whales were observed in the southwestern section of the Lease Area in June, northwest of the Lease Area near Rhode Island Sound in July, and in the center of and east of the Lease Area (near the Nantucket Shoals) in August and September (NEAq 2020, a-g). The dolphin observations occurred throughout the MA/RI WEA but outside the Lease Area. One hundred unidentified seals were observed hauled out near Tuckernuck Island in June 2020 (NEAq, 2020a); 150 unidentified seals were observed hauled out on Nomans Land Island in December 2020 (NEAq, 2020k). Four harbor porpoises were observed east of the Lease Area in January 2021 (NEAq, 2020m).

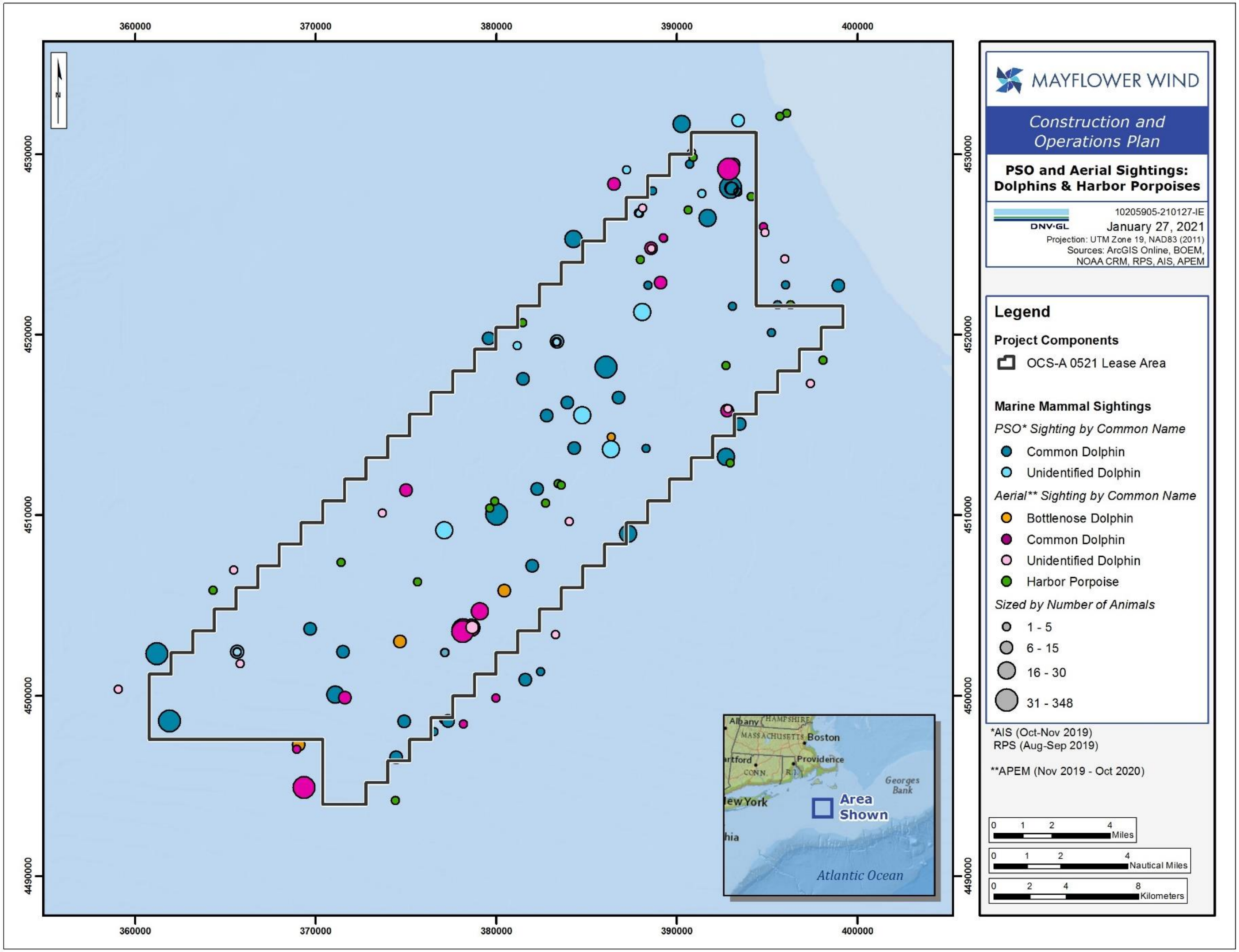
Aerial surveys of the Project Area conducted in November and December 2019 recorded 17 short-beaked common dolphins, one gray seal, and several other unidentified pinniped and dolphin species (Mayflower-APEM, 2020a, 2020b, for detailed information on aerial surveys see Section 6.1). One gray seal, one harbor porpoise, nine common dolphins, and several unidentified pinniped and dolphin species were observed during the January-March 2020 aerial surveys of the Project Area (Mayflower-APEM, 2020c, 2020d, 2020e). Nine harbor porpoises, 30 common dolphins, 11 bottlenose dolphins, and several unidentified pinniped and dolphin species were observed during the April-July 2020 aerial surveys of the Project Area (Mayflower-APEM, 2020f-i). Seven hundred forty-nine common dolphins, 14 bottlenose dolphins, and one minke whale were observed during the August-October 2020 aerial surveys of the Project Area (Mayflower-APEM, 2020j-m). Gray seal, harbor seal, Atlantic white-sided dolphin, Risso's dolphin, and short-beaked common dolphin were also observed during visual and acoustic surveys conducted in the Project Area in Summer and Fall of 2019 and geotechnical surveys conducted in the Project Area in 2020 (AIS Inc., 2020; RPS, 2019).

Figure 6-39, **Figure 6-40**, and **Figure 6-41** show the locations of dolphin, seal, and whale observations recorded during the 2019 Protected Species Observer (PSO) surveys (AIS Inc., 2020; RPS, 2019) and aerial surveys (Mayflower-APEM, 2020a-m). Passive acoustic monitoring observations from the RPS (2019) survey without corresponding visual observations (i.e., during periods of darkness or low visibility) did not have estimates for the numbers of animals recorded; instead, the numbers of animals observed in such cases were estimated by DNV as the average of the four observations of the same species with the nearest timestamps (two occurring before and two occurring after). Co-occurrence of this group of small and medium marine mammal species with Project activities is expected to be common, with the exception of Atlantic white-sided dolphin, Risso's dolphin, and pilot whale, which were observed less frequently and are therefore expected to have an uncommon co-occurrence with Project activities.

Small and medium marine mammals rarely observed in the MA/RI WEA include dwarf and pygmy sperm whales (*Kogia spp*.), Cuvier's beaked whale (*Ziphius cavirostris*), four species of Mesoplodon beaked whales—Blainsville's (*Mesoplodon densirostris*), Gervais' (*M. europaeus*), Sowerby's (*M. bidens*), and True's (*M. mirus*)—striped dolphin (*Stenella coeruleoalba*), and harp seal (*Pagophilus groenlandicus*) (Hayes et al., 2018; Kraus et al., 2016; Roberts et al., 2016; Kenney and Vigness-Raposa, 2010). These species are generally found outside the MA/RI WEA in deeper waters along the OCS slope areas west of the Georges Bank and in the Gulf Stream (NMFS, 2019; Palka et.al, 2017). None of the rarely observed species were identified during the NLPS or during visual and acoustic surveys conducted for the proposed Project (AIS Inc., 2020; Mayflower-APEM, 2020a-m; RPS, 2019). Striped dolphins were observed in the Lease Area during geophysical and geotechnical surveys conducted for the proposed Project in 2020. Information on the abundance and distribution of these species, except harp seal, is very limited. Harp seals are highly migratory species and are considered annual vagrants in the MA/RI WEA; they are generally only found in U.S. waters from January to May (Harris et al., 2002). Therefore, co-occurrence of the marine mammal species described directly above with activities in the Project Area is considered to be rare.

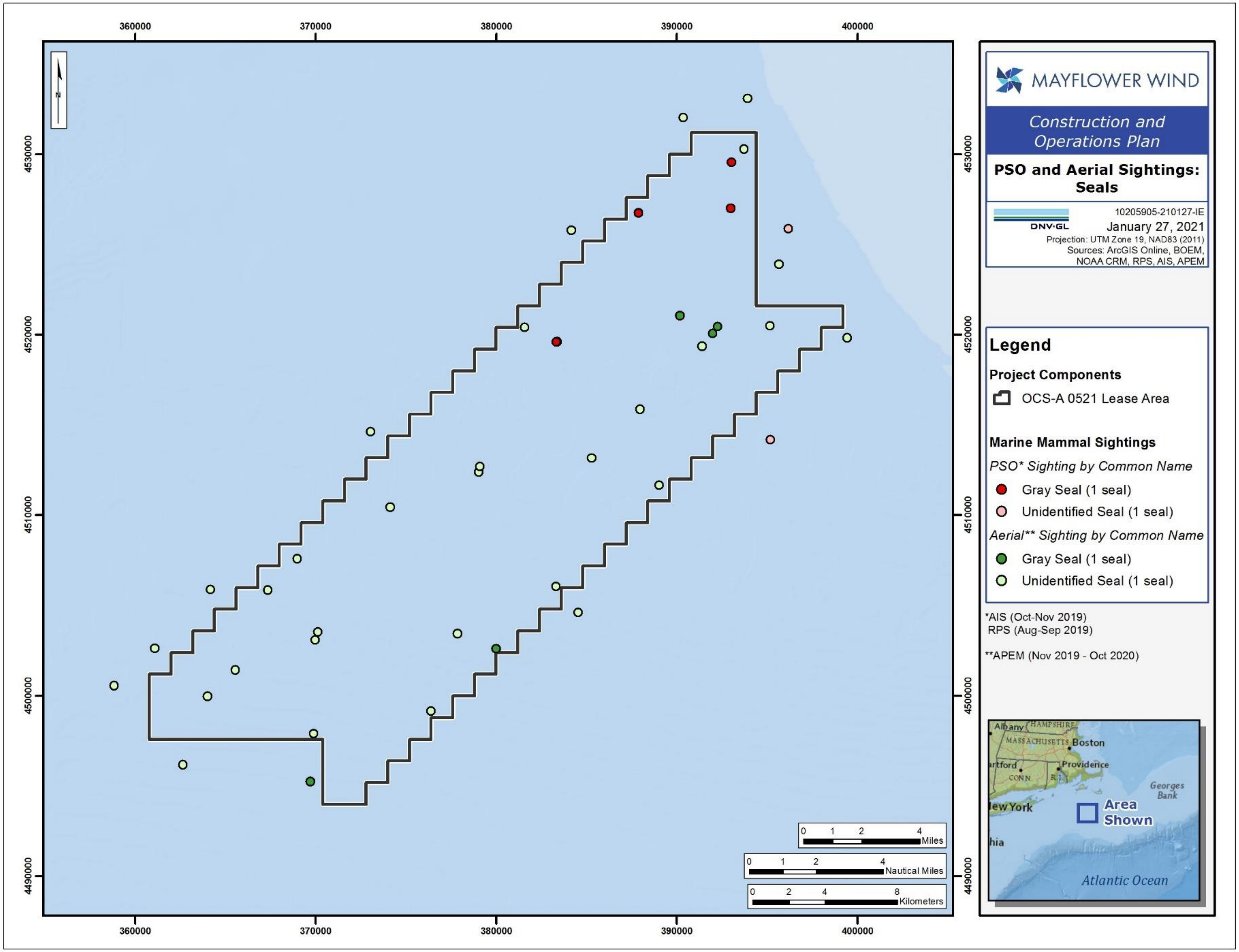
6.8.1.2 Endangered and Threatened Marine Mammals

The 31 marine mammal species described in **Table 6-62** are all protected under the Marine Mammal Protection Act (MMPA); however, only five baleen whales and one toothed whale with the potential to occur in the Project Area are federally or state listed as threatened or endangered, or belong to a depleted population (stock) and are afforded additional protection under the ESA, MESA, and/or Rhode Island's SGCN. These species include blue whale, fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), NARW, sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). While sightings of the West Indian manatee (*Trichechus manatus*), which is federally listed as threatened, have occasionally been recorded, these are considered extralimital and rare, and thus this species is not further discussed as it is not anticipated to occur in the Project Area (Schwartz, 2021). No dolphins, porpoises, or pinnipeds with the potential to occur in the Project Area are federally or state listed.



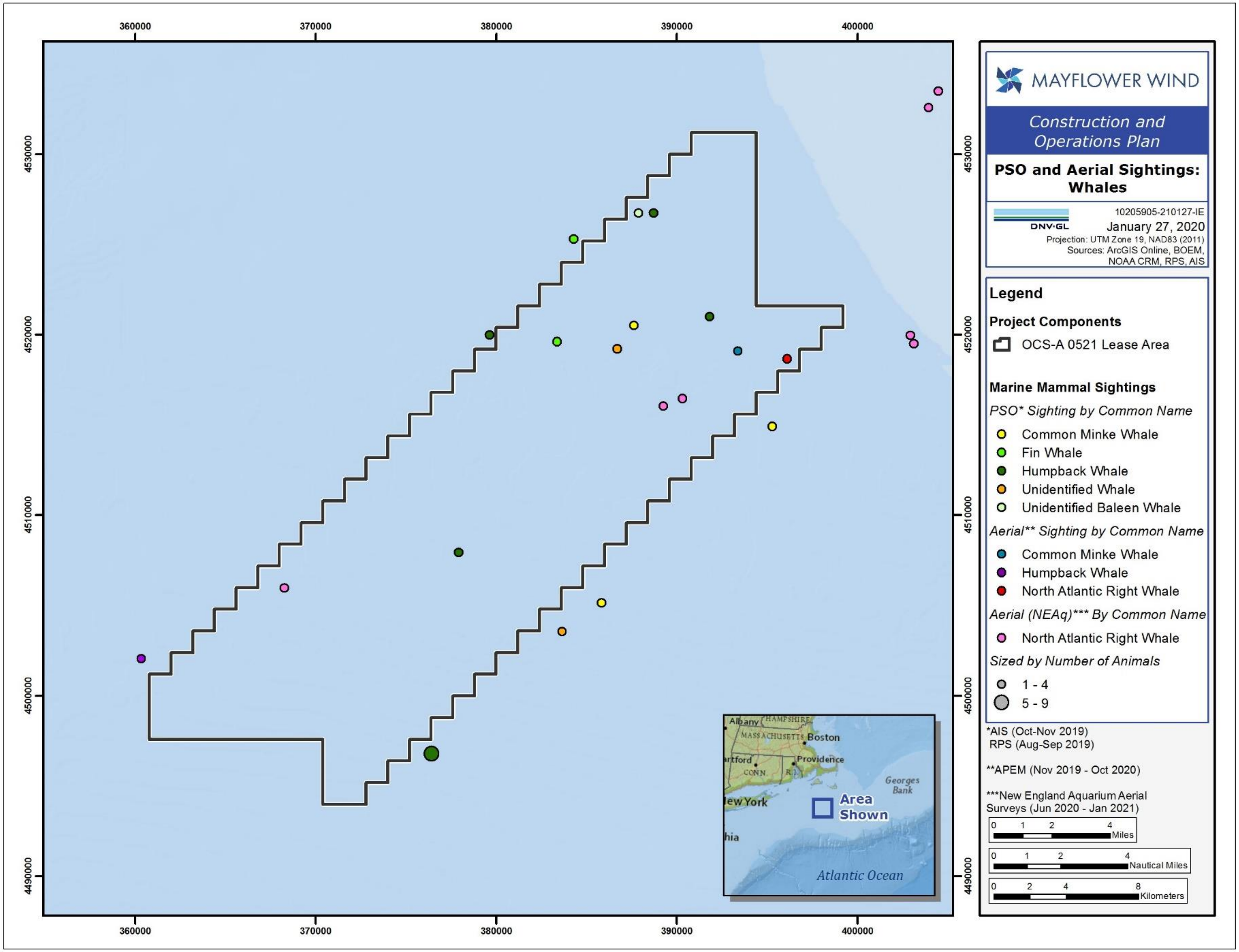
Source: AIS Inc., 2020; Mayflower-APEM, 2020a-m; NEAq, 2020a-m; RPS, 2019

FIGURE 6-39. ACOUSTIC AND VISUAL PSO SIGHTINGS OF DOLPHINS AND HARBOR PORPOISES (2019-2020)



Source: AIS Inc., 2020; Mayflower-APEM, 2020a-m; RPS, 2019

FIGURE 6-40. ACOUSTIC AND VISUAL PSO SIGHTINGS OF SEALS (2019-2020)



Source: AIS Inc., 2020; Mayflower-APEM, 2020a-m; NEAq, 2020a-m; RPS, 2019

FIGURE 6-41. ACOUSTIC AND VISUAL PSO SIGHTINGS OF WHALES (2019-2020)

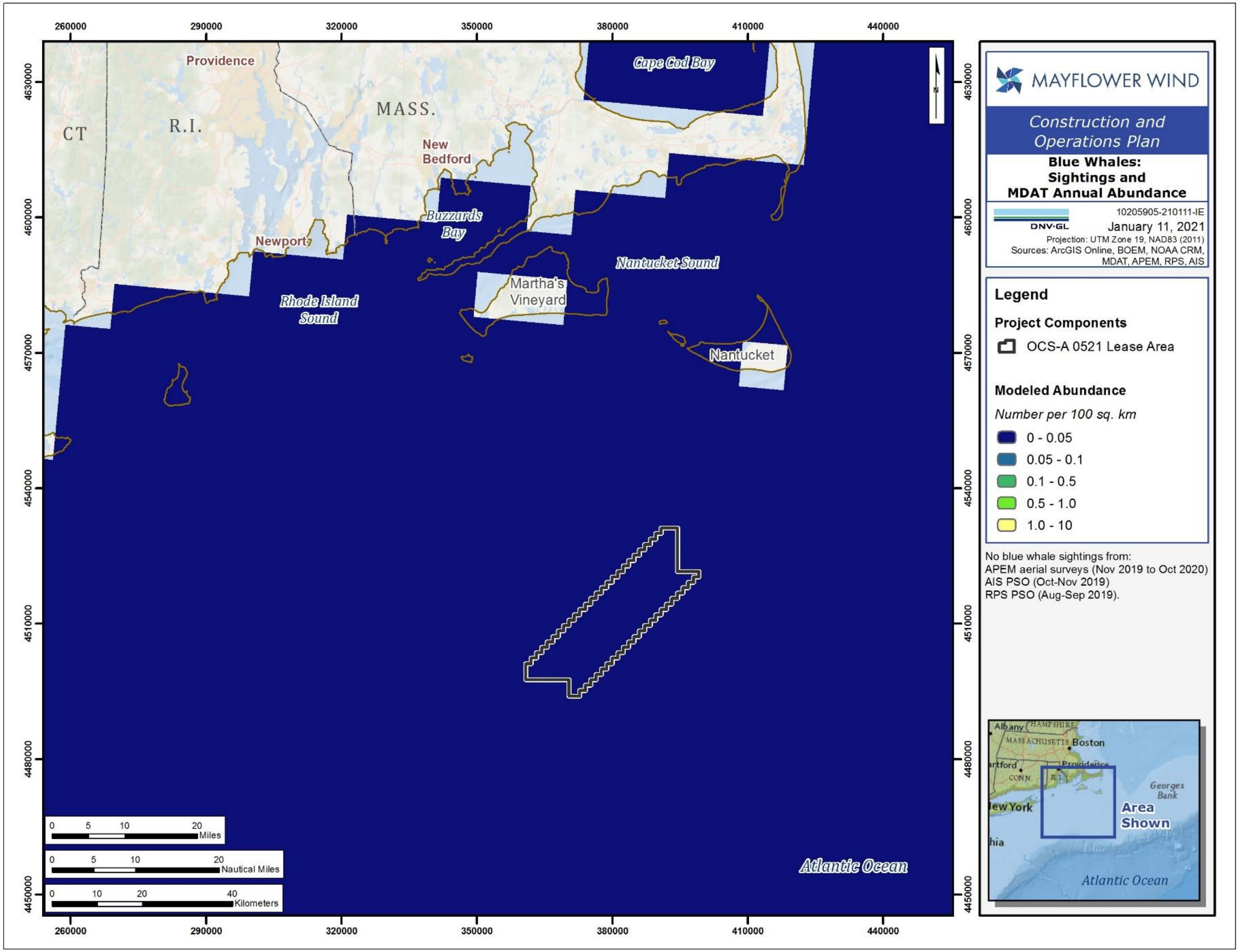
Modeled abundance estimates from the MDAT are presented in this section to supplement information on observed occurrences of endangered and threatened mammals (**Figure 6-42** through **Figure 6-47**); the MDAT team was developed in the Marine Geospatial Ecology Lab of Duke University and collaborates with the Northeast Regional Council, NOAA, and NEFSC to characterize the abundance and distribution of marine life to inform regional ocean planning (Curtice et al., 2019). The MDAT models interpolate visual survey data (collected during NEFSC pre-Atlantic Marine Assessment Program for Protected Species [AMAPPS], AMAPPS surveys conducted between 1995 and 2014, and NEFSC North Atlantic Right Whale Sighting Surveys conducted between 1999 and 2016) based on multiple covariates (e.g., slope, distance to shore, salinity, wind speed, chlorophyll concentration and net primary production) through generalized additive models (Curtice et al., 2019). The predicted density models for marine mammals were updated to reflect additional data gap assessment and analysis (Robert et al., 2018). The outputs of the MDAT model are grid surfaces for each species with 100 km square-cells, where the cell values represent the predicted density. Of the six whale species discussed in the section below, five have MDAT predicted density at the monthly scale. For the maps presented in this report, the 12 monthly surfaces were averaged. The predicted density surface layer for blue whales is based on annual data only due to insufficient visual survey data available for analysis.

6.8.1.2.1 Blue Whale

Occurrence Level	Seasonality in Project Area
Rare	Lease Area: Not determined, based on rare occurrence Proposed export cable corridors: Not determined, based on rare occurrence

Blue whales are listed as federally and state endangered and are rare in nearshore waters of Massachusetts. This species is considered an occasional visitor in the western North Atlantic in the winter and typically occurs further north of the MA/RI WEA (Hayes et al., 2020; Sears et al., 1987). In the northeastern U.S., they are observed primarily in deeper waters along the shelf edge and slope, but they have been sighted in the Project Area in the winter (Kraus et al., 2016). Blue whales were detected acoustically during the NLPS but were never visually observed in the MA/RI WEA between 2011 and 2015 (Kraus et al., 2016). Three blue whale observations were recorded in the northeast U.S. Atlantic during the 2010-2013 AMAPPS summer/fall shipboard surveys, all of which occurred during the summer months (Palka et al., 2017). The MDAT model for the species estimates between 0 and 0.05 blue whales per 100 km^2 on an average annual basis in the Lease Area (**Figure 6-42**, Robert et al., 2018).

No blue whale observations were recorded during visual or acoustic surveys conducted in the Project Area (AIS Inc., 2020; Mayflower-APEM, 2020a-m; RPS, 2019). Therefore, in light of its infrequent occurrence in the region, blue whale occurrence in the Project Area is expected to be rare.



Source: Roberts et al., 2018

FIGURE 6-42. MODELED BLUE WHALE PREDICTED DENSITY

6.8.1.2.2 Fin Whale

Occurrence Level	Seasonality in Project Area
Common	Lease Area: Year-round occurrence with a peak in the late-spring and summer months Proposed export cable corridors: Year-round occurrence with a peak in the late-spring and summer months

Fin whales are the most commonly observed baleen whales in continental shelf waters from the U.S. mid-Atlantic coast to Nova Scotia (Roberts et al., 2018; Palka et al., 2017; Hain et al., 1992; CETAP, 1982). Current abundance estimates available for the Western North Atlantic fin whale stock in U.S. waters is 7,418 individuals (Hayes et al., 2020). The North Atlantic fin whale stock is listed as depleted under the MMPA and listed as endangered under the ESA and MESA and are listed under SGCN. Like most other whale species along the U.S. Atlantic, vessel strikes and entanglement are perennial causes of serious injury and mortality to fin whales. For the period from 2013 to 2017, the minimum annual rate of human-caused mortality and serious injury to fin whales was estimated to be 2.35 individuals per year (Hayes et al., 2020).

Fin whales are a widely distributed species that occurs year-round in the Project Area, with more frequent sightings in the MA/RI WEA in spring and summer and along the Falmouth export cable corridor in late winter and spring (Stone et al., 2017; Kraus et al., 2016; O'Brien et al., 2021). Distribution along the offshore portions of the Brayton Point export cable corridor is similar to that of the MA/RI WEA, with year-round occurrence and increased occurrence in spring and summer (O'Brien et al., 2021; Kraus et al., 2016). Fin whales have also been sighted along the Brayton Point export cable corridor, through the Sakonnet River, but these are rare (Schwartz 2021). New England waters act as major feeding habitat for fin whales. The species has the largest stock and the largest food requirements, and therefore the largest influence on ecosystem processes of any baleen whale species (Kenney et al., 1997; Hain et al., 1992). Fin whales are recorded to consume up to two tons of food daily (NMFS, 2020). Fin whale mating and calving (and general wintering) areas are largely unknown (Hayes et al., 2020; Hain et al., 1992). An analysis of neonate whale stranding data suggests that calving may take place during the fall and early winter in the U.S. mid-Atlantic region (Hain et al., 1992). Two areas designated as Biologically Important Areas (BIAs)[4] for fin whale feeding are located to the southwest and northeast of the MA/RI WEA in the southern Gulf of Maine and east of Montauk Point, respectively (LaBrecque et al., 2015). The area to the northeast is considered a BIA for fin whales year-round, while the southwestern area is a BIA from March to October.

The NLPS recorded several fin whale observations in the MA/RI WEA (Kraus et al., 2016); observations occurred year-round with a spike in observations in the late-spring and summer months. The fin whales were observed in variable locations throughout the MA/RI WEA with some observations falling within the Lease Area; no fin whale observations were recorded in the offshore portions of the Falmouth export cable corridor area near the Muskeget Channel (note the study extent included offshore water and did not extend to nearshore waters). The species was often observed closer to shore during the

[4] According to NOAA, a BIA is a reproductive area, feeding area, migratory corridor, and area in which small and resident populations of marine mammals are concentrated and are region-, species-, and time-specific.

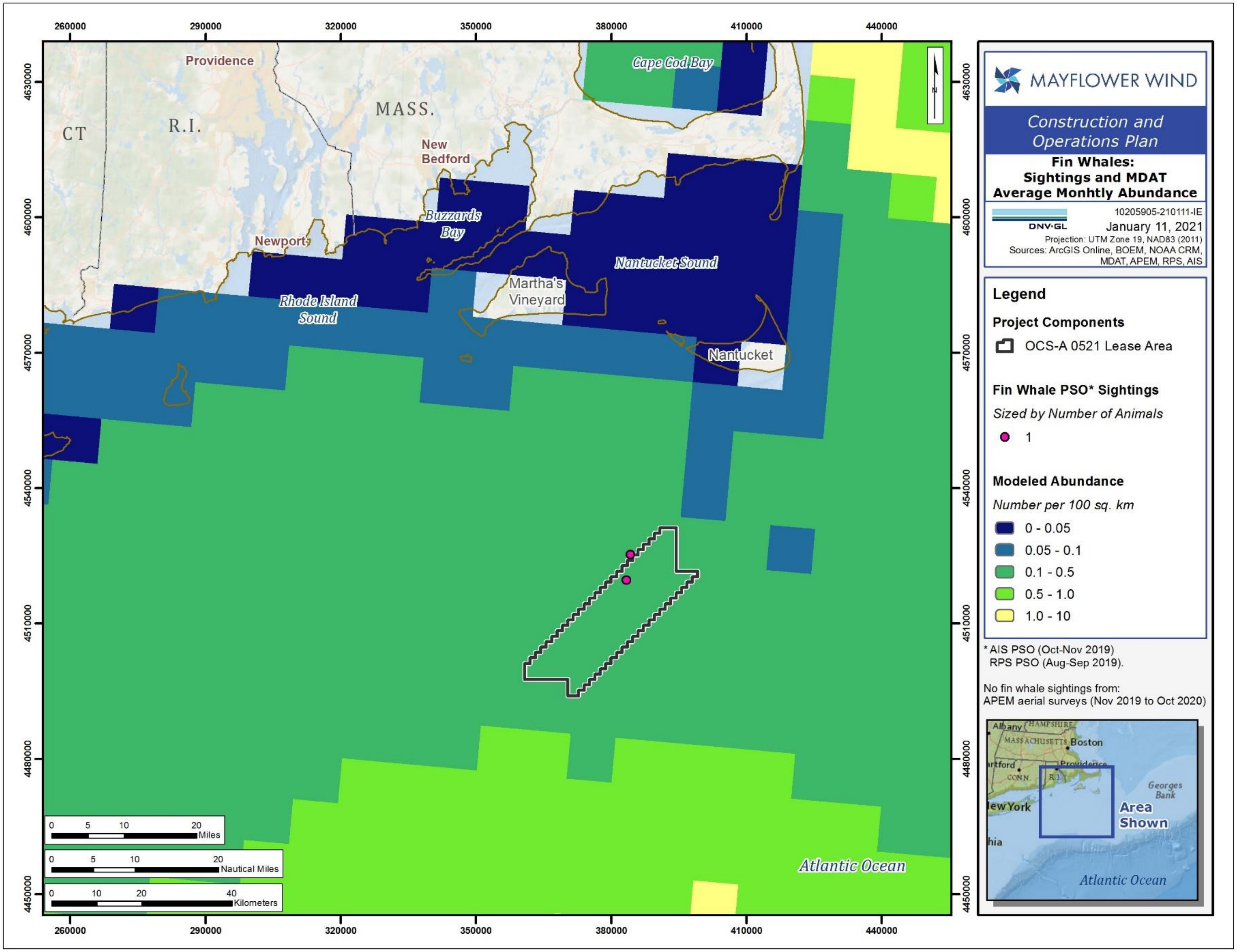
summer months. Fin whales were acoustically detected in the MA/RI WEA on 87 percent of survey days between 2011 and 2015 (889/1,020 days). Acoustic detections do not differentiate individuals, therefore, detections on multiple days may have represented individuals that had been previously detected. A total of 127 fin whale observations were recorded in the northeast U.S. Atlantic during the 2010-2013 AMAPPS summer/fall shipboard surveys, and 68 fin whale observations were recorded during the 2010-2013 AMAPPS aerial surveys (Palka et.al, 2017). All shipboard survey observations occurred during the summer, and the aerial survey observations were evenly distributed across the spring, summer, and fall, except one observation that occurred in the winter. Five fin whale observations were recorded in the northeast U.S. Atlantic region during AMAPPS II surveys in winter 2017-2018 (NEFSC, 2018). The MDAT models estimated a monthly average of 0.1 to 0.5 fin whales occurring per 10,000 hectares (ha) in the Lease Area (Roberts et al., 2018, **Figure 6-43**). During aerial surveys in the MA/RI WEA conducted by NEAq, three fin whales and one fin whale were observed in June and July of 2020, respectively (NEAq, 2020a; c). Two fin whales were observed during Winter 2020—one in December 2020 and one in January 2021 (NEAq, 2020l-m). The whales were observed outside the southwestern section of the Lease Area in June and July 2020 and northwest of the Lease Area in December 2020 and January 2021.

Four observations of fin whales moving through the Project Area were recorded during visual surveys; one whale was observed in September 2019 and three whales were observed in November 2019 (**Figure 6-43**, AIS Inc., 2020; RPS, 2019). No fin whale observations were recorded during visual surveys conducted in the Project Area between November 2019 and October 2020 (Mayflower-APEM, 2020a-m). Based on the information above, fin whales are expected to commonly occur in the Project Area and there is potential for fin whales to co-occur with Project activities.

6.8.1.2.3 Humpback Whale

Occurrence Level	Seasonality in Project Area
Common	Lease Area: Potential occurrence during the spring and summer months Proposed export cable corridors: Potential occurrence during the winter months during winter migration

The abundance estimate of the Gulf of Maine humpback whale stock in U.S. waters is 1,396 individuals (Hayes et al., 2020). The humpback whale was previously listed as endangered under the ESA. However, in September 2016, NMFS identified 14 distinct population segments (DPS) of humpback whale and revised the ESA listing. Four DPS were listed as federally endangered, one as federally threatened, and the remaining nine DPS were not listed. Humpback whales in the Western North Atlantic belong to the West Indies DPS, which is not listed under the ESA (81 Fed. Reg. 62,269, 2016). Although the humpback whale is not federally listed, it is listed as endangered under the MESA and is listed under SGCN and is afforded state-level protections. For the period from 2013 to 2017, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock was estimated to be 12.2 individuals per year (Hayes et al., 2020). Humpback whales in the Western North Atlantic have been experiencing unusually high mortality rates since January 2016 that may be related to an increase in vessel collisions (NOAA, 2017).



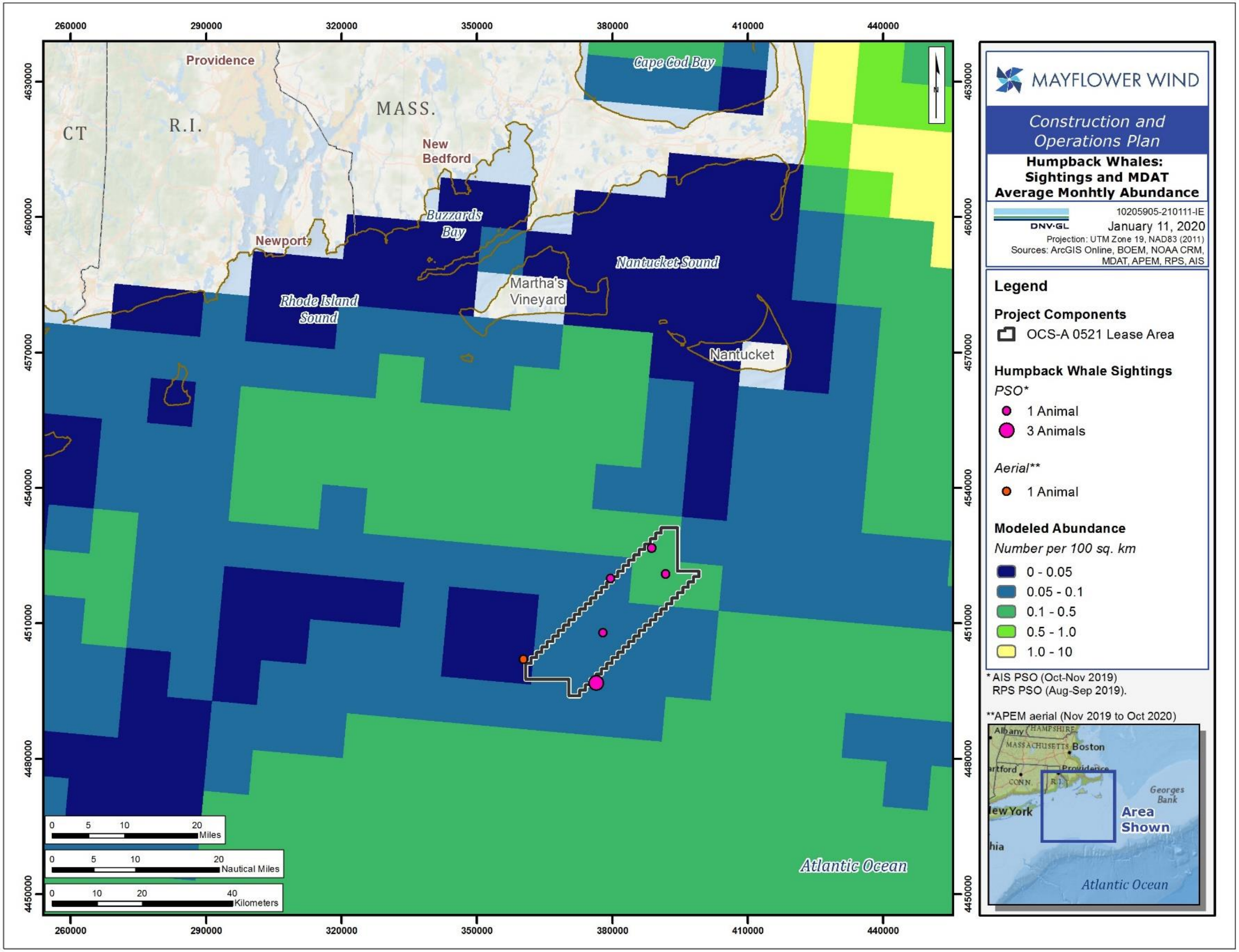
Source: AIS Inc., 2020; Roberts et al., 2018; RPS, 2019

FIGURE 6-43. MODELED PREDICTED DENSITY AND OBSERVED FIN WHALES

The range of the Gulf of Maine humpback whale stock spans from the U.S. mid-Atlantic, through the Gulf of Maine and north to western Greenland (Katona & Beard, 1990). Many of these humpback whales migrate to the West Indies (including the Antilles, Dominican Republic, Virgin Islands, and Puerto Rico) in the winter where they mate and calve their young (Palsbøll et al., 1997; Katona & Beard, 1990). However, not all humpback whales from the Gulf of Maine stock migrate to the West Indies every winter; there have been winter observations of humpback whale in the Western North Atlantic region (Swingle et al., 1993). Humpback whales have a BIA for feeding in the Gulf of Maine from March through December which is located east of the Project Area (LaBrecque et al., 2015).

Humpback whales occur year-round in the MA/RI WEA with more frequent sightings in spring and summer, and limited sightings along the Falmouth export cable corridor in the winter. Distribution along the offshore portions of the Brayton Point export cable corridor is similar to that of the MA/RI WEA, with year-round occurrence and increased occurrence in spring and summer (O'Brien et al., 2021; Kraus et al., 2016). Humpback whales have also been sighted along the Brayton Point export cable corridor, through the Sakonnet River, with sighting increasing close to shore in more recent years (Schwartz, 2021; Kenney, 2019). The NLPS recorded several humpback whale observations in the MA/RI WEA (Kraus et al., 2016). Humpback whales were sighted year-round; almost all observations occurred in the spring and summer months and the species was nearly absent in the fall and winter (Stone et al, 2017). There was an even distribution of humpback whale sightings across the MA/RI WEA in spring and summer, and limited sightings to the east and north of the MA/RI WEA in the fall and spring. Calves were observed feeding in the MA/RI WEA 10 times during the Kraus et al. (2016) study; one instance of courtship behavior was also observed. Although humpback whales were only rarely seen during fall and winter surveys, acoustic data indicates that this species may be present within the MA/RI WEA year-round, with the highest rates of acoustic detections occurring in winter and spring (Kraus et al., 2016). Humpback whales were acoustically detected in the MA/RI WEA on 56 percent of survey days (566/1,020 days), with a high monthly acoustic presence during the winter through early summer months. A total of 83 humpback whale observations were recorded in the northeast U.S. Atlantic during the 2010-2013 AMAPPS summer/fall shipboard surveys, and 95 humpback whale observations were recorded during the 2010-2013 AMAPPS aerial surveys (Palka et al., 2017). All shipboard survey observations occurred during the summer; aerial survey observations were highest in summer and fall, with lower numbers in spring and only one observation in winter. Ten humpback whale observations were recorded in the northeast U.S. Atlantic region during AMAPPS II surveys in winter 2017-2018 (NEFSC, 2018). The MDAT models estimate a monthly average of 0.05 to 0.5 humpback whales occurring per 10,000 ha in the Lease Area (**Figure 6-44**, Roberts et al., 2018). During 2020 NEAq surveys of the MA/RI WEA, five humpback whales were observed in June, two in July, nine in August, three in September, one in October, one in November, and one in December (NEAq, 2020a-l). One humpback whale was also observed during January 2021 NEAq surveys (NEAq, 2020m).

Fourteen observations of humpback whales were recorded during visual/acoustic surveys of the Project Area: four in August 2019 and two in September 2019 (**Figure 6-44**, AIS Inc., 2020; RPS, 2019). The whales were observed exhibiting a variety of behaviors, including blowing, diving, fluke slapping, and feeding. No humpback whale observations were recorded during visual surveys conducted in the Project Area between November 2019 and October 2020 (Mayflower-APEM, 2020a-m). Given the abundance and distribution of the Gulf of Maine stock, humpback whales are considered common in the area and there is the potential for humpback whales to co-occur with activities in the Project Area.



Source: AIS Inc., 2020; Robert et al., 2018; RPS, 2019

FIGURE 6-44. MODELED PREDICTED DENSITY AND OBSERVED HUMPBACK WHALES

6.8.1.2.4 North Atlantic Right Whale

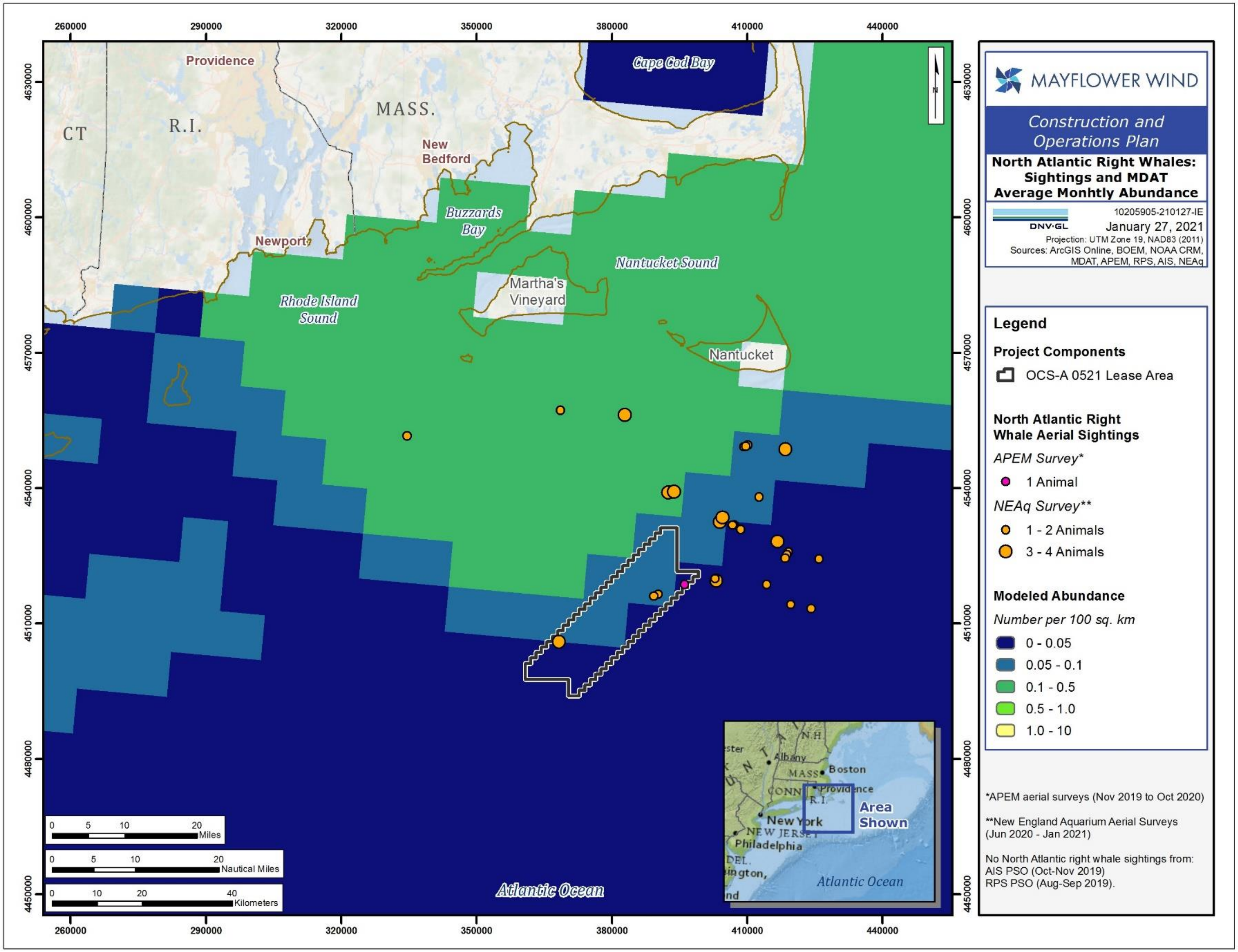
Occurrence Level	Seasonality in Project Area
Common	Lease Area: Potential occurrence during spring migration Proposed export cable corridors: Potential occurrence during spring migration and during the winter months

The North Atlantic right whale (NARW) is of particular conservation concern, as this species is among the rarest of all marine mammals in the Atlantic Ocean. The Western Atlantic stock ranges primarily from calving grounds in coastal waters of the southeastern U.S. to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence, with high concentrations of recorded sightings along the Florida/Georgia coastline, Cape Cod Bay, and the Gulf of St. Lawrence (Hayes et al., 2020). The Western Atlantic NARW stock is classified as a strategic stock under the MMPA; NARWs are listed as endangered under the ESA and MESA and also listed under SGCN. The most current available population estimate for the NARW stock is 428 individuals (Hayes et al., 2020). For the period from 2013 to 2017, the minimum rate of annual human-caused mortality and serious injury to NARW was estimated to be 6.9 individuals per year. Like most other whale species in the U.S. Atlantic, vessel strikes and entanglement with fishing gear are common causes of serious injury and mortality to NARWs.

NARWs are likely found in the MA/RI WEA and along the offshore waters of Rhode Island, specifically portions of the Brayton Point export cable route in the spring while traveling northward for feeding during their breeding period. There are also observation records of NARW in the mouth of the Muskeget Channel, along the Falmouth export cable corridor, during the winter (Kraus et al., 2016). Right whales have also been observed in Narragansett Bay and along coastal Rhode Island near the Sakonnet River, though these sighting are rare (Schwartz, 2021). New England waters are important feeding habitats for NARW, where they feed primarily on copepods. Right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo & Marx, 1990). All NARW BIAs for feeding are located northeast of the MA/RI WEA in Jeffrey's Ledge near New Hampshire, in Cape Cod Bay and Massachusetts Bay, and in the Great South Channel (LaBrecque et al., 2015). However, the BIA for NARW migration runs along the eastern U.S. coastline and does include the MA/RI WEA. Federally designated NARW critical habitat is located along the Atlantic coast in the northeast and southeast U.S. The northeast critical habitat area is located to the north and west of the MA/RI WEA. Additionally, Seasonal Management Areas for reducing ship strikes of NARWs have been designated in the U.S. and Canada. All vessels greater than 65 ft (19.8 m) in length must operate at speeds of 10 knots or less within these areas during seasonal time periods. The closest Seasonal Management Area overlaps the western portion of the MA/RI WEA and a short portion of the Brayton Point export cable corridor and becomes active between November 1 and April 30 each year.

During the NLPS, 77 individual NARWs were observed in the MA/RI WEA over the duration of the survey period (October 2011-June 2015; Leiter et al., 2017; Kraus et al., 2016). Peak NARW observations were recorded in the winter and spring in the northeastern portion of the MA/RI WEA, near Muskeget Channel and south of Nantucket (Stone et al, 2017). There were no NARW observations in the summer and fall. Most NARW observations during the NLPS occurred outside of the Lease Area, but there were some observations recorded in the northeastern portion of the Lease Area and near the proposed export cable corridor. During the Kraus et al. (2016) NLPS, NARWs were acoustically detected on approximately 443 of the 1,020 days of recording in the MA/RI WEA; highest monthly acoustic presence occurred in the late winter and early spring months. Four NARW observations were recorded in the northeast U.S. Atlantic during the 2010-2013 AMAPPS summer/fall shipboard surveys, and five NARW observations were recorded during the 2010-2013 AMAPPS aerial surveys (Palka et.al 2017). All shipboard survey observations occurred during the summer, and three aerial survey observations were in the spring, summer, and fall. No NARW observations were recorded in the northeast U.S. Atlantic region during AMAPPS II surveys in winter 2017-2018 (NEFSC 2018). The MDAT models estimated a monthly average of 0 to 0.1 NARW occurring per 100 km^2 in the Lease Area (**Figure 6-45**, Roberts et al., 2018). Fourteen NARWs were observed in the MA/RI WEA during aerial surveys conducted by NEAq in between July and October 2020 (NEAq, 2020c-h); one in July, two in August, eight in September, and three in October. All NARW observations occurred northeast of the Lease Area in the Nantucket Shoals. One NARW was observed in the western portion of the Lease Area in November 2020 and six NARW observations occurred in December 2020 northeast of the Lease Area (NEaq, 2020j-l). Four NARW observations occurred east of the Lease Area during the January 2021 NEAq survey period (NEAq, 2020m).

One potential NARW observation was recorded in January 2020 during aerial surveys of the Lease Area from November 2019 to October 2020 (Mayflower Wind Energy et al., 2020, **Figure 6-45**). The potential NARW observation occurred near the eastern border of the Lease Area. NMFS and the NEAq were alerted to this potential observation and concluded that the observation was unlikely to be a NARW. No further NARW observations were recorded during visual surveys conducted in the Project Area between February and October 2020 (Mayflower-APEM, 2020d; e-m). Given the abundance and distribution of NARW in the MA/RI WEA, there is the potential for NARWs to co-occur with activities in the Project Area, particularly in the proposed export cable corridors during the winter and spring.



Source: Curtice et al., 2019; Mayflower Wind et al., 2020; NEAq, 2020a-m

FIGURE 6-45. MODELED PREDICTED DENSITY AND OBSERVED NORTH ATLANTIC RIGHT WHALES

6.8.1.2.5 Sei Whale

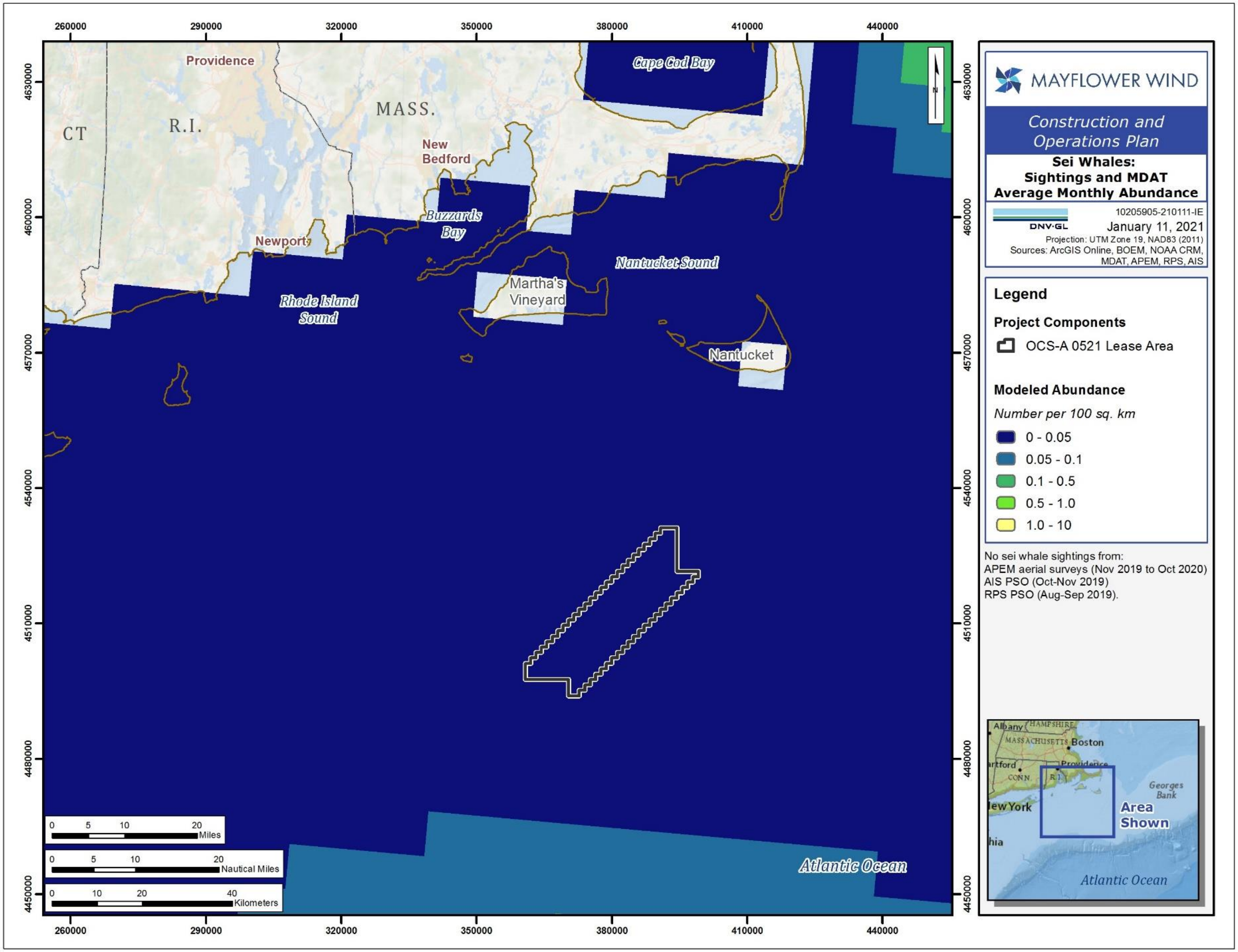
Occurrence Level	Seasonality in Project Area
Common	Lease Area: Potential occurrence in the spring and early summer Proposed export cable corridors: Potential occurrence in the spring and summer

Sei whales are commonly observed in deeper, colder waters along the OCS and the shelf edge but will occasionally travel inshore to forage (Hain et al., 1985). The Nova Scotia stock occurs in the northeastern U.S Atlantic, and the range of the stock is centered around the continental shelf waters of the northeastern U.S. northward to Newfoundland (NMFS, 2019). Sei whales are most abundant in New England waters from spring to fall; during the fall and winter, the species is predicted to be largely absent (Roberts et al., 2016). Sei whales are listed as endangered under the ESA and MESA; the Nova Scotia sei whale stock is considered strategic under the MMPA. The most current available population estimate for the Nova Scotia sei whale stock is 6,292 individuals (NMFS, 2019). For the period from 2013 to 2017, the minimum rate of annual human-caused mortality and serious injury to sei whales was 1.0 individual per year.

A BIA for sei whale feeding occurs east of the MA/RI WEA in the Gulf of Maine, parts of the northern and southern shelves of Georges Bank, and the Great South Channel from May to November (LaBrecque et al., 2015). There are no critical habitat areas designated for the sei whale under the ESA.

Sei whales can be found in the MA/RI WEA in the spring and summer; there were no recorded sei whale observations in the proposed Falmouth export cable corridor (Stone et al., 2017; Kraus et al., 2016; O'Brien et al., 2021). Sei whales have not been observed in Narragansett Bay and along coastal Rhode Island near the Sakonnet River (Schwartz, 2021). Twenty-five sei whales were observed in the MA/RI WEA and surrounding areas during the NLPS, and observations only occurred between the months of March and June (Kraus et al., 2016). Calves were observed three times and feeding was observed four times during the survey period. Spring sei whale observations were recorded toward the southern portion of the MA/RI WEA; summer observations shifted northward in the MA/RI WEA and toward the Muskeget Channel. Most sei whale observations during the NLPS fell outside of the Lease Area. Due to the uncertainty associated with identifying sei whale vocalizations, this species was not included in NLPS acoustic survey efforts. A total of 10 sei whale observations were recorded in the northeast U.S. Atlantic during the 2010-2013 AMAPPS summer/fall shipboard surveys, and 23 sei whale observations were recorded during the 2010-2013 AMAPPS aerial surveys (Palka et al., 2017). All shipboard survey observations occurred during the summer, and aerial survey observations occurred in all four seasons. No sei whale observations were recorded in the northeast U.S. Atlantic region during AMAPPS II surveys in winter 2017-2018 (NEFSC, 2018). The MDAT models estimated a monthly average of 0 to 0.05 sei whales occurring per 10,000 hectares in the Lease Area (**Figure 6-46**, Curtice et al., 2019).

No sei whales were observed visually or detected acoustically during surveys of the Project Area (AIS Inc., 2020; Mayflower-APEM, 2020a-m; TerraSond, 2019a; TerraSond 2019b). Although not as commonly observed as other threatened or endangered marine mammals, there is the potential for sei whales to co-occur with Project activities in the Project Area, particularly during the spring and summer.



Source: Curtice et al., 2019

FIGURE 6-46. MODELED SEI WHALE PREDICTED DENSITY

6.8.1.2.6 Sperm Whale

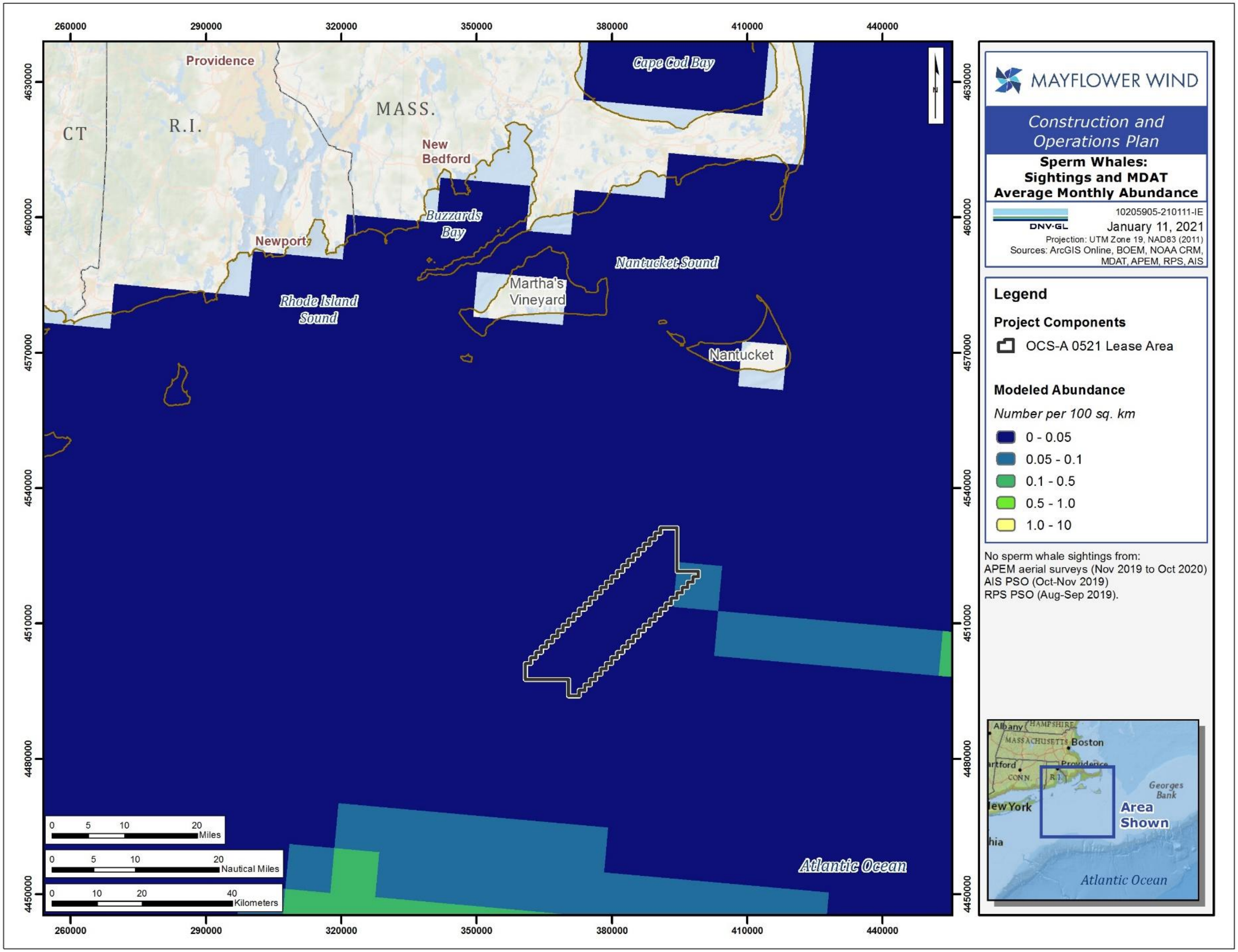
Occurrence Level	Seasonality in Project Area
Uncommon	Lease Area: Potential of limited occurrence during the summer and fall Proposed export cable corridors: Occurrence unlikely, due to preference of OCS area

Sperm whales are listed as endangered under the ESA and MESA; the North Atlantic sperm whale stock is considered strategic under the MMPA (i.e., anthropogenic impacts resulting in mortality or serious injury for the stock exceeds the maximum individual loss allowed without population-level effects). There are currently no reliable abundance estimates for the North Atlantic sperm whale stock. The most recent and reliable abundance estimates for this stock are from 2016 surveys, which estimated a stock of 4,349 individuals (Hayes et al., 2020). There were no documented annual human-caused serious injury to the North Atlantic sperm whale stock in the U.S. Atlantic waters between 2013-2017 (Hayes et al, 2020). Current threats to sperm whales include vessel strikes, exposure to anthropogenic noise and toxic pollutants, and entanglement in fishing gear (Gomez et al., 2016; Nowacek et al., 2015; Carrillo & Ritter, 2010; McGillivary et al., 2009). There are no critical habitat areas designated for the sperm whale under ESA or BIAs for the species.

Sperm whales, the largest of all toothed whales, are deep-diving whales that hunt squid, sharks, skates, and fish (NMFS, 2018). They are generally observed along the OCS from the equator, to the edges of the northern and southern polar ice packs, and along the continental shelf edge in Massachusetts waters (BOEM, 2013; Whitehead, 2002). Sperm whales form stable social groups and exhibit a geographically distinct 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 (Engelhaupt, 2009; Whitehead, 2002).

Sperm whales are primarily expected in the Lease Area in summer and fall but are not expected to travel nearshore and occur in either of the Project's proposed export cable corridors (Kraus et al., 2016). The NLPS recorded limited sightings of sperm whales in the MA/RI WEA (Stone et al., 2017; Kraus et al., 2016). Nine sperm whales, traveling alone or in groups of three or four, were observed in 2012 and 2015; six individuals were observed in August and September of 2012 and three individuals were observed in June 2015. Sperm whale click frequency exceeds the maximum frequency of the acoustic equipment used in the NLPS, thus no acoustic data for this species were recorded during the study (Kraus et al. 2016). A total of 208 sperm whale observations were recorded in the northeast U.S. Atlantic region during the 2010-2013 AMAPPS summer/fall shipboard surveys, and 13 sperm whale observations were recorded during the 2010-2013 AMAPPS aerial surveys (Palka et al., 2017). All shipboard survey observations occurred during the summer, and the aerial surveys occurred in all seasons except winter. Sperm whales were primarily found in deep offshore waters which were predominately surveyed only in the summer. No sperm whales were observed in the northeast U.S. Atlantic region during AMAPPS II surveys in winter 2017-2018 (NEFSC 2018). The MDAT models estimated a monthly average of 0 to 0.1 sperm whales occurring per 10,000 ha in the Lease Area (**Figure 6-47**, Roberts et al., 2018).

Sperm whales were not observed visually or detected acoustically during surveys of the Project Area (AIS Inc., 2020; Mayflower-APEM, 2020a-m; TerraSond, 2019). Given the location of its general range and lack of recorded sightings in the MA/RI WEA, sperm whales are unlikely to co-occur with activities in the Project Area.



Source: Roberts et al., 2018

FIGURE 6-47. MODELED SPERM WHALE PREDICTED DENSITY

6.8.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

The IPFs identified herein result from Project activities (or accidental events from said activities) that have the potential to behaviorally or physically disturb or harm marine mammal species. Mayflower Wind also includes an analysis of whether, and to what extent, marine mammals may be affected if they are exposed to one or more IPFs. The following tables present a summary of the IPFs that are likely to be caused by Project activities and components. Potential effects for the marine mammal species are addressed in **Table 6-64**. The following sections provide detailed explanations, based on the best available science literature, of the IPFs during each Project phase.

TABLE 6-64. IPFS AND POTENTIAL EFFECTS ON MARINE MAMMALS IN THE OFFSHORE PROJECT AREA

IPF	Potential Effects		Period of Effect		
	Project Components		Project Phase		
	Lease Area	Export Cable Corridors	Construction	O&M	Decomm.
Introduced Sound into the Environment (in-air or underwater)	Behavioral disturbance	Behavioral disturbance	X	X	X
Actions that may cause direct injury or death of biological resources—Vessel Operations	Serious injury or mortality from strikes	Serious injury or mortality from strikes	X	X	X
Seabed (or ground) Disturbance	Displacement/harassment	Displacement/harassment	X	-	X
Actions that may displace biological resources, cultural resources, or human uses–Habitat Disturbance and Modification	Reduced prey availability/habitat loss Artificial reef effect	Reduced prey availability/habitat loss Artificial reef effect	X	X	X
Actions that may cause direct injury or death of biological resources—Entanglement	Harassment/mortality	Harassment/mortality	X	X	X
Planned Discharges	Harassment/mortality	Harassment/mortality	X	X	X
Accidental events—Marine Debris, Unplanned Discharges	Harassment/mortality	Harassment/mortality	X	X	X

6.8.2.1 Introduced Sound into the Environment (In-Air or Underwater)

TABLE 6-65. FINDINGS SUMMARY – INTRODUCED SOUND INTO THE ENVIRONMENT (IN-AIR OR UNDERWATER)

Sources of Introduced Sound	Summary
Construction	
Pile driving Inter-array cable installation Increased vessel traffic Export cable installation	• Physiological effects may occur for marine mammals in close proximity to the pile driving zone • Behavioral effects on marine mammals (e.g., avoidance behaviors/stress response) would likely be seasonal, temporary and localized • Effects of introduced sounds will be avoided, minimized, or mitigated by appropriate mitigation measures
O&M	
WTG Noise Increased vessel traffic	• Physiological or behavioral effects are not expected for marine mammals • Marine mammal species may acclimate to operational WTG and maintenance vessel sounds
Decommissioning	
Foundation removal Increased vessel traffic	• Physiological effects are not expected for marine mammals • Behavioral effects may occur for marine mammals (e.g., avoidance behaviors, stress response) but would be seasonal, short-term, and localized • Effects of introduced sounds will be avoided, minimized, or mitigated by appropriate mitigation measures

Marine mammals use sound for various activities, including feeding, communication, migration, and predator avoidance. Marine mammals also use sound to learn about their surroundings by gathering information from other marine mammals, prey species, or natural elements (e.g., wind, waves, rain, Erbe et al., 2016; Clark & Ellison, 2004; National Academy of Sciences, 2003; Richardson et al., 1995).

Most baleen whales are low-frequency cetaceans and are most sensitive to sounds under one kilohertz (kHz) (NMFS, 2018; Southall, 2016; Richardson et al., 1995). However, there is considerable variation in the vocal capabilities of low-frequency cetaceans, which may indicate broader hearing ranges for certain species. For example, based on their vocal capabilities, the fin whale's hearing range may extend as low as 10 Hz to 15 Hz, and humpback whales can produce vocalizations greater than one kHz, including sounds up to 1.8 kHz or even possibly 8.2 kHz (Cranford & Krysl, 2015; Erbe, 2002; Ketten, 2000; Richardson et al., 1995). An analysis of NARW ear anatomy found that the species has a hearing range of 10 Hz to 22 kHz (Parks et al., 2007). Dolphins, toothed whales, beaked whales, and bottle-nosed whales are typically classified as mid-frequency cetaceans with functional hearing between 150 Hz and 160 kHz and porpoises are classified as high-frequency cetaceans with a functional hearing range between 200 Hz and 160 kHz (NMFS, 2018; BOEM, 2012; Southall et al., 2007). Phocid pinnipeds (e.g., gray, harp, and harbor seals) have a functional hearing range between 75 Hz and 75 kHz. A table of marine mammal species known to occur in the Project Area and their hearing ranges are listed in **Table 6-66**.

TABLE 6-66. AUDITORY AND THRESHOLD SHIFT RANGES OF MARINE MAMMALS OF INTEREST

Species	Auditory Ranges	Temporary Threshold Shifts a/	Permanent Threshold Shifts b/	
			Impulsive	Non-Impulsive
Low-frequency cetaceans				
Blue whale	7 Hz–35 kHz	179 dB	219 dB	199 dB
Fin whale				
Humpback whale				
Minke whale				
North Atlantic right whale				
Sei whale				
Mid-frequency cetaceans				
Atlantic white-sided dolphin	150 Hz–160 kHz	178 dB	230 dB	198 dB
Blainville's, Gervais', True's, and Sowerby's beaked whales				
Common bottlenose dolphin				
Cuvier's beaked whale				
Pilot whale (long-finned and short-finned)				
Risso's dolphin				
Short-beaked common dolphin				
Sperm whale				
Striped dolphin				
High-frequency cetaceans				
Dwarf and pygmy sperm whale	200 Hz–160 kHz	153 dB	202 dB	173 dB
Harbor porpoise				
Phocid pinnipeds				
Gray seal	75 Hz- 75 kHz (in water) 75 Hz- 30 kHz (in air)	181 dB	218 dB	219 dB
Harp seal				
Harbor seal				

Source: NMFS, 2018

Notes:

a/ Weighted temporary threshold shift onset thresholds for non-impulsive sources calculated using the Cumulative Sound Exposure Level (SELcum) Metric (NMFS, 2018)

b/ Non-impulsive values are weighted permanent threshold shift onset thresholds calculated using the SELcum Metric. Impulsive values are flat-weighted (un-weighted) zero peak pressure thresholds. Impulsive sounds are defined as transient and brief with high peak sound pressure, while non-impulsive sounds are defined as prolonged or intermittent no high peak sound pressure (NMFS, 2018). Peak sound pressure has a reference value of 1 µPa.

Marine mammals can experience physical injury as a result of noise. In 2018, NOAA issued updated guidelines for determining potential effects of noise on marine mammals (Hayes et al., 2018). NOAA based the criteria on the potential for noise to result in a permanent threshold shift (PTS). PTS occurs when exposure to noise results in permanent hearing loss in a portion of the marine mammal's frequency spectrum. PTS can result from repeated or prolonged exposures to temporary threshold shifts

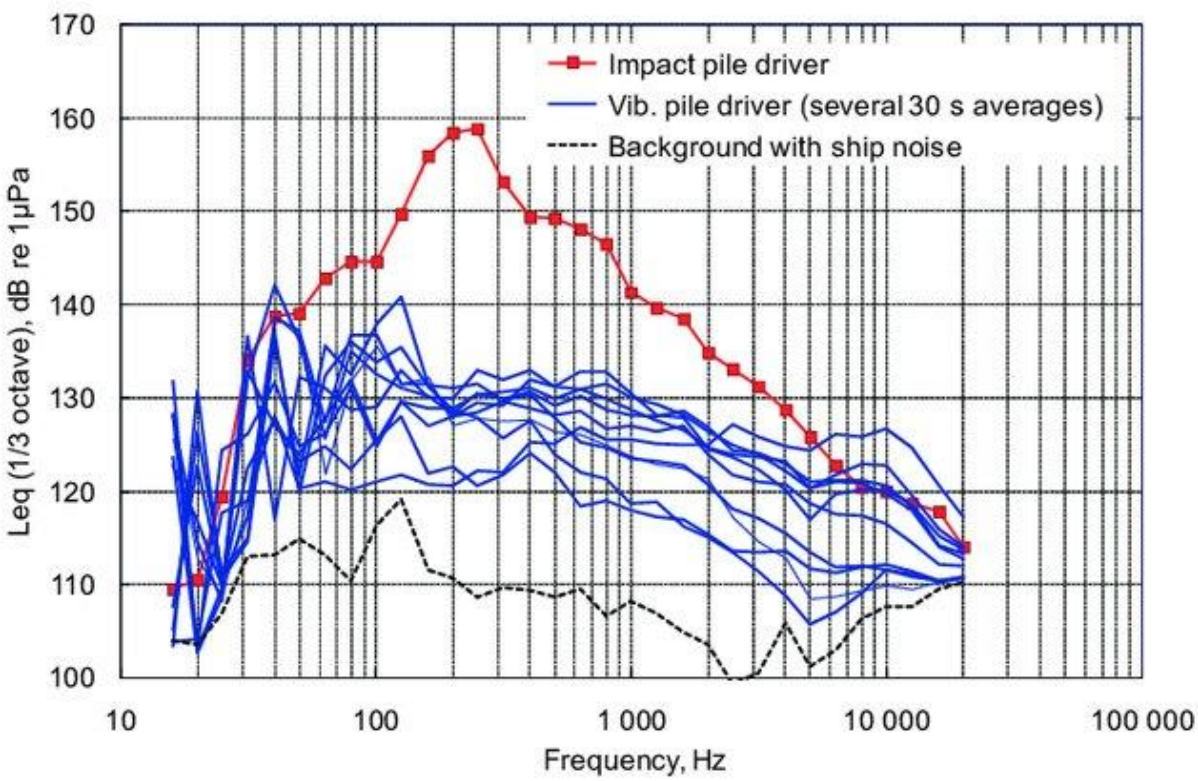
(TTS), or acute exposure to an intense sound that causes immediate damage. PTS thresholds are used to determine if Level A Harassment (injury) may occur.

Behavioral responses of marine mammals to noise range from no response, to mild aversion, to panic and flight (Broker, 2019; Erbe et al., 2018; Castellote et al., 2012; Ellison et al., 2012; Southall et al., 2007). Short- and long-distance displacement have been observed for seals and cetaceans in response to noise. Studies have shown that harbor porpoises may temporarily leave an area in response to pile driving noise (Nabe-Nielsen et al., 2018; Dähne et al., 2013; Brandt et al., 2011). The same behavior has also been noted in harbor and gray seals (Edrén et al., 2010). Displacement due to noise or other disturbances could cause animals to move into less suitable habitat with reduced prey availability or into areas with a higher risk from vessel strikes or other anthropogenic impacts. Noise can also cause masking, which is interference with a marine mammal's ability to send and receive acoustic signals used for intraspecific communication, navigation, hunting, etc. A marine mammal's susceptibility to masking depends on the frequencies at which the marine mammal sends and receives signals and the frequencies, intensity, and other attributes of the masking noise (Erbe et al., 2016; David, 2006). Low-frequency cetaceans such as baleen whales may be vulnerable to masking by low-frequency noise (Erbe et al. 2018; Richardson et al., 1995), including vessel traffic noise (Redfern et al., 2016).

Some studies have found that marine mammal habituation and/or adaptation to anthropogenic sound sources may occur. One study observed that harbor porpoise behavioral responses decreased over time with repeated exposure to pile-driving noise (Graham et al., 2019); however, the study could not confirm with certainty that habituation was taking place. Some cetaceans may be able to modulate their hearing to reduce the sound of loud noise and physiologically reduce the effects of masking in noisy environments (Nachtigall et al., 2018; Nachtigall & Supin, 2008).

6.8.2.1.1 Pile Driving Noise

Pile driving is expected to be the most disruptive activity to marine mammals during the construction phase of the proposed Project. Noise generated by the impact hammer would involve regular, pulsed sounds of short duration. These pulsed sounds are typically high-energy with fast rise times and sharp peaks, which can cause both behavioral changes and injury, depending on the marine mammal's proximity to the sound source and a variety of environmental and biological conditions (Dahl et al., 2015; Nedwell et al., 2007). Typically, sound pressure decreases, and pulse duration increases as distance from the noise source increases (Bailey et al., 2010). Measurements have also indicated that when at least two km from the pile driving noise source, the noise is at peak energy around 100 Hz to two kHz (Bailey et al., 2010). A study simulating pile driving in a proposed offshore wind location found that pile driving emitted a noise frequency between 100-300 Hz and the maximum sound pressure level was measures at 178-188 dB and the source level was 220 dB re 1µPa to 230 dB re 1µPa (Wu et al., 2017). A spectral plot comparing noise generated by impact and vibratory pile driving activities is included in **Figure 6-48** (Matuschek & Betke, 2009). Noise generated by vibratory hammers would be continuous, but with lower energy without sharp peaks; therefore, vibratory hammering would likely result in behavioral effects only. These behavioral effects may occur at farther ranges, and may differ among individuals (Graham et al., 2017; Southall et al., 2016; Ellison et al., 2012). Thresholds typically used for behavioral responses for all marine mammals is 160 dB re 1 µPa for impulsive sounds and 120 dB re 1 µPa for prolonged sounds, which makes for a larger impact range zone (Gomez et al., 2016). Vibratory hammering is oftentimes used instead of impact hammering as a mitigative measure (Graham et al., 2017); however, vibratory hammering may require a longer construction phase which could cause cumulative sound energy that exceeds non-impulsive thresholds for marine mammals. Regarding pile driving activities for the proposed Project, pile driving would typically last up to four hours per pile for both impact or vibratory hammers, with periods of non-piling for moving of equipment and other breaks (see Section 3.3.1, Substructures, for more information on proposed pile driving activities).

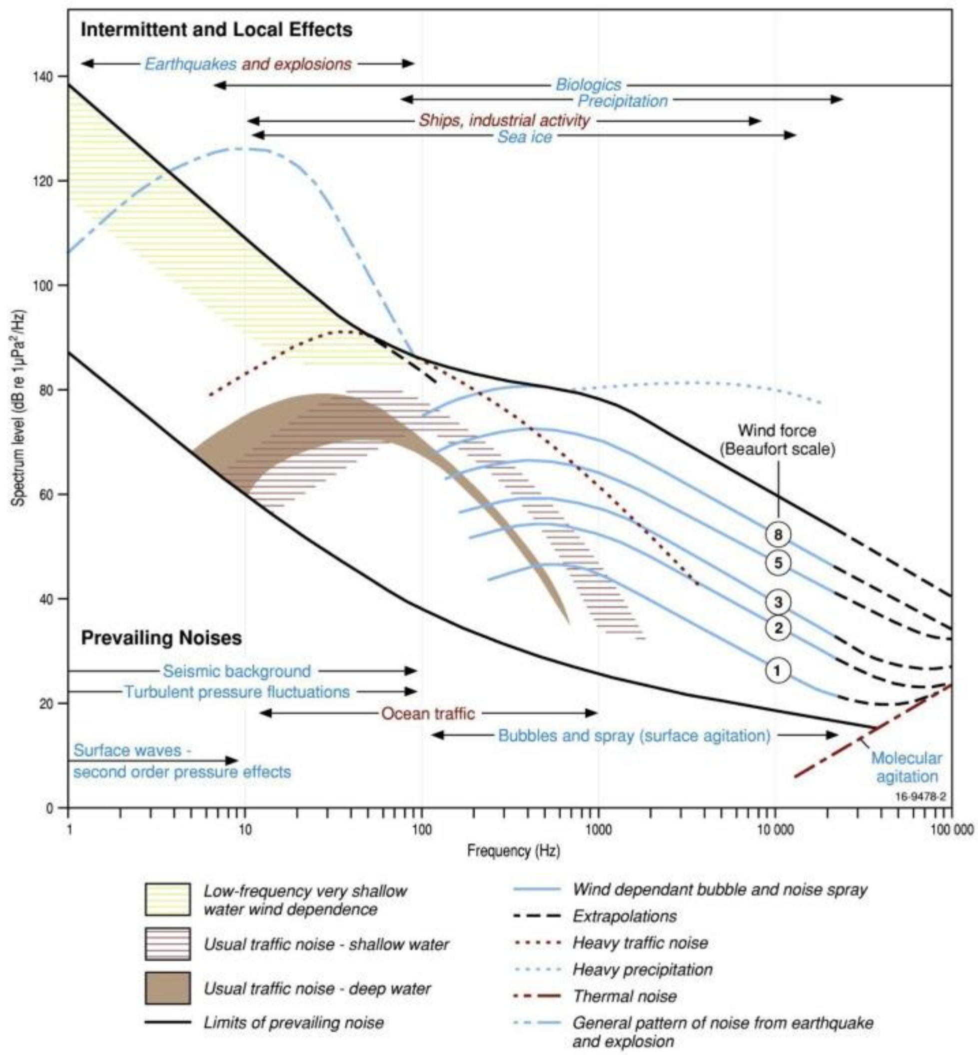


Source: Matuschek & Betke, 2008

FIGURE 6-48. SPECTRAL PLOT OF IMPACT AND VIBRATORY PILE DRIVING NOISE

According to NMFS's thresholds for injury and behavioral harassment, harassment risk to marine mammals is likely to occur from a maximum of approximately 0.27 nm (0.5 km) for potential injury to several kilometers (km) for potential behavioral disturbances based on modeled and measured noise from pile driving (Nedwell et al., 2007). Harbor porpoises, for example, have been observed eliciting a behavioral response from pile driving from up to 14 nm (26 km) away from the sound source (Brandt et al., 2011). However, field studies have indicated that distances over which injury might occur may be smaller (Bailey et al., 2010).

The risk to marine mammals from pile driving noise must also be considered in the context of existing ambient noise in the Project Area. Other anthropogenic noise sources could potentially mask intense pile driving noises at larger distance from the pile driving site (**Figure 6-49**). Kraus et al., (2016) recorded ambient noise in the MA/RI WEA from 2011 to 2015 and found sound levels in the 70.8 to 224 Hz frequency band with variations between 96 and 103 dB re 1 µPa during 50 percent of the recording time.



Source: Carroll et al., 2017

FIGURE 6-49. SPECTRAL PLOT OF MARINE AMBIENT NOISE FROM NATURAL AND ANTHROPOGENIC SOURCES

For low-frequency noises such as pile driving, mid-frequency cetaceans are known to be less sensitive than high- and low-frequency cetaceans (Finneran, 2015; BOEM, 2013). Baleen whales and seals are low-frequency specialists and are likely to be particularly sensitive to the low frequencies of pile driving noise; they will be able to detect the noise at farther distances than mid- and high-frequency cetaceans (Finneran, 2015; Kastelein et al., 2013). Although low-frequency marine mammals may hear pile driving noise at greater distances than mid- and high-frequency cetaceans, they are likely less vulnerable to acute noise exposure than high-frequency cetaceans because the peak energy of noise must be higher for low-frequency cetaceans to experience PTS (Southall et al., 2019; Morandi et al., 2018; Finneran, 2015). Risk from pile driving noise to mid-frequency cetaceans is low as these species are relatively less sensitive to impulsive noises compared to other cetaceans (Southall et al., 2019; Finneran, 2015); it is expected that mid-frequency cetaceans would have to be in close proximity to pile driving activities (110-280 m; Ford et al., 2017) for the sound energy to be high enough to affect behavior or cause injury.

NARWs are of particular concern because they are listed as endangered under the ESA, and the Western Atlantic stock is very low and currently in decline due to unusual mortality events and anthropogenic effects (NMFS, 2019; see Section 6.8.1). In addition, the NARW's range is relatively limited compared to other baleen whale species, with a hearing range between 10 Hz and 22 kHz (Parks et al., 2007). NARWs have been documented to modify the amplitude of their calls during periods of increased ambient noise, suggesting some ability to adapt to temporarily noisy environments (Parks et al., 2011). However, NARWs may experience chronic stress associated with relatively constant anthropogenic noise already existing in their environment which could be compounded by Project activities (Rolland et al., 2012). To reduce impacts to NARW and other marine mammals, Mayflower Wind does not intend to conduct pile driving activity from January 1 through April 30. Mayflower Wind's proposed suite of mitigation measures are expected to reduce risk to NARWs (see Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan).

Marine mammal abundance and distribution can also play a role in exposure to pile driving noise. Present year-round in the Project Area, gray seals spend periods of time on land at haul-outs and breeding sites where they will not be subject to construction noises from the Project Area. Likewise, harbor seals would not be subject to underwater noise effects while on land. The risk of behavioral disturbances is difficult to quantify, but these disturbances may result in displacement and/or decline in foraging success in the Project Area. The estimated density of cetaceans suggests that baleen whale abundance is low in the Project Area, with BIAs located outside the Project Area (LaBrecque et al., 2015).

An Underwater Acoustic Assessment completed for the proposed Project included modeling of the predicted introduced sound energy that will be created from pile driving activities (Appendix U2, Underwater Acoustic Assessment). Results of the assessment found that proposed impact driving will generate peak sound energy that varies based on the foundations utilized by the proposed Project. The assessment concluded that the number of exposures above injury thresholds are expected to be low overall for marine mammals but will vary by frequency hearing group and differences in local mean monthly density. Appendix U2 presents species-specific exposure ranges for low- to high-frequency cetaceans and pinnipeds during the worst-case realistic and maximum pile driving scenarios for a monopile and piled jacket foundation. Results are shown with broadband attenuation of 0, 6, 10, and 15 dB. Appendix U2 also presents the worst-case mean number of individual animals expected to exceed Level A and Level B thresholds during realistic and maximum pile driving scenarios, assuming broadband attenuation of 0, 6, 10, and 15 dB during the summer season. For more detailed information on the assessment methodology and results in all proposed pile driving scenarios, see Appendix U2, Underwater Acoustic Assessment.

With respect to airborne sound, hauled-out seals could potentially be affected by pile driving activities. A Belgian wind farm study evaluated how far pile driving noise may travel from offshore pile driving locations and if that noise meets behavioral disturbance criteria. The results found that noise effects are expected to be very low at distances over 5.4 nm (10 km) (Van Renterghem et al., 2014). The closest major seal haul-out site to the Project Area where pile driving would take place is on the northwestern side of Nantucket Island, which is approximately 24.3 nm (45 km) from the Project Area. Given the distance from the Project Area, airborne noise from pile driving is likely to not reach NOAA thresholds for Level B Harassment (disturbance) of seals at major haul-out sites.

6.8.2.1.2 Vessel Noise

Ship engines and vessel hulls emit continuous sound, generally ranging from 150 to 200 dB re 1 µPa m at low frequencies below 1,000 Hz, which overlaps with the hearing frequency range for all marine mammals (Erbe et al., 2019; NSF & USGS, 2011). Researchers have reported a change in the distribution and behavior of marine mammals in areas experiencing increased vessel traffic, likely due to increases in ambient noise from concentrated vessel activity (Mikkelsen et al., 2019; Tsujii et al., 2018; Pirotta et al., 2012; Erbe, 2002a; Jelinski et al., 2002). Possible effects from vessel noise are variable and would be contingent on species and other factors such as the marine mammal's activity, its proximity to the vessel, and its habituation to the vessel traffic noise and vessel movements.

For details on vessel operations, including trips per year, during construction and O&M phases of the Project, see Section 3, Description of Proposed Activities.

Because vessel traffic throughout the MA/RI WEA is typically high, marine mammals local to the area are presumably habituated to common vessel noise (BOEM, 2013). NARWs are known to continue to feed in Cape Cod Bay despite disturbance from passing vessels (Nowacek et al., 2004; Brown & Marx, 2000). Construction vessels will likely be stationary on site for significant periods of time; large construction vessels will likely travel to and from the Project Area at low speeds, potentially producing lower noise levels than vessel transit at higher speeds (Leaper, 2019; Pine et al., 2018; McKenna et al., 2013). See Section 3.3.14, Vessels, Vehicles, and Aircrafts, for more information on proposed Project vessels. Marine mammals are likely to be exposed to vessel traffic noise because Project vessels are likely to occur in the Project Area for much longer periods of time than typical vessels that frequent the area. However, marine mammals in the Project Area are regularly subjected to commercial shipping noise and would potentially be habituated to vessel noise as a result of this exposure (BOEM, 2013).

6.8.2.1.3 Cable-Laying Noise

Noise effects from inter-array cable installation and offshore export cable installation are expected to be comparable to vessel noise emitted from increased vessel traffic in the Project Area.

6.8.2.1.4 Operational WTG Noise

Underwater noise from constructed WTGs is low-energy and low-frequency (Nedwell et al., 2003); operational underwater noise from WTGs is generally emitted below 700 Hz with a source level of 80 to 150 dB re 1 µPa @ 1 m (Pangerc et al., 2016; Betke et al., 2004). Operational WTG measurements taken at the Block Island Wind Farm in BOEM OCS Study 2019-028 gives overall average underwater SPL RMS sound levels ranging from 112.2 dB re 1 µPA at a wind speed of 2 m/s to 120.6 dBA re 1 µPa at wind speeds 13 m/s and greater. The study concluded that there was no risk of temporary or permanent hearing damage (PTS or TTS) expected even if the (marine species) receptor remained in the water at 50 m (164 ft) from the WTG for a full 24-hour period (HDR 2019). These noise levels can vary based on the type of WTG foundation used and wind conditions. Since known WTG noise is below the TTS ranges for marine mammals, physical disturbances from operational WTG noise are not expected to occur; however, research on the effects of operational WTGs on marine mammals is limited and is difficult to examine (Norro & Degraer, 2016; Bergström et al., 2014; Madsen et al., 2006). Additionally, due to ambient noise in the Project Area, marine mammals are unlikely to be able to detect sounds generated by WTGs unless they are in close proximity to WTG foundations. A study on noise emissions from three different WTG types found that WTG noise was only measurable above ambient noise levels at frequencies below 500 Hz (Tougaard et al., 2009); operating WTG noise has been found to approach ambient levels at approximately 1,640 ft (500 m) from the foundation (Thomsen et al., 2015). A study on the behavioral effects of operational WTGs on harbor porpoises in the United Kingdom found no evidence of harbor porpoise behavioral disturbance while WTGs were in operation (Russell et al., 2016). In fact, the study observed an increase of harbor porpoise usage in the area compared to prior to construction, but it was determined that the higher usage was not caused by the wind farm. Marine mammals may habituate to the low WTG noise levels produced in the Lease Area, especially species that typically occur in areas with ambient noise emissions similar to those generally emitted by WTGs and thus would be unlikely to respond to WTG noise (Scheidat et al., 2011).

6.8.2.1.5 Construction

Introduced sound during the construction phase will include pile driving noise, noise from inter-array cable and export cable installation, and vessel noises from Project vessels. Marine mammals exposed to pile driving sounds from the proposed Project are likely to exhibit a behavioral avoidance response and may leave the construction area during the relatively short, intermittent pile driving periods. Potential effects are expected to be seasonal, temporary and localized. Pile driving noise exposure levels are expected to vary by species seasonality and occurrence in the Lease Area. Potential effects to marine mammals from pile driving noise can be reduced with the implementation of appropriate mitigation and BMPs (see Section 16 and Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan).

Noise within the proposed Project's export cable corridors due to cable installation is comparable to vessel noise and is expected to have an insignificant effect on marine mammal behavior. High-frequency (greater than200 kHz) and low- and mid-frequency (less than 200 kHz) acoustic geophysical surveys could be conducted during construction activities to inform the WTG and cable installation process. With appropriate monitoring and mitigation procedures, marine mammals are unlikely to be exposed to geophysical survey noise.

6.8.2.1.6 Operations and Maintenance

Maintenance and repairs to the Project WTGs could generate noise that temporarily displaces nearby marine mammals, but effects are expected to be insignificant. Marine mammals may habituate to the low WTG noise levels produced in the Lease Area, especially species that typically occur in areas with ambient noise emissions similar to those generally emitted by WTGs, and thus would be unlikely to respond to WTG noise (Scheidat et al., 2011). Vessel traffic during the O&M phase is expected to be lower compared to vessel traffic during the construction and decommissioning phases of the proposed Project; therefore, exposure to vessel noise is expected to be lower during O&M and effects on marine mammals from vessel noise are not anticipated.

6.8.2.1.7 Decommissioning

Decommissioning is expected to have similar levels of vessel traffic as the construction phase of the proposed Project; however, pile driving is not required for the decommissioning phase of the proposed Project. Therefore, noise is not expected to be a primary risk during decommissioning. During the decommissioning phase of the proposed Project, WTGs and their foundation components will be removed from the Project Area. Noise produced by such equipment is not comparable to pile driving and is not expected to disturb or harm marine mammals more than general vessel traffic noise (Pangerc et al., 2016; Reine et al., 2012). See Section 3.3.1, Substructures, and 3.3.2, Wind Turbine Generator, for more information on substructure and WTG foundation decommissioning activities for the proposed Project.

Effects of noise produced from removing the cables would be short-term, localized to the proposed export cable corridors, and similar to those experienced during cable installation. See Section 3.3.5, Offshore Export Cables, for more information on proposed offshore export cable decommissioning activities. The Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there would be no effects to the environment.

High frequency (greater than 200 kHz) and low to medium frequency (less than 200 kHz) acoustic geophysical surveys could be conducted during decommissioning activities to inform proper removal of the WTG, cables, and other Project components. As with the construction phase geophysical surveys, appropriate monitoring and mitigation procedures will be observed, and the effects on marine mammals are expected to be low.

6.8.2.2 Vessel Operations

TABLE 6-67. FINDINGS SUMMARY—VESSEL OPERATIONS

Sources of Changes in Vessel Traffic	Summary
Construction	
Increased vessel traffic – construction Project vessels	• Physiological effects are not expected due to the relatively low amount of time marine mammals spend at the ocean surface and avoidance behaviors • Behavioral effects may occur for marine mammals (avoidance behaviors/stress response) but would be temporary • Due to their common occurrence, exposure to changes in vessel traffic would be highest for sei whales, fin whales, NARWs, and humpback whales • Effects of changes in vessel traffic will be avoided, minimized, or mitigated by appropriate mitigation measures
O&M	
Increased vessel traffic – O&M Project vessels	• Physiological effects are not expected for marine mammal species • Behavioral effects may occur for marine mammals (avoidance behaviors/stress response) but would be temporary.
Decommissioning	
Increased vessel traffic – decommissioning Project vessels	• Physiological effects are not expected due to the relatively low amount of time marine mammals spend at the ocean surface and avoidance behaviors • Behavioral effects may occur for marine mammals (avoidance behaviors/stress response) but would be temporary • Due to their common occurrence, exposure to changes in vessel traffic would be highest for sei whales, fin whales, NARWs, and humpback whales • Effects of changes in vessel traffic will be avoided, minimized, or mitigated by appropriate mitigation measures

Vessel strikes resulting in serious injury or death is a common cetacean mortality risk that can occur, mainly due to large commercial shipping container vessels. However, a variety of vessel classes have been involved in recorded strikes of marine animals, ranging from vessels less than 49 ft (15) m to very large motorized vessels greater than 262 ft (80 m, Schoeman et al., 2020). The vessels typically used during offshore wind development are turbine installation vessels (246 to 525 ft [75 to 160 m] in length), cable-lay vessels (82 to 492 ft [25 to 150 m] in length), heavy lift vessels (328 to 591 ft [100 to 180 m] in length), tug boats (66 to 164 ft [20 to 50 m] in length), barges (82 to 328 ft [25 to 100 m] in length), offshore supply vessels (148 to 361 ft [45 to 110 m] in length), personnel transport vessels (66 to 230 ft [20 to 70 m] in length), and survey vessels (49 to 525 ft [15 to 160 m] in length, Douglas-Westwood, LLC., 2013). See Section 3.3.14, Vessels, Vehicles, and Aircrafts, for more information on proposed Project vessels.

Vessel strikes resulting in serious injury or death to whales typically occur when the vessel is traveling at speeds above 7.2 m/s (a14 knots); vessel strikes at speeds exceeding 9.3 m/s (18 knots) are almost certain to be lethal to marine mammals (Conn & Silber, 2013; Vanderlaan & Taggart, 2007; Laist et al., 2001). Although improbable, the greatest risk of a vessel strike would most likely occur during transit to and from the Project Area when Project vessels may be traveling at higher speeds. Baleen whales are more at risk to vessel strikes than any other marine species due to their size and extended time spent at the surface feeding or recovering from deep dives (Constantine et al., 2015; McKenna et al., 2015; Wiley et al., 1995). A review of stranding deaths of seven large whale species from 1975 to 1996 along the U.S. Atlantic Coast found that 67 percent of sei whale, 33 percent of fin whale, 33 percent of NARW, 8 percent of humpback whale, and 5 percent of minke whale stranding deaths included signs of vessel collision (Laist et al., 2001). Due to their common occurrence in the MA/RI WEA, and that they do not appear to avoid vessel strikes as well as smaller marine mammals, exposure to changes in vessel traffic would be highest for sei whales, fin whales, NARWs, and humpback whales. Several studies have reported changes in marine mammal distribution and behavior in high traffic areas (Nowacek et al., 2004; Erbe, 2002a; Jelinski et al., 2002). Marine mammal avoidance of construction and operation vessels and pile driving noise could result in reduced vessel collision risk. Lower vessel speeds have been shown to reduce the risk of collision-related mortality for NARWs (Conn & Silber, 2013) and are likely to be beneficial to other marine mammals as well (Redfern et al., 2019). Risk of collision with vessels in the Project's proposed export cable corridors is expected to be similar to the risk experienced with construction activities in the Lease Area; however, because the proposed export cable corridors are closer to shore, vessel transit times would decrease, reducing vessel collision risk. To reduce collision risk, vessel speed limits detailed in Section 16 and Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan will be observed during Project activities; Project vessels will employ PSOs to ensure vessels remain a sufficient distance away from marine mammals that are observed in the Project Area. For details on vessel operations, including trips per year, during construction and O&M phases of the Project, see Section 3, Description of Proposed Activities.

6.8.2.2.1 Construction

Potential exposure of marine mammals to vessels used during the construction phase is considered low due to the high seasonality of marine mammals present in the Project Area and the low amount of time marine mammals spend at the surface. There is a possibility that marine mammals may alter their behavior while in close proximity to vessels, but this avoidance behavior is expected to decrease vessel collision risk and is not expected to significantly affect marine mammals in the Project Area. Project mitigation measures (see Section 16 and Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan) designed to reduce or eliminate vessel strikes with marine species will be implemented to further reduce potential effects of increased vessel traffic.

6.8.2.2.2 Operations and Maintenance

Changes in vessel traffic during the O&M phase of the proposed Project are expected to have less effects on marine mammals than vessel traffic changes during the construction and decommissioning phases of the proposed Project. Risk of vessel collision with marine mammals during the construction phase is low; therefore, the risk of vessel collisions for marine mammals is expected to be low as well.

6.8.2.2.3 Decommissioning

Vessel traffic during Project decommissioning is expected to be similar to vessel traffic during the construction phase; therefore, the risk from vessel collisions to marine mammals during construction and decommissioning will be similar. The Project's export cables may be left in place to minimize environmental effects, which would mean a reduction in vessel traffic along the Project's proposed export cable corridors. See Section 3.3.5, Offshore Export Cables, for more information on proposed export cable decommissioning activities. Collision risk from removing the cables would be minimal and localized to the proposed export cable corridors, and similar to those experienced during cable installation.

6.8.2.3 Seabed (or Ground) Disturbance

TABLE 6-68. FINDINGS SUMMARY – SEABED DISTURBANCE

Sources of Seabed Disturbance	Summary
Construction	
Seafloor preparation Pile driving Foundation and scour protection installation Inter-array cable installation Export cable installation Vessel anchoring (including spuds)	• Physiological effects are not expected for marine mammals • Some avoidance behavior may be exhibited by marine mammals; however, seabed disturbance is unlikely to affect marine mammals since they often reside in turbid waters • Any effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures
Decommissioning	
Seafloor preparation Foundation and scour protection removal	• Physiological effects are not expected for marine mammals • Some avoidance behavior may be exhibited by marine mammals; however, seabed disturbance is unlikely to affect marine mammals since they often reside in turbid waters • Any effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures

Seafloor disturbance will occur during the installation of the WTG and OSP foundations, inter-array cables, and offshore export cables. During the operations phase, potential disturbance will be caused by the presence of the WTG and OSP foundations and anchored maintenance vessels. The WTG and OSP foundations and scour infrastructure will change the seafloor and could create an artificial reefing effect that results in colonization by benthic species that could increase prey availability for marine mammals, particularly harbor porpoises and pinnipeds (Russell et al., 2014; Todd et al., 2009). There is very little information available about the effects of seabed disturbance on marine mammals. Some avoidance behavior may be exhibited by marine mammals that frequent the Project Area during these activities; however, seabed disturbance is unlikely to affect marine mammals since they often reside in turbid waters (Todd et al., 2014). Furthermore, seabed disturbance is expected to be short-term and localized, and Project mitigation measures (Section 6.9.2.5) will minimize seabed disturbance and turbidity.

6.8.2.3.1 Construction

During the construction phase of the proposed Project, some avoidance behavior may be exhibited by marine mammals in the Project Area during activities likely to cause seabed disturbance. However, seabed disturbance is expected to be short-term and localized. Project mitigation measures will minimize the potential effects of seabed disturbance on marine mammals (see Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan).

6.8.2.3.2 Decommissioning

During the decommissioning phase of the proposed Project, seabed disturbance effects are expected to have similar levels of seabed disturbance as the construction phase of the proposed Project. WTGs and their foundation components will be removed from the Project Area. See Section 3.3.1, Substructures, and 3.3.2, Wind Turbine Generators, for more information on proposed substructure and WTG decommissioning activities. This process is not expected to disturb or harm marine mammals more than general vessel traffic noise, and turbidity will be minimized therefore foraging will be untouched.

The effects on marine mammals from removing offshore export cables will be localized to the proposed export cable corridors and similar to those experienced during construction. See Section 3.3.5, Offshore Export Cables, for more information on proposed offshore export cable decommissioning activities. The Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there will be no effects from decommissioning.

6.8.2.4 Habitat Disturbance and Modification

TABLE 6-69. FINDINGS SUMMARY – HABITAT DISTURBANCE AND MODIFICATION

Sources of Habitat Disturbance and Modification	Summary
Construction	
Foundation and scour protection installation Offshore export cable installation	• Physiological effects for marine mammals are not expected to occur • Behavioral effects may occur due to changes in prey availability; these effects would be temporary and localized
O&M	
Benthic colonization of Project foundation areas	• Foundation areas (and potentially some areas along the export cable corridors) will create artificial reef habitat that may have a positive effect on marine mammals, particularly harbor porpoises and pinnipeds • Attraction of fish to artificial reefs may attract increased vessel traffic from fisheries and recreational activity, which could increase vessel strike risk for marine mammals
Decommissioning	
Foundation and scour protection removal	• Physiological effects for marine mammals are not expected to occur • Behavioral effects may occur due to changes in prey availability; these effects would likely be temporary and localized

Marine mammal populations have been affected by habitat loss and modification, largely due to changes in spatial distributions and prey availability due to warming oceans, overfishing, and resource extraction in critical habitats (Albouy et al., 2020; Harwood, 2001). Project activities may affect marine mammals that utilize Massachusetts and Rhode Island waters for migration and essential foraging, such as fin whales, humpback whales, NARWs, and sei whales. However, because BIAs for these species are located outside of the Project Area, there is only the potential for indirect effects to these areas. Effects from habitat disturbance are expected to be temporary and localized during the construction phase of the proposed Project due to noise disturbances (Dähne et al., 2017).

6.8.2.4.1 Construction

The construction phase of the proposed Project is expected to affect prey availability in the Project Area, which may cause marine mammal habitat disturbance. However, habitat disturbance during the construction phase is expected to be temporary and reversible.

6.8.2.4.2 Operations and Maintenance

Submerged structures in the ocean, comparable to WTGs, are known to create artificial reef habitat that may have a positive effect on marine mammals, particularly harbor porpoises and pinnipeds (Russell et al., 2014; Todd et al., 2009). Artificial reef structures attract fish and other marine invertebrates, which may in turn attract marine mammals for foraging opportunities. However, this attraction of fish to artificial reefs may attract increased vessel traffic from fisheries and recreational activity, which could increase vessel strike risk for marine mammals (Kraus et al., 2019). Implementation of mitigation and BMPs (see Section 16 and Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan) will minimize these potential effects to marine mammals.

6.8.2.4.3 Decommissioning

During the decommissioning phase of the proposed Project, habitat disturbance and modification are expected to similarly affect marine mammals as habitat disturbance and modification during the construction phase of the proposed Project. The removal of the WTGs during decommissioning may affect marine mammal prey availability, but the disturbance is expected to be temporary and reversible following Project decommissioning.

6.8.2.5 Entanglement

TABLE 6-70. FINDINGS SUMMARY – ENTANGLEMENT

Sources of Entanglement	Summary
Construction, Decommissioning	
Lines and anchoring equipment utilized during construction and decommissioning activities	• Physiological and behavioral effects are not expected to occur for marine mammals • Any potential entanglement effects will be avoided, minimized, or mitigated by appropriate mitigation measures

There are currently no records of marine mammal entanglement occurring at any offshore renewable energy sites. Research assessing marine mammal entanglement risk at offshore renewable energy developments is still limited and preliminary; available studies have generally found that entanglement risk to marine mammals at offshore wind farms is low and can be further reduced by following mooring line designs known to pose the least amount of entanglement risk (Benjamins et al., 2014). Given the types of equipment and structures that are known to create potential entanglement risk are generally related to finishing activity and will not be used here, the effects of marine mammal exposure to entanglement risk in the Project Area is considered to be insignificant.

6.8.2.5.1 Construction

Marine mammal exposure to entanglement during the construction phase is expected to be very low. The proposed Project will employ industry standard mitigation methods to reduce entanglement risk (see Section 16).

6.8.2.5.2 Decommissioning

Marine mammal exposure to entanglement during decommissioning is expected to be similar to potential entanglement exposure during the construction phase; therefore, effects of entanglement during decommissioning are unanticipated. The proposed Project will employ industry standard mitigation methods to reduce entanglement risk (see Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan).

6.8.2.6 Planned Discharges

TABLE 6-71. FINDINGS SUMARRY – PLANNED DISCHARGES

Sources of Planned Discharges	Summary
Construction, O&M, Decommissioning	
Planned vessel discharges	• Potential effects to marine mammals will likely be insignificant • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of discharges and spills

Vessels used during offshore construction activities are known to routinely release bilge water, engine cooling water, deck drainage, and/or ballast water. Such releases are temporary and would be immediately dispersed and diluted. Due to the expected and controlled dispersion and dilution of planned discharges, potential effects to finfish and invertebrate species are expected to be insignificant. See Section 3.3.14, Vessels, Vehicles, and Aircrafts, for more information on proposed Project vessel operations and Section 3.3.15, Health, Safety, and Environmental Protections, for more information on the environmental protection measures for the proposed Project.

6.8.2.6.1 Construction

Due to the expected dispersion and dilution of planned discharges, planned vessel discharges during the construction phase of the Project are not expected to have a significant effect on marine mammals in the Project Area.

6.8.2.6.2 Operations and Maintenance

There is potential for entrapment of juvenile seals within the vertical intake pipes of the CWIS, based on historical evidence of entrapment in cooling water intakes at other facilities. In Southern California, harbor seal and California sea lion takes have occurred due to entrapment in cooling water intakes for coastal power plant facilities (Mehta, 2000; SWFSC, 2017). Takes of harbor, hooded, harp, and gray seals have also been recorded from intakes of a coastal power plant on the East Coast withdrawing water from offshore New Hampshire (North Atlantic, n.d.). Entrapment may occur at intakes that do not have bar racks to prevent animals from entering the intake pipe. Mayflower Wind will consult with EPA and NMFS to ensure appropriately sized bar racks are included in the engineering design to minimize the risk of entrapment at the CWIS.

Indirect impacts of OSP operations to marine mammals include potential loss of prey items resulting from entrainment of important prey species. A primary concern for marine mammal prey entrainment includes the risk of key forage species upon which threatened and endangered whale species feed on in offshore Massachusetts waters, particularly copepods (*Calanus* spp. and *Pseudocalanus* spp.) and other zooplankton. Previous studies have illustrated how occurrence and distribution of the critically endangered NARW in New England waters and the Gulf of St. Lawrence are influenced by presence of *Calanus* spp. copepods (Payne et al., 1990; Sorochan et al., 2021). The North Atlantic Right Whale has also been a focus of recent prey entrainment impact analysis for the Northeast Gateway Project. Bioenergetic modelling of prey biomass—estimating the amount of prey needed to meet metabolic requirements of individual right whales in waters off Massachusetts—estimated the daily and annual consumption rates were 642 kg/day and 46,587 kg/year (Northeast Gateway, 2012). Those rates were expected to be orders of magnitude greater than any reasonable estimates of prey removals by the Northeast Gateway Project cooling operations, which utilizes substantially greater cooling water flow (up to 56 MGD). Zooplankton and other forage species removals were considered negligible, compared to estimated requirements for whales at the population level. The OSP operations utilizing considerably less cooling water (up to 10.2 MGD) would be expected to entrain proportionally lower numbers of prey, which therefore would also be considered as negligible.

To minimize potential impacts to zooplankton from impingement and entrainment, the northernmost HVDC converter OSP will be located outside of a 10 km buffer of the 30 m isobath from Nantucket Shoals.

Planned vessel discharges during the O&M phase of the proposed Project are not expected to have a significant effect on marine mammals in the Project Area.

6.8.2.6.3 Decommissioning

Effects associated with planned discharges in the Project Area during decommissioning are expected to be similar to the effects described in the construction phase of the proposed Project.

6.8.2.7 Accidental Events

TABLE 6-72. FINDINGS SUMMARY – ACCIDENTAL EVENTS

Sources of Accidental Events	Summary
Construction, Operations & Maintenance, Decommissioning	
Marine debris Unplanned vessel discharges	• Potential effects to marine mammals will likely be insignificant • In the unlikely event the proposed Project generates marine debris, marine debris would be removed in compliance with all regulatory requirements • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of discharges and spills

As noted in Section 3.4, Summary of Impact Producing Factors, discharge of marine debris is not expected to occur during proposed Project activities. The EPA and other relevant federal organizations implement oceanic protections to prevent further marine debris from entering the U.S. marine environment. In the unlikely event that the proposed Project generates marine debris, the proposed Project will ensure that personnel remove debris in accordance with USCG and EPA regulations (BOEM, 2019; EPA, 2017; Marine Debris Research, Prevention, and Reduction Act, 2006). See Section 3.3.15, Health, Safety, and Environmental Protections, for more information on the environmental protection measures developed for the proposed Project.

Project vessels may experience unplanned releases of oil, solid waste, or other materials. Increased vessel traffic in the area of construction and at nearby ports may increase the likelihood of unplanned releases. Accidental spills and unplanned discharges are not expected to be produced by the proposed Project during the construction, O&M, or decommissioning phases. In the event an unplanned spill does occur in the Project Area, the proposed Project will comply with the regulatory requirements related to the prevention and control of discharges and spills, consistent with MARPOL regulations as documented in the proposed Project's OSRP (Appendix AA).

6.8.2.7.1 Construction

Discharge of marine debris is not expected to occur during proposed construction phase activities. Increased vessel traffic in the area of construction and at nearby ports may increase the likelihood of unplanned releases. Due to the rare occurrence of unplanned discharges, unplanned vessel discharges during the construction phase of the Project are not expected to have a significant effect on marine mammals in the Project Area. In the unlikely event unplanned discharges occur in the Project Area, Mayflower Wind will comply with MARPOL regulations as documented in the OSRP (Appendix AA).

6.8.2.7.2 Operations and Maintenance

Discharge of marine debris is not expected to occur during proposed O&M phase activities. Unplanned vessel discharges during the operations phase of the proposed Project are not expected to have a significant effect on marine mammals in the Project Area. In the unlikely event unplanned discharges occur in the Project Area, Mayflower Wind will comply with MARPOL regulations as documented in the OSRP (Appendix AA).

6.8.2.7.3 Decommissioning

Discharge of marine debris is not expected to occur during proposed decommissioning phase activities. Effects associated with unplanned discharges in the Project Area during decommissioning are expected to be similar to the effects described in the construction phase of the proposed Project.

6.8.3 Conclusion

There are 12 marine mammal species that commonly occur and have the potential to be exposed to IPFs in the Project Area. Twenty species (blue whale, sei whale, Atlantic spotted dolphin, Pantropical spotted dolphin, white-beaked dolphin, Risso's dolphin, striped dolphin, pilot whale, dwarf and pygmy sperm whale, killer whale, Cuvier's beaked whale, *Mesoplodon* beaked whales, harp seal, hooded seal, and West Indian Manatee) are uncommon or rare, and therefore, co-occurrence with Project activities that cause IPFs is expected to be highly unlikely. Other than seals and humpback whales, the probability of marine mammal occurrence in the Sakonnet River and Mount Hope Bay is low.

All potential effects to marine mammals should be localized in and near the Project Area, which comprises only a small portion of the potentially affected species' ranges. Although there is potential risk for vessel collision, mitigation and implementation of BMPs will reduce this risk. No marine mammal mortality is expected as a result of the proposed Project.

Marine mammals considered to be common (see **Table 6-62**) in the region are more likely to be exposed to IPFs such as introduced sound, vessel operations, seabed disturbance, habitat disturbance and modification, marine debris, entanglement, and planned and unplanned discharges because of their extensive use of the Project Area. However, with the implementation of mitigation measures at the proposed Project, it is unlikely that population-level effects will occur for the species. Mid-frequency cetaceans (i.e., common bottlenose dolphin, short-beaked common dolphins, Atlantic white-sided dolphins) are considered less sensitive to pile driving and vessels and may already be habituated to vessel activity (Finneran, 2016).

For ESA-listed large cetaceans such as sei whales, fin whales, and NARWs, there is no anticipated injury or mortality in individuals, but some disturbance is anticipated. Behavioral responses for these species are likely limited to short-term disruption or displacement related to construction noises (i.e., pile driving). Similar responses would be anticipated for humpback whales. BIAs for feeding occur near but not within the Project Area for all marine mammal species (LaBrecque et al., 2015).

NARWs are endangered under the ESA and are in decline (Pace et al., 2017); because of its rarity, the species is more vulnerable to population-level effects than other marine mammals in the region. NARWs may experience some increased stress levels due to additional anthropogenic noise in their environment (Rolland et al., 2012); however, unlike commercial vessel traffic noise, pile driving noise in the Project Area will be limited to a small portion of the NARW range and be of short duration. Project mitigation, which will likely be included in future MMPA permits and Best Management Practices, should minimize risks to NARW individuals and the overall population. NARWs are vulnerable to vessel strikes (Laist et al., 2001), but laws governing vessel speeds, PSO monitoring and other collision avoidance guidelines are expected to result in reduced vessel strike risk.

Harbor porpoises are high-frequency cetaceans, which make them more susceptible to injury or feeding habitat displacement from high-frequency pile driving noise (Finneran, 2015). However, feeding can occur in nearby areas if harbor porpoises are temporarily displaced; these areas may even be preferred compared to the Project Area.

Harbor and gray seals are low-frequency specialists (Kastelein et al., 2009; Kastak & Schusterman, 1999). Gray and harbor seals are present year-round in the Project Area and spend periods of time on land at haul-outs and breeding sites where they would not be subject to stressors from Project activities. Both species primarily occur farther north than the Project Area, limiting the numbers of individuals with potential exposure to pile driving (Hayes et al., 2017).

Many marine mammals have a seasonal component to their occurrence in the Project Area. Humpback and fin whales are mainly present in the spring and summer (BOEM, 2013), and NARWs are mainly present in the Project Area in the spring and fall (Kraus et al., 2016). Sei whales are also mainly present in the spring and summer but are less common than the other baleen whales due to their preference for more pelagic, colder waters. Blue whales are expected to be a rare migrant in the Project Area during the winter. Harbor porpoises and harbor seals tend to migrate from the Project Area in the summer. Potential risk to seasonal marine mammal species from Project activities can be minimized or offset through mitigation strategies, such as applying time-of-year restrictions to construction and operation activities in the Project Area.

In summary, the most likely IPF to affect the greatest number of marine mammal species throughout the life-cycle of the Project will be disturbance from pile driving noise during the construction phase. Co-occurrence probability is insignificant for rare species (such as blue whale and harp seal), unlikely for uncommon species (such as sei whales and Risso's dolphin) but is likely for common species in seasons during which they are present. Potential effects from noise are expected to be brief and will likely lead to some habituation and adaptation to the noise source. Effects will be localized in the Project Area and nearby waters, which make up only a small portion of the marine mammal ranges. The two most directly vulnerable species are NARWs and harbor porpoises. However, both species are predicted to occur in higher abundance outside of the Project Area. Mitigation and BMPs will be implemented to reduce risk to levels that meet regulatory requirements under ESA, MMPA, MESA, and other applicable laws.

The mitigation and monitoring measures identified above are similar to those included in Mayflower Wind's lease and have been required by federal agencies for other types of offshore infrastructure projects. Mayflower Wind's final suite of measures will be informed by future engagements with the relevant federal and state agencies. For protected species-specific mitigation measures for marine mammals see Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan.

6.9 SEA TURTLES

This section describes sea turtle species with the potential to occur in the Offshore Project Area and includes an evaluation of potential Project-related effects. For this section, the Project Area is defined as the Offshore Project Area (i.e., the Lease Area and offshore export cable corridors). This evaluation is based on a review of published scientific literature and publicly available reports, including sea turtle-specific monitoring and vessel-based monitoring reports conducted in the MA/RI WEA for adjoining offshore wind leases in the Northeast Atlantic in the U.S. federal and state waters.

Mayflower Wind evaluated the best available literature and government databases and site-specific analyses conducted for the proposed Project. **Table 6-73** provides an overview of the published literature, guidelines, reports, and other data sources used to identify sea turtle physiological thresholds, habitat preferences, and species occurrence in the Project Area.

Technical appendices relating to sea turtles include:

- Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan

TABLE 6-73. SEA TURTLE LITERATURE, GUIDELINES, REPORTS, AND DATA SOURCES

Author	Source Title	Citations
ANSI-Accredited Standards Committee	Sound Exposure Guidelines for Fishes and Sea Turtles	Popper et al., 2014
BOEM	Environmental Studies EMF & Marine Life	BOEM, 2020b
BOEM	National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf	BOEM, 2019
BOEM	Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts. Revised Environmental Assessment	BOEM, 2014
BOEM	Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles	Kraus et al., 2016
BOEM	Megafauna Aerial Surveys in the Wind Energy Areas of Massachusetts and Rhode Island with Emphasis on Large Whales: Summary Report Campaign 5, 2018-2019	O'Brien et al., 2021
BOEM	Effects of EMFs from Undersea Power Cables on Elasmobranch and Other Marine Species	Normandeau Associates, et al., 2011
BOEM	Atlantic Marine Assessment Program for Protected Species, 2010-2014	Palka et al., 2017
CRMC	Data analysis of marine mammal and sea turtles of Narragansett Bay, Block Island sound, Rhode Island sounds, and nearby waters	Kenney & Vigness-Raposa, 2010
DON	Navy OPAREA Density Estimates for the Northeast OPAREAS: Boston, Narragansett Bay, and Atlantic City	DON, 2007
GARFO	GARFO Acoustic Tool: Analyzing the effects of pile driving on ESA-listed species in the Greater Atlantic Region	GARFO, 2016

Author	Source Title	Citations
Aquatic Mammals Journal	Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects	Southall et al., 2019
Marine-life Data and Analysis Team	Technical report on the methods and development of marine-life data to support regional ocean planning and management	Curtice et al., 2019
Massachusetts Division of Fish and Wildlife	Natural Heritage & Endangered Species Program	Retrieved from: https://www.mass.gov/orgs/masswildlifes-natural-heritage-endangered-species-program
NMFS	2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing	NMFS, 2018
NMFS	An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve: Chapter 8: Estuarine Habitat of Narragansett Bay	Schwartz, 2021
NOAA	Species Directory	Retrieved from: https://www.fisheries.noaa.gov/species-directory
The Nature Conservancy	The Northwest Atlantic Marine Ecoregional Assessment	Whelchel & Clark, 2010
Northeast Fisheries Science Center & Southeast Fisheries Science Center	AMAPPS, 2011-2018	Northeast Fisheries Science Center & Southeast Fisheries Science Center, 2011-2017; 2018
Southeast Fisheries Science Center	Sea Turtle Stranding Narrative Report	Southeast Fisheries Science Center, 2020
The Nature Conservancy	The Northwest Atlantic Marine Ecoregional Assessment	Whelchel & Clark, 2010
U.S. Environmental Protection Agency	Statutes and Regulations Affecting Marine Debris	U.S. Environmental Protection Agency, 2017
Related COP Sections and Appendices		
AECOM	Emergency Response Plan/ Oil Spill Response Plan	Appendix AA
A.I.S., Inc.	AIS Protected Species Observer Report	A.I.S., Inc., 2020
Gradient	Electric and Magnetic Field Assessment for the Proposed Mayflower Wind Project	Appendix P1
JASCO Applied Sciences	Mayflower Wind Underwater Acoustics Technical Report: Underwater Acoustic Modeling and Animal Exposure Estimation for Mayflower Wind Energy, LLC.	Appendix U2
LGL Ecological Research Associates, Inc.	Marine Mammal and Sea Turtle Monitoring and Mitigation Plan	Appendix O
Mayflower Wind and APEM	Monthly survey data of the Project Area	Mayflower-APEM, 2020a-l
RPS	Protected Species Observer Reports	RPS, 2019

6.9.1 Affected Environment

Four species of sea turtles have the potential to occur in the MA/RI WEA and the Project Area, all of which are federally and state-listed in Massachusetts and also listed as a Species of Greatest Conservation Need (SGCN) in Rhode Island (**Table 6-74**). The sea turtle species listed in **Table 6-74** have been previously observed and recorded during surveys for BOEM-specific offshore wind development assessments and/or surveys conducted near and within the Project Area as part of long-term population assessments (see **Table 6-73**).

TABLE 6-74. SEA TURTLE SPECIES WITH POTENTIAL TO OCCUR IN THE PROJECT AREA

Common Name	Scientific Name	ESA Status a/	MESA Status a/	RI Status a/	Occurrence within Project Area
Green sea turtle	*Chelonia mydas*	T	T	SGCN	Uncommon
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E	SGCN	Uncommon
Atlantic Hawksbill sea turtle	*Eretmochelys imbricata*	E	E	-	Rare
Leatherback sea turtle	*Dermochelys coriacea*	E	E	SGCN	Common
Loggerhead sea turtle	*Caretta caretta*	T	T	SGCN	Common

Notes:
a/ ESA = Endangered Species Act (16 U.S.C §.1531 et seq.); MESA = Massachusetts Endangered Species Act (321 CMR 10.00); Rhode Island Wildlife Action Plan Species Profiles, Species of Greatest Conservation Need (SGCN). SGCN species are identified by RIDEM and the Rhode Island Chapter of The Nature Conservancy in the Rhode Island Wildlife Action Plan. It should be noted that SGCN designation does not represent an equivalent to ESA or MESA species listings; rather, this represents a publicly available data source to identify species which Rhode Island considers to be of greatest concern, based on the threat affecting each (RIDEM, 2015). E = Endangered; T = Threatened; NL = Not listed.

This section identifies and describes the different types of sea turtles that may be present in and around the Project Area during construction, operations, and decommissioning activities. Mayflower Wind has also included an analysis of whether, and if so to what extent, sea turtles may be exposed to Project activities and whether these species may be affected.

Mayflower Wind evaluated the best available literature and government databases, local and regional information evaluating the habitat use, abundance, and distribution of sea turtles known to occur in Massachusetts waters, and site-specific surveys conducted for the proposed Project. Existing threats (i.e., impact-producing factors) to sea turtles that may occur in the Project Area are also identified and evaluated in Section 6.9.2. During the construction phase, sea turtles may co-occur with, and be affected by, Project activities in the Lease Area and in the offshore export cable corridors. During the operations phase, sea turtles may co-occur with the WTGs, OSPs, and the offshore export cable corridors, including vessel traffic for maintenance and associated effects. Sea turtle likelihood of co-occurrence with Project activities is a function of overall occurrence levels that range from "rare" to "common" and varies seasonally.

Sea turtle species that have the potential to occur in and in the vicinity of the Project Area include the loggerhead sea turtle (*Caretta caretta*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*) and green sea turtle (*Chelonia mydas*). Federally endangered hawksbill sea turtles (*Eretmochelys imbricata)* generally prefer tropical and subtropical waters and are very rarely seen in Massachusetts and Rhode Island waters (observations are typically the result of cold-stun strandings), and therefore, will not be evaluated further in this assessment (Lutz & Musick, 1997; NMFS & USFWS, 1993; Lazell, 1980). Although the green sea turtle is also uncommon off the coast of Massachusetts and Rhode Island, the species is evaluated herein for qualitative comparison to other regional assessments. All five sea turtle species are listed under the ESA and MESA and are considered vulnerable to anthropogenic impacts including bycatch and vessel strikes. Although Rhode Island does not have state listed threatened and endangered species, four of these five species are also considered SGCN in the Rhode Island Wildlife Action Plan

Data on sea turtle abundance and distribution in Massachusetts and Rhode Island waters are limited. However, available studies suggest that all four species are generally found in the MA/RI WEA during the summer and fall (Kraus et al., 2016; Lazell, 1980; Schwartz, 2021). Loggerhead, leatherback, green, and Kemp's ridley sea turtles are highly migratory and are known to forage in nearby Cape Cod Bay during the summer months when sea surface temperatures range from 61 to 79 degrees Fahrenheit (16 to 26 degrees Celsius) (CETAP, 1982).

6.9.1.1.1 Green Sea Turtle

Occurrence Level	Seasonality in Project Area
Uncommon	• Lease Area: Uncommon; occurrence primarily in the summer • Export cable corridors: Uncommon; occurrence primarily in the summer

Green sea turtles occur globally and typically forage in nearshore coastal waters or in bays and lagoons. The species was listed under the ESA in 1978 and was subsequently separated into two ESA-listing designations: endangered for breeding populations 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, NMFS listed eleven DPSs of green sea turtle; the DPS known to occur in the Project Area, the North Atlantic DPS, is listed as a threatened population.

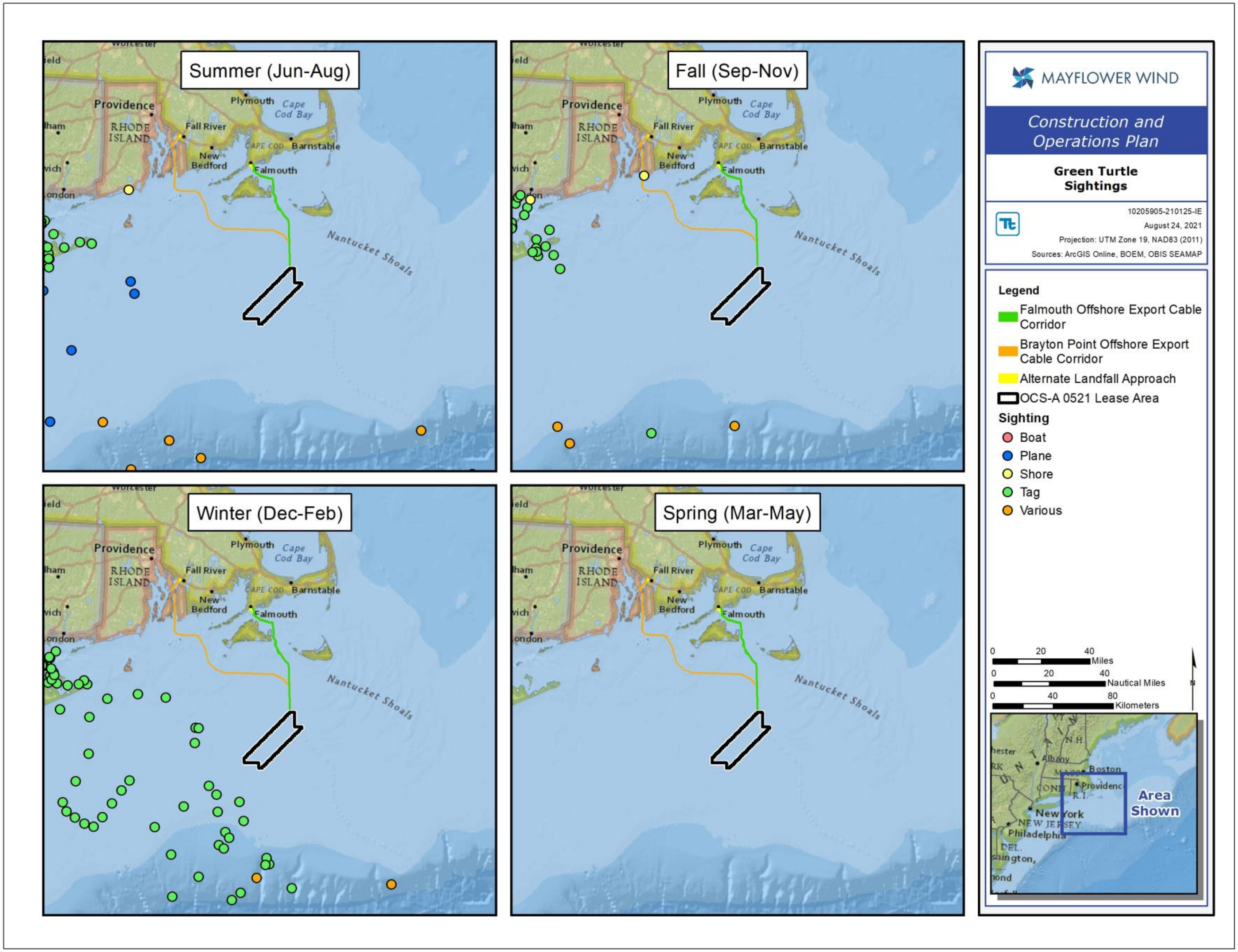
Sea turtle population estimates are often assessed using nesting and bycatch data because of their low survey detectability and elusive nature. However, there can be inconsistencies in population estimates due to fluctuations and variability in clutch sizes and fidelity to nesting sites (TEWG, 2007). Florida nesting data from 2006 estimated 2,745 nesting green turtle females in 2004-2005 (Fish and Wildlife Research Institute, 2006). There are no population estimates for green turtle occurrence in northeastern U.S. Atlantic waters due to too few recorded observations (Kenney & Vigness-Raposa, 2010; Shoop & Kenney, 1992).

Like other sea turtle species, green sea turtles migrate long distances for foraging but return to subtropical or tropical waters between 30° N and 30° S to nest (NMFS, 2020b). In U.S. waters, green turtles are more commonly found on the west coast; the majority of green turtle nesting sites in the U.S. occur throughout the Hawaiian Islands. On the east coast, green sea turtles' nest between Florida and

North Carolina. There are recorded observations of green sea turtles foraging in Cape Cod Bay, which is approximately 58 miles (94 km) from the Project Area, and the species is commonly recorded in Cape Cod stranding data associated with cold-stunned sea turtles, although in lower numbers than loggerhead and Kemp's ridley sea turtles (Still et al., 2005; Schwartz, 1978). In pelagic habitats, juvenile green sea turtles typically feed on invertebrates associated with pelagic Sargassum macro algae and other small animals. As they grow larger, juvenile green turtles' transition to a strictly herbivorous diet of seagrass and algae, which is unique among sea turtles (NMFS, 2020b; Kenney & Vigness-Raposa, 2010; Bjorndal, 1997). Due to the varying reproductive success characteristic of sea turtles, green sea turtles are vulnerable to a variety of anthropogenic impacts, including bycatch from fisheries (Murray & Orphanides, 2013; Wallace et al., 2013; Haas, 2010; Brazner and McMillan, 2008), wildlife trafficking trade, vessel strikes, loss or degradation of critical habitat (Fuentes et al., 2016), ingestion of marine debris (Bolten et al., 2011) and climate change (Von Holle et al., 2019; Rees et al., 2016).

In the MA/RI WEA, no green turtles were observed during the NLPS conducted from 2011-2015 (Kraus et al., 2016). There were also no recorded observations of green turtles in northeastern U.S. waters during AMAPPS I surveys or AMAPPS II surveys conducted from 2010-2016 and 2017-2018, respectively (NEFSC & SEFSC, 2018; Palka et al., 2017). Four green sea turtle observations were recorded in Sea Turtle Stranding and Salvage Network (STSSN) reports of Massachusetts waters from 2015-2019 (SEFSC, 2020). Observations included three stranding events in August and October of 2016 and one stranding event in October 2018. Seasonal geospatial data for green sea turtle occurrence in the MA/RI WEA are depicted in **Figure 6-50**; the data were collected from the U.S. Navy's Northeast Marine Resources Assessment study and NMFS-NEFSC and were aggregated by sightings per unit effort (SPUE) (Shoop & Kenney, 1992).

No green sea turtles were observed during PSO surveys or aerial surveys conducted for the proposed Project (AIS Inc., 2020; Mayflower Wind Energy, LLC et al., 2020; Mayflower-APEM, 2020). Due to a lack of historic and recent records of green sea turtle occurrence in the MA/RI WEA and their preference for warmer waters, the species is considered to be uncommon to the Project Area, primarily in summer months. Based on the information above, co-occurrence of green sea turtles with activities in the Project Area is expected to be uncommon.



Source: Whelchel & Clark, 2010

FIGURE 6-50. GREEN SEA TURTLE SIGHTINGS PER UNIT EFFORT

6.9.1.1.2 Kemp's Ridley Sea Turtle

Occurrence Level	Seasonality in Project Area
Uncommon	• Lease Area: Uncommon; occurrence primarily in the summer/early fall • Export cable corridors: Uncommon; occurrence primarily in the summer/early fall

Kemp's ridley sea turtles are the smallest and 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 MESA (NMFS, 2020d). They are also considered SGCN in the Rhode Island Wildlife Action Plan. There are no definitive population estimates for the Kemp's ridley sea turtle, especially for northeastern U.S. waters. Using historical and recent nesting data, the global population of nesting female Kemp's ridley sea turtles is estimated at 7,000-8,000 individuals (NMFS & USFWS, 2007; TEWG, 2000). According to the International Union for Conservation of Nature, the global Kemp's ridley sea turtle population is estimated to be 22,341 individuals (Wibbels & Bevan, 2019).

The species is most common in coastal waters of the Gulf of Mexico, but juveniles are known to migrate far north for foraging opportunities that are often considered essential for their development. Juvenile Kemp's ridley sea turtles can travel as far as Nova Scotia to forage and then make their way south to warmer waters when winter approaches (Hart et al., 2006; Bleakney, 1955). In pelagic waters, juvenile Kemp's ridley sea turtles feed on small invertebrates associated with pelagic Sargassum (Bjorndal, 1997); in nearshore habitats, their diet is primarily composed of crabs. Historical records and confirmed sightings of Kemp's ridley sea turtles suggest that this species has the potential to occur in the Project Area, primarily in the summer and early fall (Kraus et al., 2016).

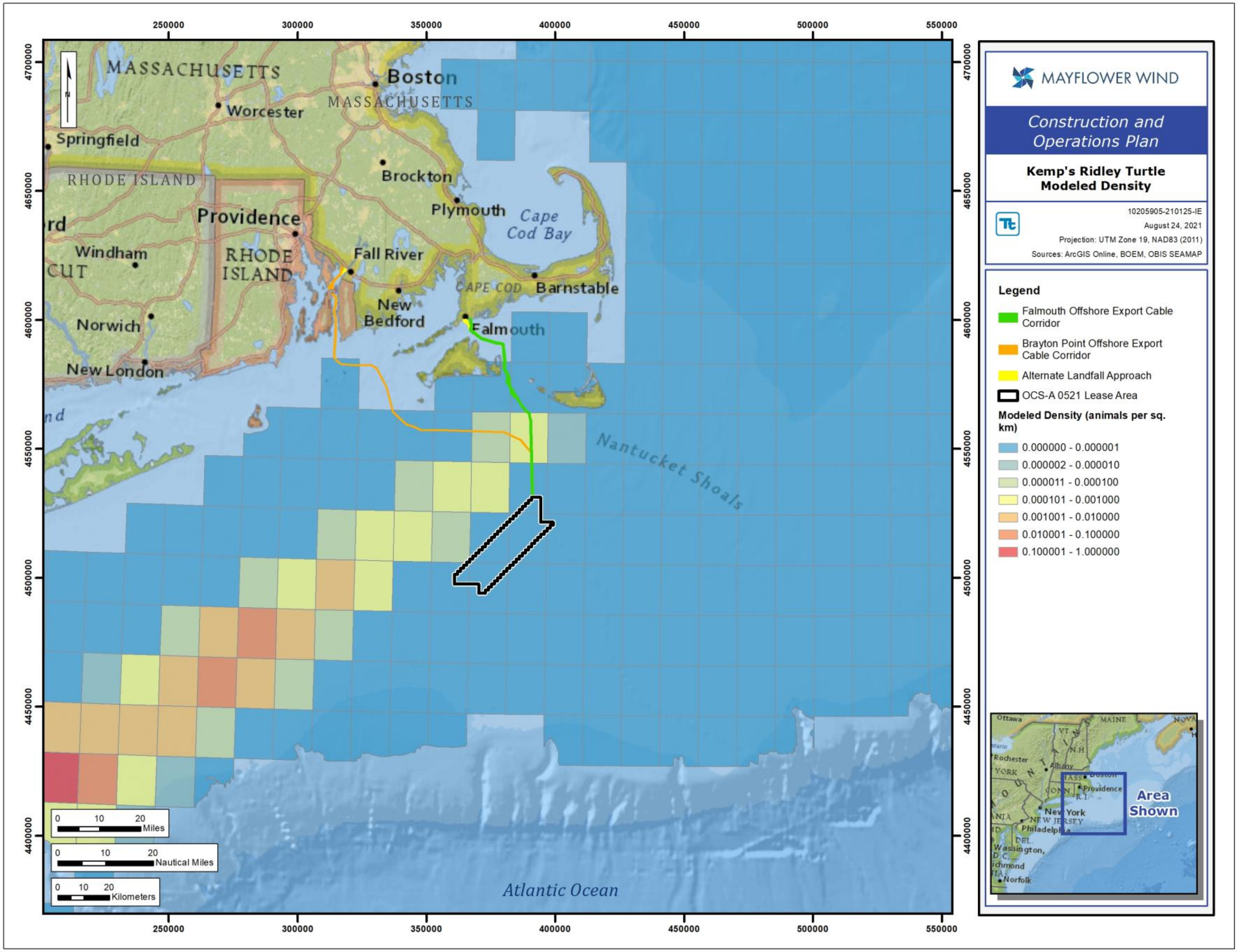
The primary nesting site for Kemp's ridley sea turtles occurs in Rancho Nuevo, Mexico; 95 percent of the species' population originates from this site along with two other sites in Tamaulipas, Mexico. Other Kemp's ridley sea turtle nesting sites occur in other parts of Mexico, and on a much smaller scale in Texas, Florida and the Carolinas (NMFS, 2020d; Bevan et al., 2016; Hildebrand, 1963). The major nesting site in the U.S. occurs on the Padre Island National Seashore in Texas. Once widely abundant, nesting sites in Rancho Nuevo and other areas in the Gulf of Mexico declined sharply from the 1940s to 1980s due to anthropogenic impacts that nearly caused extinction of the species (Bevan et al., 2016; Heppell et al., 2007). Nesting site abundance increased in the 1990s due to strong conservation efforts, but nesting site numbers are still relatively low and are being closely monitored by researchers.

Kemp's ridley sea turtles are vulnerable to anthropogenic impacts that commonly affect other sea turtle species, including cold-stunning caused by drastic changes in water temperatures during the transition from summer to fall (Lutz and Musick, 1997; Burke et al., 1991). Kemp's ridley sea turtles become physically inactive from hypothermia once water temperatures drop below 50 degrees Fahrenheit (10 degrees Celsius). It has recently been suggested that ocean temperature changes and rates of cold-stunning may be related to anthropogenic climate change (Griffin et al., 2019; Liu et al., 2019). Kemp's ridley sea turtles become physically inactive from hypothermia once water temperatures drop below 50 degrees Fahrenheit (10 degrees Celsius).

A study involving the aggregation and analysis of sighting, stranding and bycatch data in Massachusetts and Rhode Island from 1979-2002 documented 12 Kemp's ridley sea turtle observations in the summer, two observations in the fall, and no observations in the winter or spring (Kenney & Vigness-Raposa, 2010). The study concluded that Kemp's ridley sea turtle numbers are much lower than loggerhead or leatherback turtle numbers in northeastern U.S. waters, but that juvenile Kemp's ridley sea turtles likely move through Massachusetts waters to get to Cape Cod Bay for foraging during growth and development. The study also noted that estimates for the species may be biased low because the relatively small juvenile turtles are more difficult to detect during surveys. Because juvenile Kemp's ridley sea turtles are susceptible to cold-stunning if waters become uncharacteristically cold in early fall as they are migrating south, a STSSN in the state of Massachusetts has implemented extensive monitoring and conservation efforts for cold-stunned sea turtles since 1979 (Liu et al., 2019). Although observed strandings are generally limited to Cape Cod Bay, the STSSN data provide an index of sea turtle cold-stunning events in the region. Observations of Kemp's ridley sea turtle fatality events due to cold-stunning have increased in the past decade. 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).

Kemp's ridley sea turtles were rarely observed in the MA/RI WEA during the NLPS (Kraus et al., 2016). Six Kemp's ridley sea turtle observations were recorded; one in August 2012 and five in September 2012. No Kemp's ridley sea turtles were observed in the MA/RI WEA during the 2009-2015 AMAPPS or 2017-2018 AMAPPS II northeast aerial surveys (NEFSC & SEFSC, 2018; Palka et al., 2017). Twenty Kemp's ridley sea turtle observations were recorded in STSSN reports of Massachusetts waters from 2015-2019 (SEFSC, 2020). Observations included nineteen stranding observations in the summer and fall of 2015-2019 and one incidental capture in October 2017. Modeled density estimates of Kemp's ridley sea turtle occurrence in the MA/RI WEA using NMFS-NEFSC aerial data from 1998-2005 (excluding 2000, 2001, and 2003) are mapped by season in **Figure 6-51** (DON, 2007).

Two Kemp's ridley sea turtles were observed during visual surveys conducted in the Project Area between May and July 2020 (Mayflower Wind Energy, LLC et al., 2020). One Kemp's ridley sea turtle was observed surfacing in May 2020 and the other Kemp's ridley sea turtle was observed surfacing in July 2020. No Kemp's ridley sea turtles were observed during PSO surveys or aerial surveys conducted for the proposed Project (AIS Inc., 2020; Mayflower Wind Energy, LLC et al., 2020). Based on the available data in the MA/RI WEA, Kemp's ridley sea turtle co-occurrence with activities in the Project Area is expected to be uncommon.



Source: Department of the Navy, 2007. Densities did not differ among seasons.

FIGURE 6-51. MODELED DENSITY OF KEMP'S RIDLEY SEA TURTLES

6.9.1.1.3 Leatherback Sea Turtles

Occurrence Level	Seasonality in Project Area
Common	• Lease Area: Some potential to occur in the summer and fall • Export cable corridors: Some potential to occur in the summer and fall

The leatherback sea turtle is a highly migratory pelagic species that can be found in boreal and tropical waters (Dodge et al., 2014; Plotkin, 2002). The species is listed as endangered under the ESA and MESA. They are also considered SGCN in the Rhode Island Wildlife Action Plan. Leatherback sea turtles that occur off the coast of in the U.S. are divided into two populations, Pacific and Atlantic. Of the Atlantic leatherback sea turtle population, the Northwest Atlantic subpopulation occurs in the MA/RI WEA and is currently a candidate under review for listing as a Threatened DPS under the ESA (NMFS 2020c). There are no definitive population estimates for the Northwest Atlantic leatherback sea turtle population, especially for northeastern U.S. waters; female leatherback turtles are known to have varying clutch sizes and fluctuate in fidelity to nesting sites (TEWG, 2007). Using nest count data from 2004-2005, NOAA's Turtle Expert Working Group (TWEG, 2007) estimated a population of 34,000-94,000 adult leatherback turtles in the North Atlantic Ocean and 4,800 to 11,000 female leatherback sea turtles in the Northwest Atlantic.

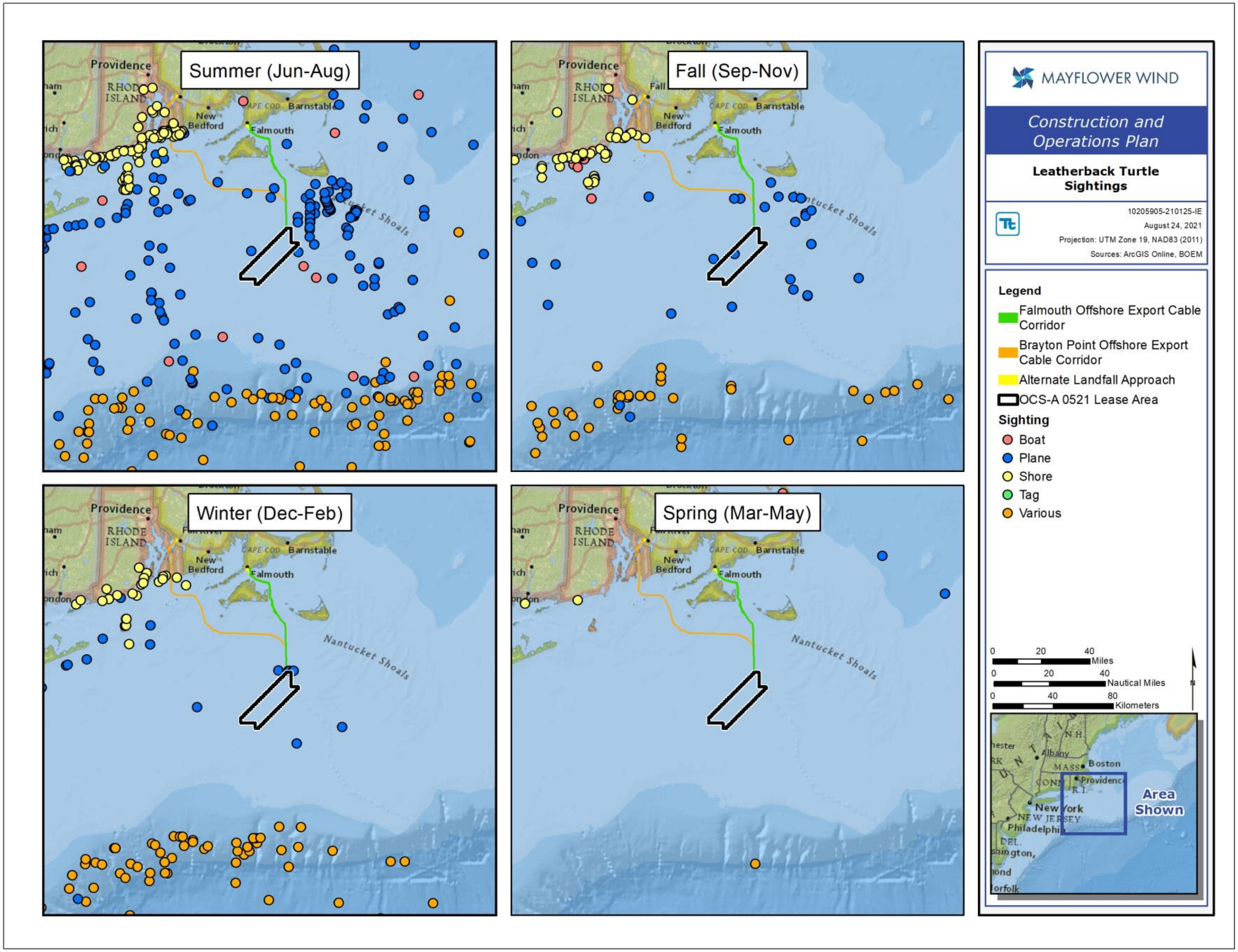
Like other sea turtle species, leatherback sea turtles are expected to occur in the Project Area primarily during the summer and fall months. The species travels further between foraging and nesting areas than other sea turtles and their range spans the globe (NMFS, 2020c). Primary nesting sites in the U.S. include the southeast Florida coastline, the U.S. Virgin Islands, and Puerto Rico, and the species is regularly recorded foraging as far north as Newfoundland. Although population trends have shown that the U.S. leatherback turtle population is growing and appears to be stable, they remain vulnerable to anthropogenic impacts (e.g., climate change, marine debris and pollution, bycatch) due to their low and variable reproductive success. In pelagic waters, leatherback turtles are the deepest diving sea turtles, reaching a maximum depth of almost 4,000 ft while foraging for jellyfish, salps, and other gelatinous prey species (NMFS, 2020c; Bjorndal, 1997; Eckert et al.,1989). However, the species is also known to take advantage of highly productive, nutrient-rich coastal and shallow waters, especially in the spring (Dodge et al., 2014; Bjorndal, 1997).

Research involving the aggregation and analysis of sighting, stranding and bycatch data in Massachusetts and Rhode Island waters from 1974-2008 documented 82 leatherback sea turtle observations in the summer, 59 observations in the fall, and one observation in the winter (Kenney & Vigness-Raposa, 2010); the study concluded that leatherback sea turtle abundance is typically lower than loggerhead turtle abundance in northeastern U.S. waters, but that leatherback sea turtles will be more likely to occur in the MA/RI WEA due to the species' higher affinity for nearshore foraging areas.

Data from recent leatherback sea turtle survey efforts coincide with historical data analyzed by Kenney and Vingess-Raposa (2010). Leatherback turtles were seen more frequently than other sea turtle species in the MA/RI WEA during the NLPS (Kraus et al., 2016). Leatherback sea turtles were also the primary sea turtle species identified during follow-up surveys conducted in 2018-2019, though these sightings mainly occurred 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 were recorded across the MA/RI WEA and in the Lease Area in the summer with a particularly heavy leatherback sea turtle presence just south of Nantucket and in the Muskeget Channel. 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 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 MA/RI WEA and a second occurred just south of the MA/RI WEA. No leatherback sea turtles were observed in the MA/RI 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/RI WEA, just north of Georges Bank (NEFSC & 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. Seasonal geospatial data for leatherback sea turtle occurrence in the MA/RI WEA are depicted in **Figure 6-52** (Whelchel & Clark, 2010); the data represented were collected from the U.S. Navy's Northeast Marine Resources Assessment study and NMFS-NEFSC (data collected between 1979-2003) and was aggregated by SPUE (Shoop & Kenney, 1992). Modeled density estimates of leatherback sea turtle occurrence in the MA/RI WEA using NMFS-NEFSC aerial data from 1998-2005 (excluding 2000, 2001, and 2003) are mapped by season in **Figure 6-53** (DON, 2007).

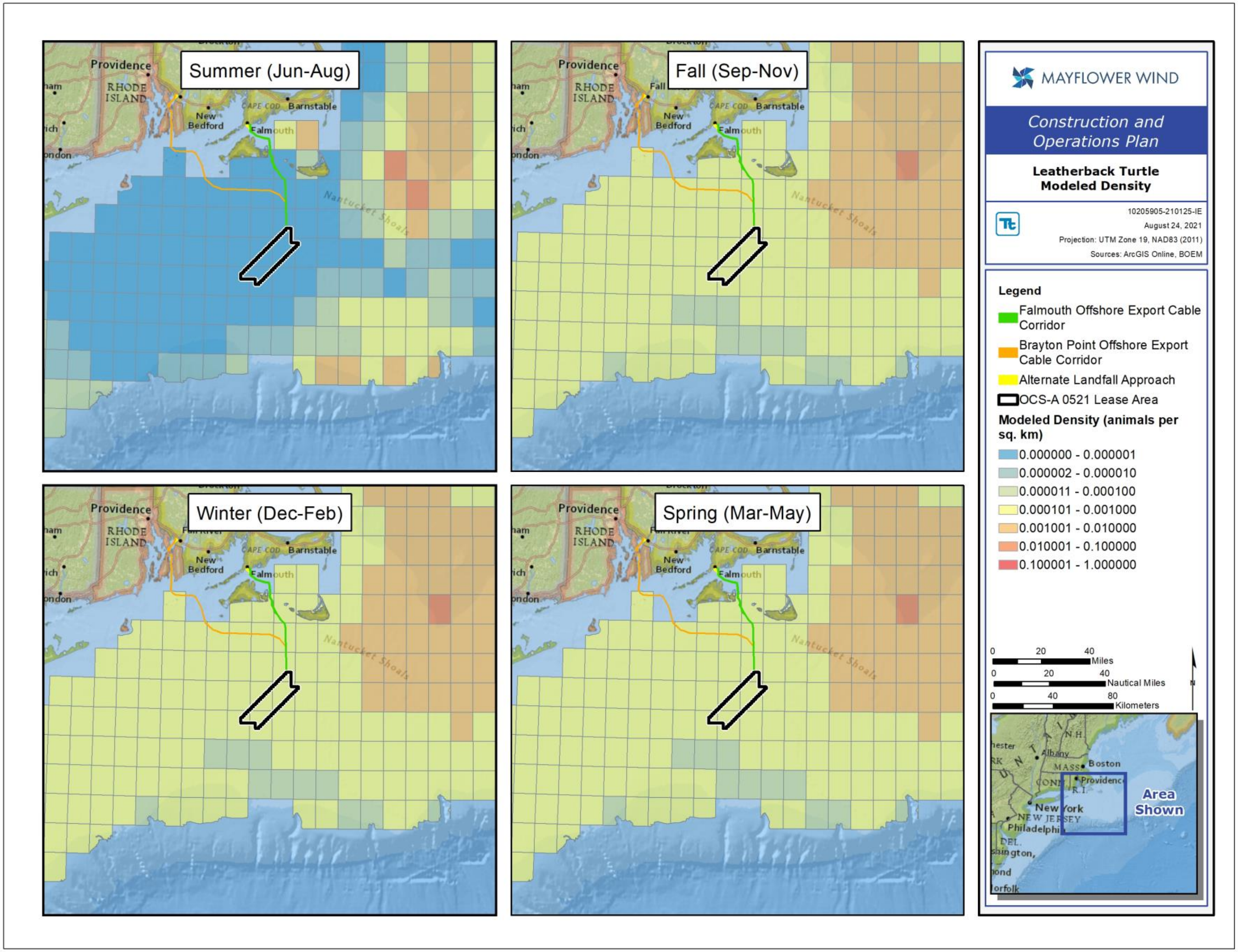
No leatherback sea turtles were observed during PSO surveys or aerial surveys conducted for the proposed Project (AIS Inc., 2020; Mayflower Wind Energy, LLC et al., 2020; Mayflower-APEM, 2020).

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 Project Area, particularly during the summer and fall and in the offshore export cable corridors due to its preference for foraging in shallow, coastal waters.



Source: NEFSC & SEFSC, 2018; Whelchel & Clark, 2010

FIGURE 6-52. LEATHERBACK SEA TURTLE SIGHTINGS PER UNIT EFFORT



Source: Department of the Navy, 2007. Fall, winter and spring quantile distributions did not differ.

FIGURE 6-53. MODELED SEASONAL DENSITY OF LEATHERBACK SEA TURTLES

6.9.1.1.4 Loggerhead Sea Turtle

Occurrence Level	Seasonality in Project Area
Common	• Lease Area: Some potential to occur in the summer and early fall • Export cable corridors: Some potential to occur in the summer and early fall

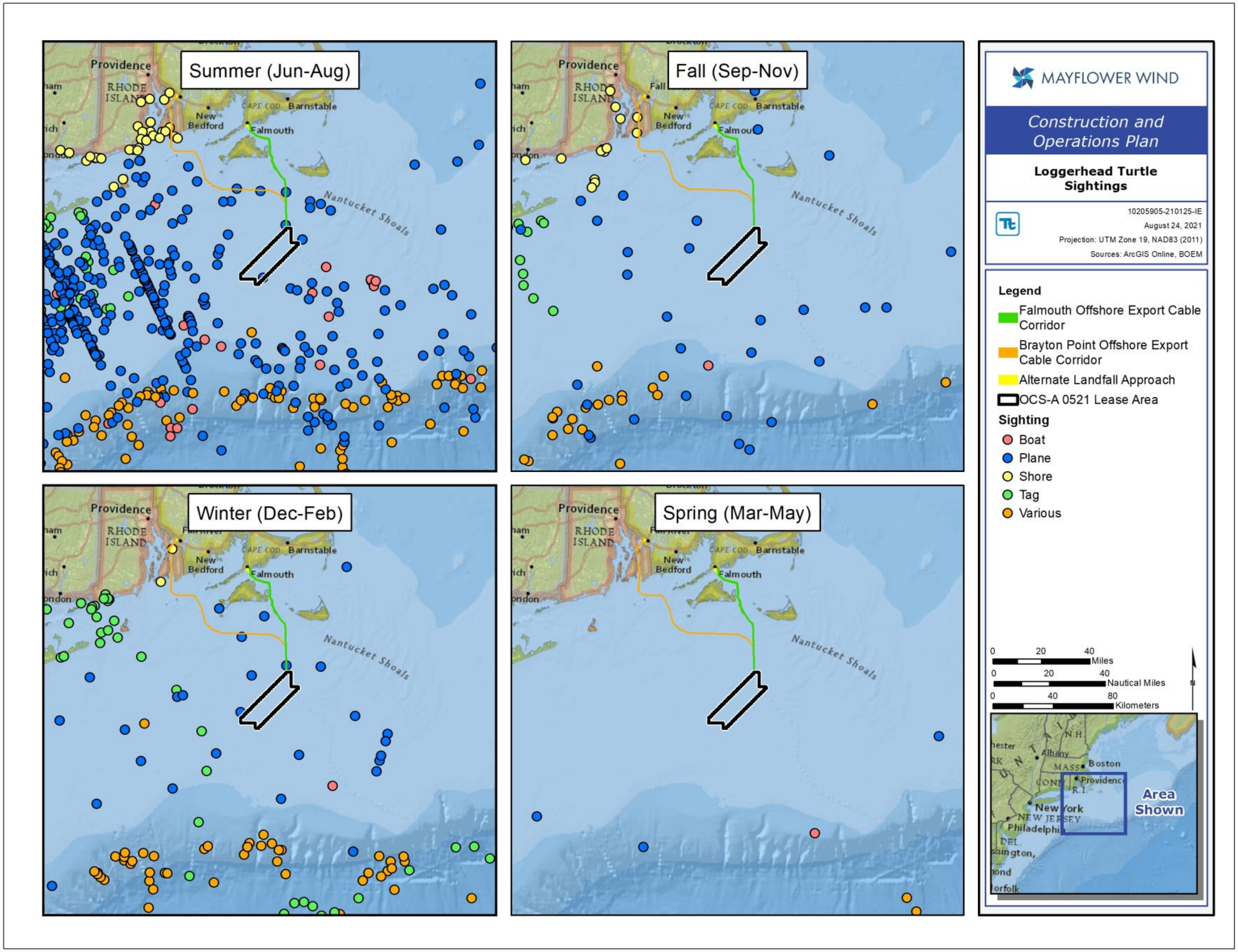
Loggerhead turtle is the most abundant sea turtle species found in the U.S. Atlantic, primarily in subtropical and tropical coastal and continental shelf waters (NMFS, 2020a). Loggerhead turtles are listed as Threatened under the ESA and MESA. They are also considered SGCN in the Rhode Island Wildlife Action Plan. The ESA has identified nine DPSs for loggerhead sea turtles; the Northwest Atlantic Ocean DPS occurs in the MA/RI WEA and is listed as threatened under the ESA. Like other sea turtle species along the U.S. Atlantic Coast, loggerhead turtles are vulnerable to a series of anthropogenic impacts, including habitat loss, pollutant ingestion, climate change and bycatch.

Due to their highly migratory nature and the challenges in tracking and monitoring sea turtles during their first years of life, there are no definitive loggerhead turtle population estimates (Ceriani et al., 2019). One study from 2011 using nest count data from 2001-2010 estimated a population of 38,334 Northwest Atlantic Ocean DPS female loggerhead sea turtles (Richards et al., 2011). Juvenile loggerhead sea turtles can migrate south to foraging areas in the waters of Central and South America, or northwards to foraging areas near the northeastern U.S., further complicating population estimates. Using aerial survey data collected in 2010, the NEFSC estimated a population of approximately 801,000 adult loggerhead turtles in the northwest Atlantic continental shelf area (NEFSC, 2011). Using aggregated historical records of sighting, stranding and bycatch data, a comparative study of sea turtle presence in Massachusetts and Rhode Island waters documented 171 loggerhead sea turtle observations in the summer, 61 sightings in the fall, and one sighting in the spring between 1963-2006 (Kenney & Vigness-Raposa, 2010). The study concluded that loggerhead sea turtle abundance is higher than leatherback sea turtle abundance in northeastern U.S. waters and that loggerhead turtles are more likely to occur outside of the MA/RI WEA as they tend to forage closer to the Atlantic continental slope.

The species typically nests in the southeastern U.S. Atlantic, but nesting females travel as far as the Mid-Atlantic for foraging (Bjorndal et al., 2013). Immature loggerhead sea turtles migrate as far north as Massachusetts for foraging and are likely to occur in the MA/RI WEA (Bjorndal et al., 2013; Arendt et al., 2012; Mansfield et al., 2009; Bowen et al., 2004; Hopkins-Murphy et al., 2003). In pelagic areas, juvenile loggerhead turtles commonly feed on invertebrates associated with pelagic Sargassum and jellyfish (Bjorndal, 1997). In coastal and continental shelf waters larger juveniles typically feed on a variety of animals including crabs, mollusks and jellyfish, and vegetation near the surface (NMFS, 2020a).

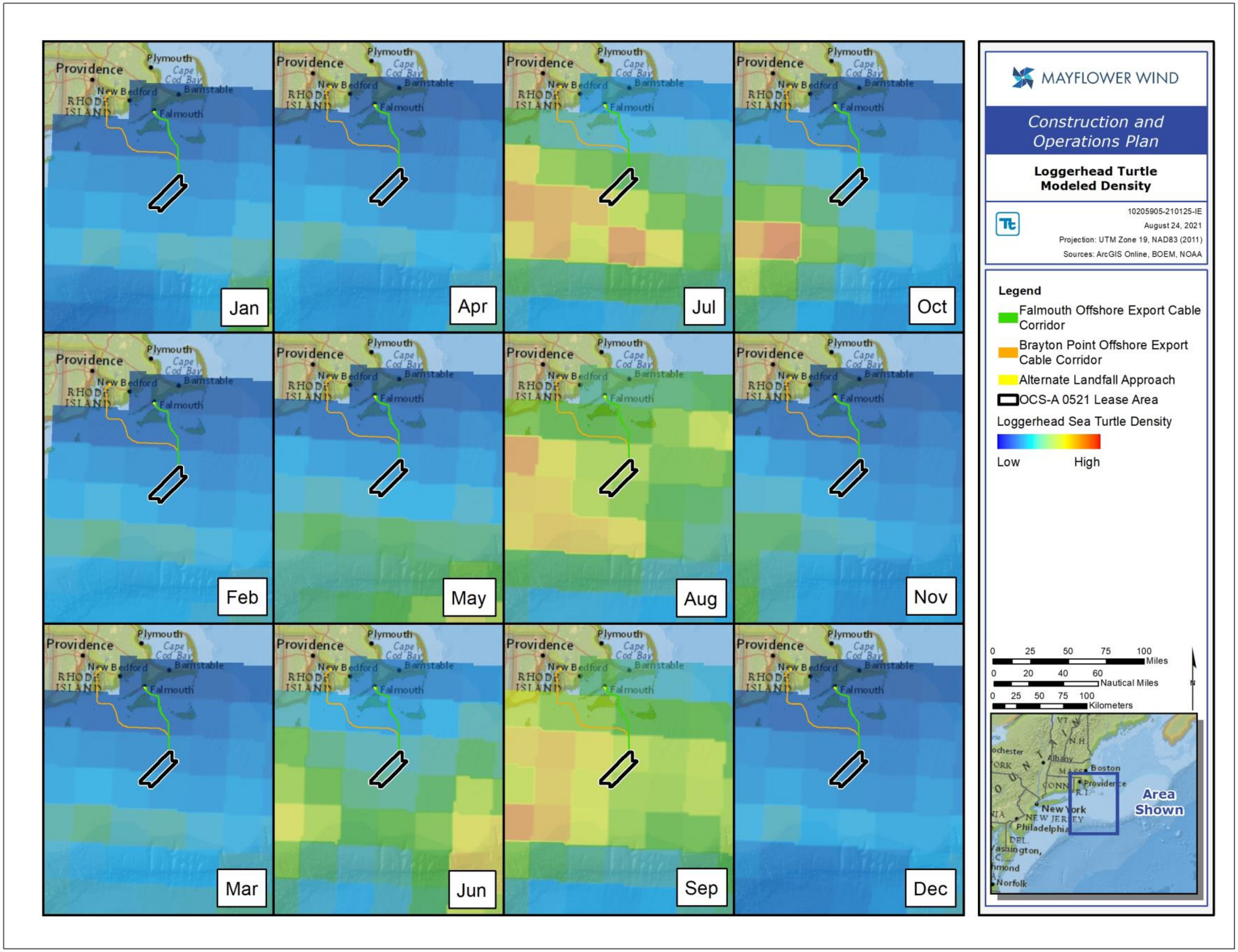
The NLPS recorded 78 loggerhead sea turtle individuals in the MA/RI WEA (Kraus et al., 2016); two observations were recorded in the spring, 31 in the summer and 45 in the fall (which all occurred in the month of September). There were no loggerhead sea turtles observed in the winter. Two Loggerheads were observed in the MA/RI WEA during follow-up surveys conducted in 2018-2019 (O'Brien et al., 2021). Recorded observations were spread evenly across the MA/RI WEA in the summer and some individuals were observed in the Project Area; there was a higher concentration of individuals in the Project Area in September likely due to turtles migrating south through the MA/RI WEA. Loggerhead sea turtle observations were recorded just northeast of the MA/RI WEA in the spring and fall. Loggerhead turtle tagging data collected as part of the AMAPPS from 2009-2015 recorded very limited loggerhead turtle observations along the southern border of the MA/RI WEA (Palka et al., 2017). Tagged individuals were more commonly found in the Mid-Atlantic and southeastern U.S. Atlantic. Forty-five loggerhead sea turtle stranding observations were recorded in STSSN reports of Massachusetts waters from 2015-2019 (SEFSC, 2020). Seasonal geospatial data for loggerhead sea turtle occurrence in the MA/RI WEA are depicted in **Figure 6-54** (Whelchel & Clark, 2010); the data shown were collected from the U.S. Navy's Northeast Marine Resources Assessment study and NMFS-NEFSC (data collected between 1979-2003) and were aggregated by SPUE (Shoop & Kenney, 1992). Modeled density estimates of loggerhead sea turtle occurrence in the MA/RI WEA using NMFS-NEFSC aerial data from 1998-2005 (excluding 2000, 2001, and 2003) are mapped by season in **Figure 6-55** (DON, 2007). No loggerhead turtles were observed in the MA/RI WEA during winter 2017-2018 AMAPPS II aerial surveys (NEFSC & SEFSC, 2018). Loggerhead sea turtles are considered regular summer visitors in the nearshore waters of Rhode Island and some have been observed in Narraganset Bay (Schwartz, 2021).

One loggerhead sea turtle was observed surfacing during visual surveys conducted in the Project Area in July 2020 (Mayflower-APEM, 2020). No loggerhead sea turtles were observed during PSO marine mega-fauna aerial surveys conducted for the proposed Project (AIS Inc., 2020; Mayflower Wind Energy, LLC et al., 2020). Based on the information above, loggerhead sea turtles are expected to be a common occurrence in the Lease Area, particularly during the summer and early fall; the sea turtles may co-occur with activities in the Project Area.



Source: Mayflower-APEM, 2020; Palka et al., 2017; Whelchel & Clark, 2010

FIGURE 6-54. LOGGERHEAD SEA TURTLE SIGHTINGS PER UNIT EFFORT



Source: Department of the Navy, 2007

FIGURE 6-55. MODELED SEASONAL DENSITY OF LOGGERHEAD SEA TURTLES

6.9.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

In this section, Mayflower Wind identifies and describes the stressors (IPFs) that may be associated with construction, operations, and decommissioning, The IPFs identified in **Table 6-75** result from Project activities (or accidental events from said activities) that may behaviorally or physically disturb or harm threatened/endangered sea turtle species. Mayflower Wind also includes an analysis of whether, and to what extent, sea turtles may be affected if they are exposed to one or more IPFs. **Table 6-75** presents the summary of the IPFs that are likely to be caused by Project activities and components. The following sections provide explanations, based on best available science literature, of the IPFs during each phase of the proposed Project.

TABLE 6-75. IPFS AND POTENTIAL EFFECTS ON SEA TURTLES IN THE PROJECT AREA

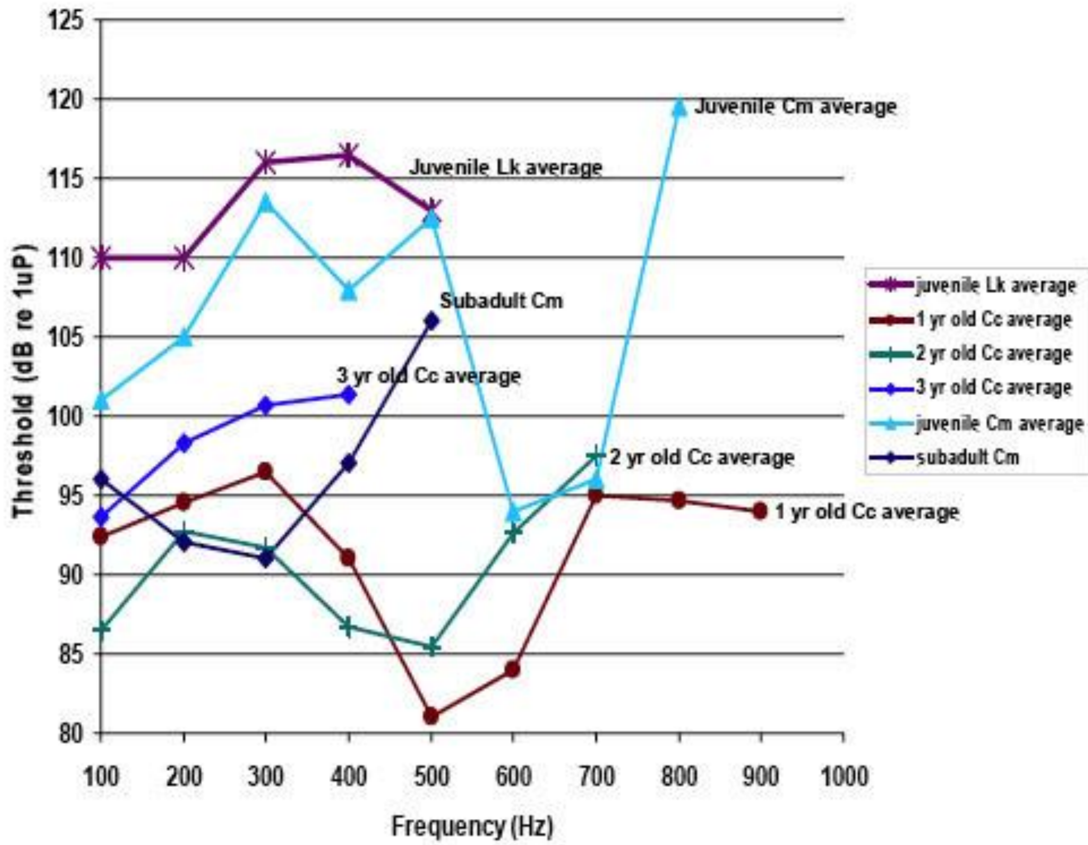
IPF	Potential Effects		Period of Effect		
	Project Components		Project Phase		
	Lease Area	ECCs	Construction	O&M	Decomm.
Introduced Sound into the Environment (in-air or underwater)	Behavioral disturbance	Behavioral disturbance	X	X	X
Actions that may cause direct injury or death of biological resources – Vessel Operations	Serious injury or mortality	Serious injury or mortality	X	X	X
Actions that may displace biological resources, cultural resources, or human uses –Habitat Disturbance and Modification	Reduced prey availability/habitat loss Artificial reef effect	Reduced prey availability/habitat loss	X	X	X
Seabed (or ground) Disturbance	Displacement/harassment	Displacement/harassment	X	-	X
Change in Ambient EM	Displacement/harassment	Displacement/harassment	-	X	-
Actions that may cause direct injury or death of biological resources – Entanglement	Harassment/mortality	Harassment/mortality	X	-	X
Planned Discharges	Harassment/mortality	Harassment/mortality	X	X	X
Accidental Events – Marine Debris and Unplanned Discharges	Harassment/mortality	Harassment/mortality	X	X	X

6.9.2.1 Introduced Sound into the Environment (In-Air or Underwater)

TABLE 6-76. FINDINGS TABLE – INTRODUCED SOUND INTO THE ENVIRONMENT (IN-AIR OR UNDERWATER)

Sources of Introduced Sound	Summary
Construction	
Pile driving Inter-array cable installation Increased vessel traffic Export cable installation	• Behavioral effects will likely be seasonal (during summer and early fall only), temporary, and localized • Loggerhead and leatherback sea turtles will likely be more exposed to pile driving noise than green or Kemp's ridley sea turtles due to their higher levels of occurrence in the Lease Area • Effects of introduced sounds will be avoided, minimized, or mitigated by appropriate mitigation measures
Operations & Maintenance	
WTG noise Increased vessel traffic	• Physiological or behavioral effects are not expected due to likely habituation to operational noise
Decommissioning	
Foundation removal Increased vessel traffic	• Behavioral effects are likely to be seasonal (during summer and early fall only), temporary, and localized • Loggerhead and leatherback sea turtles will likely be more exposed to Project noise than green or Kemp's ridley sea turtles due to their higher levels of occurrence in the Lease Area • Effects of introduced sounds will be avoided, minimized, or mitigated by appropriate mitigation measures

The Project will contribute additional noise into the environment. Information on sea turtle hearing and vocalization is limited, and there are some discrepancies between hearing range determinations; the majority of acoustic studies are on green, juvenile Kemp's ridley, and loggerhead sea turtles (Anton et al., 2010; Bartol & Musick, 2003; Ridgway et al., 1969). There is evidence that sea turtles use sound for communication; the few sea turtle vocalizations previously observed are restricted to the "grunts" of nesting females and the "chirps and grunts" of turtles in eggs and after they hatch (McKenna et al., 2019; Ferrara et al., 2013; Cook & Forrest, 2005; Mrosovsky, 1972). In general, sea turtle hearing is estimated to range between 100-400 Hz up to approximately 1,000 Hz, but then to hear best in the 100-500 Hz range (see **Figure 6-56**). While information is generally limited, there are a few studies on specific species. Green sea turtles are able to detect underwater noises emitting soundwaves between approximately 200 Hz and 1,000 Hz (Piniak et al., 2016). The loggerhead sea turtle's hearing capabilities range between 250 and 750 Hz for adults and between 50 and 1,000 Hz for juveniles (Lavender et al., 2014; Bartol et al., 1999).



Source: Ketten & Bartol, 2005

FIGURE 6-56. AUDIOGRAMS FOR THE GREEN SEA TURTLE (CM), KEMP'S RIDLEY SEA TURTLE (LK), AND THE LOGGERHEAD SEA TURTLE (CC)

Generally, it is assumed that sea turtles are less sensitive to noise than marine mammals. However, NOAA has not established acoustic guidelines for sea turtles. For marine mammals, NOAA bases its criteria for noise impacts on results from a PTS or a TTS (NMFS, 2018). PTS occurs when exposure to noise results in permanent hearing loss, and TTS are recoverable hearing injuries due to temporary noise exposure. Assuming the PTS or TTS criteria, studies assessed the potential of hearing structure damage, determined by inner ear hair cell damage, to identify permanent or temporary threshold shifts occurred. In reptiles, comparative data are limited and the level of hair cell damage to sea turtles from effects related to noise is still unclear (Warchol, 2011). The Popper et al. (2014) study is the common baseline used to gauge the effects of acoustic noise on sea turtles from offshore construction activities, particularly effects from pile driving. The study recommends the following noise guidelines for both sea turtles and fish during offshore pile driving: 210 dB SEL_{cum} or greater than 207 dB peak sound level.

6.9.2.1.1 Pile Driving Noise

The paucity of data on the effects of anthropogenic noise on sea turtles makes it difficult to predict the potential effects of pile driving and other Project activities on sea turtle hearing structures (Nelms et al., 2016). There is a possibility that sea turtles are protected from intense pile driving noises due to their rigid external anatomy (Popper et al., 2014).

Sea turtle exposure to pile driving noise should also be considered in the context of existing ambient noise and potential masking effects. Masking is a form of acoustic interference that occurs when multiple noises have similar frequencies and either overlap or occur very close to each other in time (National Research Council Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, 2003). Although masking by ambient noise (e.g., high winds, waves, vessel traffic) could decrease the intensity of pile driving noise in areas where it has attenuated (i.e., away from the pile driving source), masking by pile driving noise may also interfere with the acquisition of prey or a mate or the avoidance of predators. Sea turtles appear to be low-frequency specialists thus, potential masking noises would likely fall within 50 to 1,000 Hz (Bartol & Musick, 2003).

An Underwater Acoustic Assessment completed for the proposed Project included sound modeling of the predicted introduced sound energy that will be created from pile driving activities (Appendix U2, Underwater Acoustic Assessment). Results of the assessment found that proposed impact driving will generate peak sound energy that varies based on the foundations utilized by the proposed Project. The exposure ranges were calculated for monopile and piled jacket foundations assuming broadband attenuation of 0, 6, 10, and 15 dB. Appendix U2 presents the worst-case mean number of individual animals expected to exceed injurious and behavioral thresholds in the Lease Area during realistic and maximum pile driving scenarios, assuming broadband attenuation of 0, 6, 10, and 15 dB during the summer season. For more detailed information on the assessment methodology and results in all proposed pile driving scenarios, see Appendix U2, Underwater Acoustic Assessment.

Mayflower Wind has developed avoidance, minimization, and mitigation measures to reduce potential effects on sea turtles from introduced Project sound. See Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan for further details on the avoidance, minimization and mitigation measures to reduce the potential effects on sea turtles from Project activities.

6.9.2.1.2 Vessel Noise

Ship engines and vessel hulls emit continuous sound, generally ranging from 150 to 180 dB re 1 µPa @ 1 m, at low frequencies below 1,000 Hz, which overlaps with the hearing frequency range for sea turtle species (NSF & USGS, 2011). Noise from vessel traffic will occur during transit between multiple ports and the Lease Area, particularly during construction, operations, and maintenance activities in the Project Area (see Section 3.3.14, Vessels, Vehicles, and Aircrafts, for more information on proposed Project vessels). The data indicate that vessel ship noise is unlikely to cause sea turtle injury or death, but that vessel noise may cause behavioral changes (Tyson et al., 2017; Popper et al., 2014). These behavioral changes may directly affect sea turtles (such as leatherback and Kemp’s ridley sea turtles) who utilize the Project Area and neighboring waters. See Section 3, Description of Proposed Activities, for additional information regarding indicative Project vessels and vehicles anticipated to be used during construction and O&M, including estimated number of vessels, vessel length, operation speed, maximum speed, and annual and monthly round trips.

6.9.2.1.3 Cable-Laying Noise

Noise effects within the Lease Area due to cable installation are expected to be comparable to vessel noise effects during the construction and installation phase of the proposed Project.

6.9.2.1.4 Operational WTG Noise

Underwater noise from constructed WTGs is low-energy and low-frequency (Nedwell et al., 2003); operational underwater noise from WTGs is generally emitted below 700 Hz with a source level of 80 to 150 dB re 1 µPa @ 1 m (Pangerc et al., 2016; Betke et al., 2004). These noise levels can vary based on the type of turbine foundation used and wind conditions. There is a potential for sea turtles to detect and respond to WTG underground noise, as they have shown behavioral avoidance to low frequency sounds (Piniak et al., 2012; Bartol & Musick, 2003; Bartol et al., 1999; Ridgway et al., 1969). However, due to ambient noise in the Project Area, sea turtles are unlikely to be able to detect sounds generated by WTGs if they are not directly in the Lease Area. A study on noise emissions from three different WTG types found that WTG noise was only measurable above ambient noise levels at frequencies below 500 Hz (Tougaard et al., 2009); operating WTG noise has been found to approach ambient levels at approximately 1,640 ft (500 m) (Thomsen et al., 2015). Sea turtles may habituate to the low WTG noise levels produced in the Lease Area (Moein et al., 1995). Leatherback and Kemp's ridley sea turtles occur in areas with ambient noise emissions similar to those generally emitted by WTGs (Samuel-Rhoads et al, 2005) and thus would be unlikely to respond negatively to WTG noise.

6.9.2.1.5 Construction

The effects of introduced sound on sea turtles during construction are only expected to occur when turtles are present during the summer and early fall. Sea turtles exposed to pile driving sounds from the proposed Project are likely to exhibit a behavioral avoidance response and will leave the construction area during the short, intermittent pile driving periods. Potential effects are expected to be seasonal, short-term, and localized. Pile driving noise exposure levels are expected to vary by species; loggerhead and leatherback sea turtles will likely be more exposed to pile driving noise than green or Kemp's ridley sea turtles due to their higher levels of occurrence in the Lease Area. Potential effects to sea turtles from pile driving noise can be reduced with the implementation of appropriate mitigation and BMPs (see Section 16, Summary of Avoidance, Minimization, and Mitigation Measures, and Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan). Mitigation measures commonly used for marine mammals are applicable to monitoring for sea turtles and reduce potential exposure of sea turtles to noise from pile driving.

Sea turtle exposure to vessel traffic noise from the proposed Project during the construction phase is likely to be very low. Noise effects within the Lease Area due to cable installation are expected to be comparable to vessel noise effects and, therefore, are expected to be very low.

6.9.2.1.6 Operations and Maintenance

Of sea turtle species that inhabit or visit the Northwest Atlantic, the majority are highly mobile and unlikely to be exposed to WTG noise during the operational phase of the Project. Leatherback and Kemp's ridley sea turtles, which are commonly more attracted to nutrient-dense nearshore areas than other species, may be exposed to WTG noise but behavioral effects are predicted to be minimal. Any behavioral changes from WTG noise exposure that may occur are expected to be localized when a sea turtle is in close proximity to an operating WTG.

Given the higher level of vessel traffic in the region resulting from high mariner activity, sea turtles that frequent the area are likely habituated to vessel noise and vessels associated with the proposed Project will not significantly increase the noise to the existing soundscape. Therefore, sea turtle exposure to vessel traffic noise and other noise from the proposed Project during the operations phase is likely to be very low.

6.9.2.1.7 Decommissioning

Introduced sound during decommissioning is expected to be similar to introduced sound during the construction phase (see Section 6.9.2.1). Consequently, introduced sound effects on sea turtles during decommissioning are anticipated to be similar to those during construction.

6.9.2.2 Vessel Operations

TABLE 6-77. FINDINGS SUMMARY – VESSEL OPERATIONS

Sources of Changes in Vessel Traffic	Summary
Construction	
Increased vessel traffic – construction Project vessels	• Physiological effects are not expected due to the relatively low amount of time sea turtles spend at the ocean surface and high seasonality • Some behavioral effects are likely (avoidance behaviors) but would be temporary • Effects of changes in vessel traffic will be avoided, minimized, or mitigated by appropriate mitigation measures
Operations & Maintenance	
Increased vessel traffic – O&M Project vessels	• Physiological effects are not expected for marine mammal species • Behavioral effects are likely to be less than effects exhibited during the construction and decommissioning Project phases
Decommissioning	
Increased vessel traffic – decommissioning Project vessels	• Physiological effects are not expected due to the relatively low amount of time sea turtles spend at the ocean surface and high seasonality • Some behavioral effects are likely (avoidance behaviors) but would be temporary • Effects of changes in vessel traffic will be avoided, minimized, or mitigated by appropriate mitigation measures

Vessel strikes are a known mortality risk for sea turtles (Foley et al., 2019; Lutcavage et al., 1997). Sea turtle vessel strikes are commonly attributed to commercial fisheries boats, but a variety of vessel classes have been involved in the vessel strike of marine animals, ranging from vessels less than 49 ft (15 m) to very large motorized vessels greater than 262 ft (80 m) (Schoeman et al., 2020). The vessels typically used during offshore wind development are WTG installation vessels (246 to 525 ft [75 to 160 m] in length), cable-lay vessels (82 to 492 ft [25 to 150 m] in length), heavy lift vessels (328 to 591 ft [100 to 180 m] in length), tug boats (66 to 164 ft [20 to 50 m] in length), barges (82 to 328 ft [25 to 100 m] in length), offshore supply vessels (148 to 361 ft [45 to 110 m] in length), personnel transport vessels (66 to 230 ft [20 to 70 m] in length), and survey vessels (49 to 525 ft [15 to 160 m] in length; Douglas-

Westwood, LLC., 2013). The level of vessel strike for sea turtles is often determined by sea turtle behavioral movements, vessel size and vessel speeds. Sea turtles spend 89 to 96 percent of the time submerged, with the exception of leatherback sea turtles who spend about 55 to 80 percent of the time submerged (Hays et al., 2000; Eckert, 1989; Lanyon et al., 1989). Sea turtles are unlikely to be at risk to vessel strikes during these long periods of submergence. However, during time periods when sea turtles are foraging near the ocean surface or coming up to breathe, there is a likely correlation between vessel speed and potential for vessel strikes (Shimada et al., 2017; Hazel et al., 2007;). Sea turtles have demonstrated decreased avoidance behaviors to vessels traveling at speeds over four kilometers per hour, making them more vulnerable to vessel strikes. The higher risk of sea turtle vessel strikes may occur during vessel movement from nearby ports to the Project Area, as increased vessel speeds are typical for smaller vessels traveling farther distances offshore. Vessels will travel at speeds in compliance with the Mayflower Wind lease and other regulatory requirements. See Section 3.3.15 Vessels, Vehicles, and Aircrafts, for more information on proposed Project vessels. Alternatively, low maneuverability and visibility of large vessels may increase sea turtle vessel strike risk. Vessel traffic effects in the proposed offshore export cable corridors are expected to be similar to the effects experienced with construction activities in the proposed Project Area; vessel speeds are expected to be lower during offshore export cables installation activities (see Section 3, Description of Proposed Activities, for more details).

6.9.2.2.1 Construction

Potential exposure of sea turtles to vessels used during the construction phase is considered low due to the high seasonality of sea turtles present in the Project Area and the low amount of time sea turtles spend at the surface. Project mitigation measures (see Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan) designed to reduce or eliminate vessel strikes with marine species will further reduce potential effects. Although there is a possibility that sea turtles may alter their behavior while in close proximity to vessels, research suggests that sea turtles will continue to forage in key habitats despite increased vessel traffic (Denkinger et al., 2013).

To avoid, minimize, or mitigate potential effects to sea turtles from Project vessels, Mayflower Wind will ensure all vessels underway do not intentionally approach any sighted sea turtle, and that vessels maintain a separation of 164 ft (50 m) or greater from any sighted sea turtle. Mayflower Wind will require all vessels operating within and transiting to/from the Lease Area comply with the vessel strike avoidance measures specified in lease stipulations or NOAA authorization (see Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan).

6.9.2.2.2 Operations and Maintenance

Project vessel traffic is expected to decrease during the O&M phase; therefore, sea turtles are expected to be affected less by changes in vessel traffic during the operations phase compared to the construction phase of the proposed Project.

6.9.2.2.3 Decommissioning

Vessel traffic rates during decommissioning are expected to be similar to traffic rates during the construction phase (see Section 6.9.2.1). Consequently, the risk of vessel strikes for sea turtles during decommissioning are anticipated to be similar to those during construction. Collision risk from removing the cables will be short-term, localized to the Project Area and similar to those experienced during cable installation. If the Project’s offshore export cables are left in place to minimize environmental effects, there will be no vessel strike risk from cable decommissioning. See Section 3.3.5, Offshore Export Cables, for more information on proposed offshore export cables decommissioning activities.

6.9.2.3 Seabed (or Ground) Disturbance

TABLE 6-78. FINDINGS SUMMARY – SEABED DISTURBANCE

Sources of Seabed Disturbance	Summary
Construction, Decommissioning	
Seafloor preparation	• Physiological effects are not expected. • Some avoidance behavior may be exhibited. However, seabed disturbance is unlikely to affect sea turtles. • Any effects of seabed disturbance will be avoided, minimized, or mitigated by appropriate mitigation measures.
Pile driving	
Foundation and scour protection installation	
Inter-array cable installation	
Export cable installation	
Vessel anchoring (including spuds)	

6.9.2.3.1 Construction

Seafloor disturbances will occur during the installation of the WTG and OSP foundations and the inter-array and offshore export cables. There is very little information available about how seabed disturbance affects sea turtles. The primary prey species for Kemp's ridley, leatherback, and loggerhead sea turtles are bottom-dwelling crustaceans and mollusks and therefore are likely to be exposed to seabed disturbance from proposed Project construction activities.

During the construction phase of the proposed Project, some avoidance behavior may be exhibited by sea turtles in the Project Area during activities likely to cause seabed disturbance. However, seabed disturbance is expected to be short-term and localized. Project mitigation measures, including employing a scour protection system, will minimize the potential effects of seabed disturbance on sea turtles.

6.9.2.3.2 Decommissioning

During the decommissioning phase of the Project, seabed disturbance effects are expected to have similar levels of seabed disturbance as the construction phase of the Project. WTGs and their foundation components will be removed from the Project Area. See Section 3.3.1, Substructures, and 3.3.2, Wind Turbine Generator, for more information on proposed substructure and WTG decommissioning activities. Noise produced by such equipment is not comparable to pile driving and is not expected to disturb or harm sea turtles more than general vessel traffic noise. This process is not expected to disturb or harm sea turtles more than general vessel traffic noise, and turbidity will be minimized therefore foraging will be untouched.

Effects from removing the cables will be localized to the offshore export cable corridors and similar to those experienced during cable installation. See Section 3.3.5, Offshore Export Cables, for more information on proposed offshore export cable decommissioning activities. The proposed Project's offshore export cables may be left in place to minimize environmental effects; in this instance, there will be no effects from decommissioning.

6.9.2.4 Habitat Disturbance and Modification

TABLE 6-79. FINDINGS SUMMARY – HABITAT DISTURBANCE AND MODIFICATION

Sources of Habitat Disturbance and Modification	Summary
Construction	
Foundation and scour protection installation Export cable installation	• Physiological effects for sea turtles are not expected to occur • Behavioral effects may occur due to changes in prey availability, particularly for juvenile sea turtles; these effects will likely be temporary and localized
Operations & Maintenance	
Benthic colonization at Project foundation areas	• Foundation areas (and potentially some areas along the offshore export cable corridors) will create artificial reef habitat that may have a positive effect on sea turtles due to an increase in prey resources • Attraction of fish to artificial reefs may attract increased vessel traffic from fisheries and recreational activity, which could increase vessel strike risk for sea turtles
Decommissioning	
Foundation and scour protection removal	• Physiological effects for marine mammals are not expected to occur • Behavioral effects may occur due to changes in prey availability; these effects will likely be temporary and localized

It is commonly recognized that sea turtle populations have been greatly affected by habitat loss and modification (Fuentes et al., 2016); the greatest effect to sea turtle populations comes from nesting site alterations. Project activities may affect sea turtles (such as leatherback and Kemp's ridley sea turtles) as these species utilize the Offshore Project Area and the neighboring waters. These species could exhibit behavioral changes in foraging during proposed Project construction activities due to potential changes in prey availability. However, less is known about prey availability in this region respective to offshore wind development. Primary prey species for juvenile Kemp's ridley sea turtles (spider crabs [*Libinia emarginata*], lady crabs [*Ovalipes ocellatus*], and rock crabs [*Cancer irroratus*]) have been regularly observed in trawl surveys of Massachusetts waters (Camisa et al., 2020; Morreale & Standora, 1992, 1989). Leatherback sea turtle inshore presence has been linked to inshore movements of its primary prey, the jellyfish (Payne & Selzer, 1986; Lazell, 1980). Juvenile leatherback and Kemp's ridley sea turtles may experience higher exposure to habitat disturbance than green or loggerhead sea turtles.

6.9.2.4.1 Construction

The construction phase of the proposed Project is expected to affect prey availability in the Project Area, which may cause sea turtle habitat disturbance, particularly for juvenile sea turtles. However, habitat disturbance, and thus impacts to prey availability, during the construction phase is expected to be temporary and reversible. Project mitigation measures, including employing a scour protection system, will minimize the potential effects of seabed disturbance on sea turtles.

6.9.2.4.2 Operations and Maintenance

During the operations phase, the presence of WTG and OSP foundations and scour infrastructure will change the seafloor and could create an artificial reefing effect, resulting in colonization by benthic species that could increase prey availability for sea turtles. This attraction of prey species to artificial reefs may attract increased vessel traffic from fisheries and recreational activity, which could increase vessel strike risk for sea turtles (Kraus et al., 2019). Implementation of mitigation and BMPs (see **Section 16**, Summary of Avoidance, Minimization, and Mitigation Measures, and Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan) will minimize these potential effects to sea turtles.

6.9.2.4.3 Decommissioning

During the decommissioning phase of the Project, habitat disturbance and modification are expected to similarly affect sea turtles as habitat disturbance and modification during the construction phase of the proposed Project. The removal of the WTGs during decommissioning may affect sea turtle prey availability, but the disturbance is expected to be temporary and reversible following Project decommissioning.

6.9.2.5 Change in Ambient EMF

TABLE 6-80. FINDINGS SUMMARY – CHANGE IN AMBIENT EMF

Sources of EMF	Summary
Operations & Maintenance	
Introduced EMF from offshore export cables Introduced EMF from inter-array cables	• Physiological and behavioral effects are not expected • Industry export cable sheathing and burial methods will significantly decrease EMF detection by EMF-sensitive marine species

The Project’s offshore cable system will generate EMF that could potentially affect sea turtle movements and behaviors as well as prey availability. Sea turtles are sensitive to natural geomagnetic fields used for navigation and migration (Lohmann et al., 2001; Normandeau Associates, Inc. et al., 2011). This geomagnetic orientation can be seen in sea turtles as early as the hatchling phase. Using experimental methods, Lohmann et al. (1997) found that loggerhead hatchlings orient themselves using the Earth’s magnetic fields to migrate far distances (Lohmann et al., 2012). Available research on the effects of anthropogenic EMF generation on sea turtles suggests that sea turtles are likely unaffected by these additional EMFs (Copping et al., 2016). However, additional research is needed on the effects of EMFs on sea turtles, particularly on juvenile sea turtles (Gill & Desender, 2020).

Sea turtles commonly depend on geomagnetic mapping during migration. Earth’s geomagnetic field in U.S. waters is around 50 µT. Loggerhead and green sea turtle geomagnetic sensitivity has been documented as ranging from 0.00469 to 4,000 µT and 29.3 to 200 µT, respectively (Normandeau Associates, Inc. et al., 2011). A review of ten offshore wind farm cable systems found an average EMF output of 7.8 µT and a maximum of 14 µT. However, this average may increase as offshore wind technology continues to develop (Normandeau Associates, Inc. et al., 2011). Due to the proximity of the offshore export cable corridors to shore, sea turtles are likely to come in contact with EMF generated from Project cables while foraging. However, sea turtles tend to use other sensory cues during foraging activities as well (Endres & Lohmann, 2012; Narazaki et al., 2013; Constantino & Salmon, 2003).

Mayflower Wind conducted an EMF analysis of the Project Area, encompassing several different modeled export cable burial depths and cable spacings to represent both likely submarine cable installation conditions as well as worst-case installation conditions (Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). The analysis focused on magnetic fields only because direct electric fields are expected to be shielded by grounded metallic armoring. The target burial depth for the offshore export cables is approximately 6.6 ft (2 m), and the modeling assumed a 6.6 ft (2 m) distance from the seafloor to the tops of the Project's offshore export cables. For the conservative case installation scenario modeled in Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project, magnetic fields were modeled at 1 ft (0.3 m) above the cable under the assumption that the cable will be covered with a 1-ft thick (0.3-m thick) mattress. The analysis found that the subsea cables are expected to emit approximately 60 Hz alternating current magnetic fields, which are well outside the typical EMF detection range of magnetosensitive and electrosensitive marine species (see Appendix P1, Electric and Magnetic Field (EMF) Assessment for the Proposed Mayflower Wind Project). Depth of cable burial beneath the seafloor and the type of cable sheathing that is common for offshore export cables fortification will reduce EMFs. Considering these factors and data, the exposure level of sea turtles to EMF is expected to be very low.

6.9.2.5.1 Operations & Maintenance

The effects of sea turtle exposure to EMFs during the operations phase is expected to be insignificant. The proposed Project will employ industry standard cable burial and cable sheathing methods to reduce potential EMF effects on sea turtles.

6.9.2.6 Entanglement

TABLE 6-81. FINDINGS SUMMARY – ENTANGLEMENT

Sources of Entanglement	Summary
Construction and Decommissioning	
Lines and anchoring equipment utilized during construction and decommissioning activities	• Physiological and behavioral effects are not expected to occur for sea turtles • Any potential entanglement effects will be avoided, minimized, or mitigated by appropriate mitigation measures

Entanglement is a common mortality risk for sea turtles, typically occurring from commercial fishing gear and marine debris (Caretta et al., 2004; Plotkin & Amos, 1990; Upite et al., 2019). Research assessing entanglement risk at offshore renewable energy developments is limited and preliminary. All four sea turtle species were regularly observed entangled in equipment for oil and gas developments in the Gulf of Mexico, including trawl nets, moored buoy lines, and seismic equipment (NMFS, 2020e). Available studies have generally found that entanglement risk to marine animals at offshore wind farms is low and can be further reduced by following mooring line designs known to pose the least amount of entanglement risk (Benjamins et al., 2014). At offshore renewable energy sites, there are currently no documented reports of sea turtle entanglement as there are no lines, ropes, netting or structures that create risk of tangling or catching a sea turtle. The proposed Project will adopt mitigation strategies to reduce entanglement risk at mooring lines and in geophysical equipment during construction, such as ensuring lines are sufficiently taut and are covered with rubber sleeves to prevent tissue damage in the event entanglement does occur. Leatherback and loggerhead turtles are expected to have a higher level of exposure to due to their higher abundance in the Lease Area. However, for this proposed Project there is a lack of equipment and structure that is known to potentially entangle sea turtles.

6.9.2.6.1 Construction

Sea turtle exposure to entanglement during the construction phase is expected to be very low. The proposed Project will employ industry standard mitigation methods to reduce entanglement risk. Methods include, but are not limited to, ensuring any structures or devices attached to the seafloor for continuous periods greater than 24 hours use the best available mooring systems (vertical and float lines, swivels, shackles, and anchor designs) for minimizing the risk of entanglement or entrainment of sea turtles, while still ensuring the safety and integrity of the Project structure or device.

6.9.2.6.2 Decommissioning

Sea turtle exposure to entanglement during the decommissioning phase is expected to be very low. The proposed Project will employ industry standard mitigation methods to reduce entanglement risk (see Section 6.9.2.6.1).

6.9.2.7 Planned Discharges

TABLE 6-82. FINDINGS SUMMARY – PLANNED DISCHARGES

Sources of Planned Discharges	Summary
Construction, Operations & Maintenance, Decommissioning	
Planned vessel discharges	• Potential effects to sea turtles will likely be insignificant • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of discharges and spills

Vessels used during offshore construction activities are also known to routinely release bilge water, engine cooling water, deck drainage, and/or ballast water. Such releases are temporary and would be immediately dispersed and diluted. In the event an unplanned spill does occur in the Project Area, Mayflower Wind will comply with the regulatory requirements related to the prevention and control of discharges and spills, consistent with MARPOL regulations, as documented in Appendix AA, Oil Spill Response Plan.

6.9.2.7.1 Construction

Due to the expected dispersion and dilution of planned discharges, planned vessel discharges during the construction phase of the Project are not expected to have a significant effect on sea turtles in the Project Area.

6.9.2.7.2 Operations and Maintenance

There is potential for entrapment of sea turtles within the vertical intake pipes of the CWIS, based on historical evidence of entrapment in cooling water intakes at other facilities. Sea turtles, especially smaller or less mobile individuals, in the vicinity of the OSPs may experience entrapment within intake pipes of the CWIS. Records of sea turtles becoming trapped within cooling water intakes from power plants have been common, though incidents are primarily located in warmer regions where sea turtles are likely to occur year-round and in higher-volume cooling water systems (i.e., those of nuclear power plants) (Florida Power and Light, 1995; Florida Power Corporation, n.d.). While the likelihood of sea turtle entrapment is low due to the seasonal nature and overall low sea turtle abundance in Offshore Project Area waters (see Section 6.9.1), mitigation measures proposed to reduce overall entrainment (e.g., intake velocity of 0.5 ft/s and appropriately sized bar racks) are expected to minimize these risks further. Mayflower Wind will consult with EPA and NMFS to ensure appropriately sized bar racks are included in the engineering design to minimize the risk of entrapment at the CWIS.

The thermal plume created by effluent from cooling water discharge may also affect sea turtles occurring near the OSPs. Behavioral and biological impacts of heated effluent from cooling water discharges have been studied, however are not well understood. Research suggests green sea turtles may use plumes from cooling water effluent as thermal refuge or foraging habitat, potentially resulting in extended residence times in areas outside natural movement or migratory periods (Crear et al., 2016; Turner-Tomaszewicz and Seminoff, 2012). Green sea turtles inhabiting areas downstream of warm effluent have also been observed to have increased growth rates relative to other individuals in similar regions (Eguchi et al., 2012). It may be unlikely for sea turtles to experience these thermal impacts from Mayflower Wind cooling operations due to the relatively small discharge plume and localized temperature increase within the mixing zone in comparison to other, larger CWIS at coastal facilities.

Planned vessel discharges during the operations phase of the proposed Project are not expected to have a significant effect on sea turtles in the Project Area.

6.9.2.7.3 Decommissioning

Effects associated with planned discharges in the Project Area during decommissioning are expected to be similar to the effects described in the construction phase of the proposed Project.

6.9.2.8 Accidental Events

TABLE 6-83. FINDINGS SUMMARY – ACCIDENTAL EVENTS

Sources of Accidental Events	Summary
Construction, Operations & Maintenance, Decommissioning	
Marine debris Unplanned vessel discharges	• Potential effects to marine mammals will likely be insignificant • In the unlikely event the proposed Project generates marine debris, marine debris would be removed in compliance with all regulatory requirements • Project vessels and offshore activities will comply with all regulatory requirements related to the prevention and control of discharges and spills

As noted in Section 3.4, Summary of Impact Producing Factors, discharge of marine debris is not expected to occur during proposed Project activities. The EPA and other relevant federal organizations implement oceanic protections to prevent further marine debris and other anthropogenic contaminants from entering the U.S. marine environment. Any marine debris produced will be removed from the Project Area in accordance with all regulations under the Clean Water Act.

Project vessels may experience unplanned releases of oil, solid waste, or other materials. Increased vessel traffic in the area of construction and at nearby ports may increase the likelihood of unplanned releases. Accidental spills and unplanned discharges are not expected to be produced by the proposed Project during the construction, O&M, or decommissioning phases. In the event an unplanned spill does occur in the Project Area, the proposed Project will comply with the regulatory requirements related to the prevention and control of discharges and spills, consistent with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

6.9.2.8.1 Construction

Discharge of marine debris is not expected to occur during proposed construction phase activities. Increased vessel traffic in the area of construction and at nearby ports may increase the likelihood of unplanned releases. Due to the likely rare occurrence of unplanned discharges, unplanned vessel discharges during the construction phase of the Project are not expected to have a significant effect on sea turtles in the Project Area.

6.9.2.8.2 Operations and Maintenance

Discharge of marine debris is not expected to occur during proposed O&M phase activities. Unplanned vessel discharges during the operations phase of the proposed Project are not expected to have a significant effect on sea turtles in the Project Area. In the unlikely event unplanned discharges occur in the Project Area, Mayflower Wind will comply with MARPOL regulations as documented in Appendix AA, Oil Spill Response Plan.

6.9.2.8.3 Decommissioning

Discharge of marine debris is not expected to occur during proposed decommissioning phase activities. Effects associated with unplanned discharges in the Project Area during decommissioning are expected to be similar to the effects described in the construction phase of the proposed Project.

6.9.3 Conclusion

Green, Kemp’s ridley, leatherback, and loggerhead sea turtles, all of which are listed as threatened/endangered under the ESA and MESA, have potential to be exposed to IPFs in the Project Area. Kemp’s ridley, leatherback, and loggerhead sea turtles are listed under Rhode Island’s SGCN. Based on an analysis of best available science and data, occurrences of green and Kemp’s ridley sea turtles are predicted to be uncommon. Leatherback and loggerhead turtle occurrences are expected to be common seasonally in the MA/RI WEA and both species have potential to be exposed to IPFs from the Project.

Potential effects to the noted sea turtle populations are expected to rare; Project effects on individual species are expected to be low. All potential effects to sea turtle populations are localized in the Project Area and will likely be avoided due to the mostly pelagic, highly seasonal use of the Project Area by sea turtles. If sea turtles are exposed to the IPFs, the stressors may affect behavior of sea turtles at the individual level, although such effects will likely be short-term and intermittent. The noted sea turtle species that could occur in the Project Area have some likelihood of being exposed to IPFs such as introduced sound, vessel operations, seabed disturbance, habitat disturbance and modification, marine debris, EMFs, entanglement, and planned and unplanned discharges. Finally, and as discussed below, avoidance, minimization, and mitigation measures and other BMPs are expected to reduce effects to sea turtles in the Project Area.

Mayflower Wind has proposed avoidance, minimization, and mitigation measures to avoid potential effects to sea turtles known to occur in the Project Area, which are summarized in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan. Most mitigation measures commonly used for marine mammals may also be used to mitigate effects to sea turtles.

7 CULTURAL RESOURCES

7.1 MARINE ARCHAEOLOGY

Submerged cultural heritage may include historic materials such as shipwrecks, sunken aircraft, and other maritime infrastructure, as well as inundated terrestrial paleolandscapes associated with Native American contexts. This section describes the potential underwater cultural heritage (UCH) in areas that may be affected by the proposed Project.

The Marine Archaeological Resources Assessment (MARA, see Appendix Q) for the Offshore Project Area was conducted according to the BOEM *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR 585* (BOEM, 2020a). The information and recommendations in the MARA are intended to assist the Tribes,[5] BOEM, the Massachusetts Historical Commission (MHC), the Massachusetts Board of Underwater Archaeological Resources (BUAR), Rhode Island Historical Preservation & Heritage Commission (RIHPHC), and other interested stakeholders and consulting parties, in their review of the proposed Project's potential effects on UCH.

Mayflower Wind conducted pre-survey meetings with the Tribes, BOEM, MHC, and BUAR to discuss the objective of the MARA. The surveys were performed under consultation with MHC, which serves as the Massachusetts State Historic Preservation Office (SHPO), and in accordance with a Special Use Permit issued by BUAR. Communications and engagements are ongoing with the Tribes, BOEM, MHC, and BUAR.

Mayflower Wind conducted pre-survey meetings for the Brayton Point export cable corridor with the Tribes and Rhode Island Coastal Resources Management Council (CRMC). The marine survey approach was described in a permit application submitted to RIHPHC and CRMC, and Mayflower Wind obtained approvals from both agencies. Consultations will be ongoing during the completion of the survey and preparation of the MARA.

The MARA provides:

- A review of the Offshore Project Area's cultural context from early Paleoindian occupation through the modern period to aid in understanding the variety of materials possible and the likelihood of preservation based on geological processes and environmental conditions;
- A review of the proposed Project's natural setting including glacial influence;
- Paleolandscape reconstruction to identify landforms with potential cultural significance to the Tribes within the APE; and
- An evaluation of historic archaeological potential and known maritime sites within the APE.

[5] *The Federally Recognized Tribes including the Narragansett Indian Tribe, the Mashpee Wampanoag Tribe, the Wampanoag Tribe of Gay Head (Aquinnah), the Shinnecock Indian Nation, the Delaware Indian Tribe, the Mashantucket Pequot Tribal Nation, and the Mohegan Tribe of Connecticut, as well as any other Tribes who have indicated interest in participating in the NEPA process.*

The MARA utilizes data from ongoing HRG surveys, geotechnical vibracores, geoarchaeological cores, and geotechnical borings in the Lease Area and offshore export cable corridors to evaluate UCH within the APE from 2019-2021.

The HRG surveys utilized a sub-bottom profiler (SBP), multichannel ultra-high-resolution seismic (MUHRS) imaging, single channel ultra-high-resolution seismic (SUHRS) imaging, side scan sonar (SSS, a multibeam echo sounder (MBES, and a transverse gradiometer (TVG). These data were assessed to identify potential preserved paleolandforms, archaeological sites, and submerged hazards. Seismic data were used to assist in planning the geoarchaeological and geotechnical campaigns.

The 2020 and 2021 vibracore campaigns completed geoarchaeological and geotechnical vibracores along the export cable corridors, and geotechnical boreholes in the Lease Area. Geoarchaeological vibracores were collected to provide data for paleolandscape reconstruction. Geotechnical vibracores were collected for engineering purposes and helped support the findings of the geoarchaeological cores. Geotechnical borings were collected in the Lease Area to support engineering needs. Specific borings were subsequently age dated based on the soils present and the seismic records to support paleolandscape reconstruction in the Lease Area. The collected geotechnical and geoarchaeological data were analyzed for materials indicative of pre-contact and historic origins as well as environmental markers indicative of preserved paleolandscapes that might be affected by Project activities. The detailed methodology is provided in Appendix Q, Marine Archaeological Resources Assessment.

The assessment provides recommendations for additional investigations, proposed avoidance distances for delineated archaeological sites, and proposed minimization and mitigation measures (see Appendix Q, Marine Archaeological Resources Assessment).

7.1.1 Affected Environment

The proposed Project can directly affect UCH through seabed disturbing activities during the installation and construction of the WTGs, OSPs, inter-array cables and offshore export cables. The proposed Project can also potentially indirectly affect UCH through sediment displacement or Project induced scour in the APE.

The APE includes the maximum horizontal and vertical limits of anticipated seabed disturbance from Project components, including installation equipment. **Table 7-1** describes the maximum expected horizontal and vertical APEs, and **Figure 7-1** illustrates the APE for UCH. **Figure 7-1** does not present the inter-array cable APE as its layout is still preliminary and is based on a notional layout.

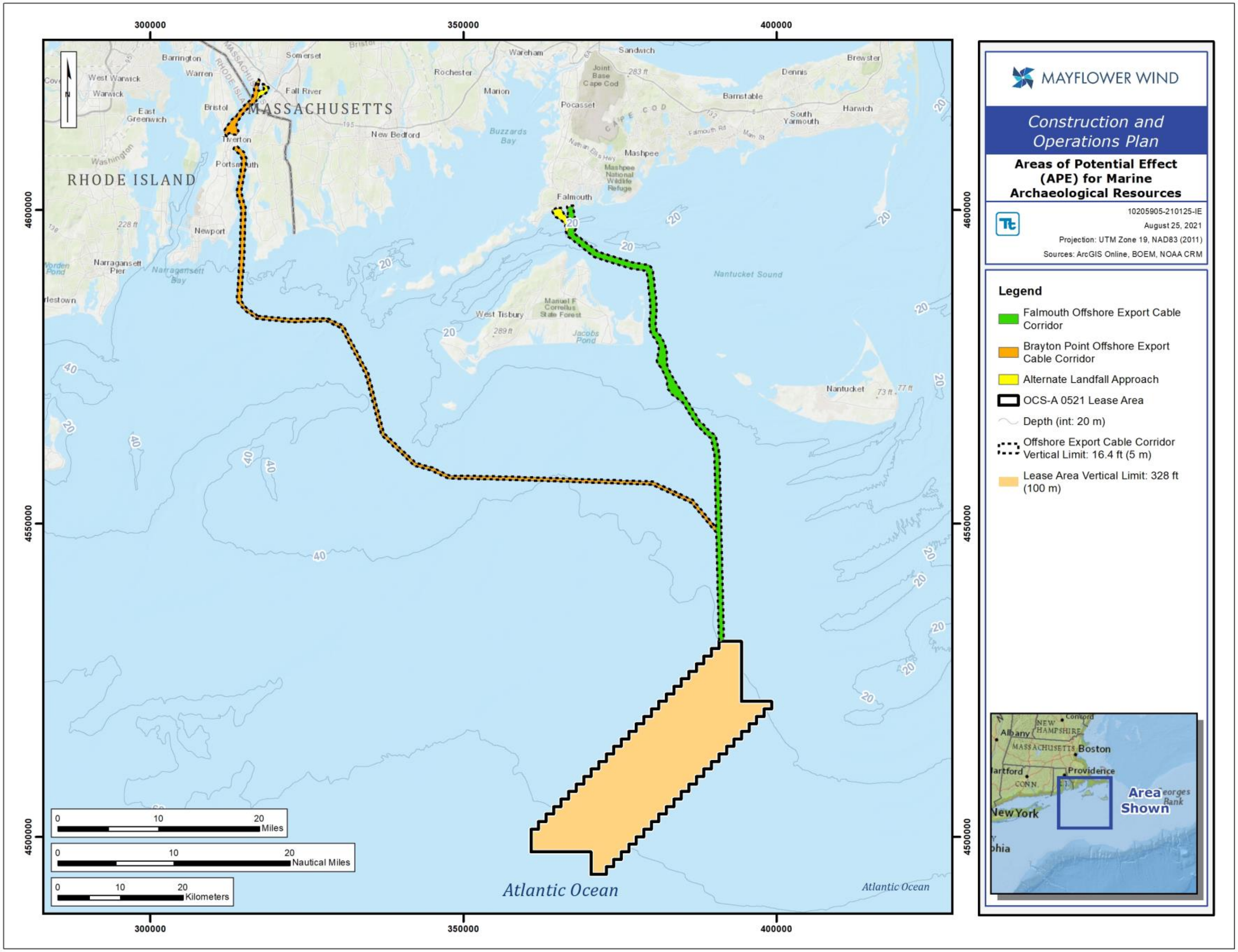


FIGURE 7-1. APE FOR UNDERWATER CULTURAL HERITAGE

TABLE 7-1. HORIZONTAL AND VERTICAL LIMITS OF THE APE FOR UCH

Project Component	APE Horizontal Limit	APE Vertical Limit
WTGs/OSPs	984 ft x 984 ft (300 m x 300 m) box per WTG/OSP.	262 ft (80 m)
Inter-array cables	295-591 ft (90-180 m) centered on the cables along their entire length.	10 ft (3 m)
Falmouth offshore export cable corridor	2,624-3,280 ft (800-1,000 m) centered on the cables along their entire length.	16.4 ft (5 m)
Falmouth HDD		90 ft (27 m)
Brayton Point offshore export cable corridor	Up to 2,300 ft (700 m) centered on the cables along their entire length.	16.4 ft (5 m)
Brayton Point HDD		90 ft (27 m)
Aquidneck Island HDD		90 ft (27 m)

Notes: Cable corridors may be locally wider in specific areas to allow for micro-routing and hazard avoidance
Cables may be micro-routed within the defined and surveyed APE Horizontal Limit

7.1.1.1 Shipwrecks and Obstructions

The HRG survey revealed the presence of multiple SSS contacts and magnetic anomalies within the APE. Some of the delineated contacts and anomalies represent UCH that may require mitigation or avoidance. Review of NOAA Electronic Navigational Charts, the NOAA Wrecks and Obstructions Database, and the BOEM Archaeological Resource Information Database was conducted in tandem. The results of the identification and investigation of any shipwrecks, preserved features, or obstructions are detailed in Appendix Q, Marine Archaeological Resources Assessment.

7.1.1.2 Paleolandscape

To complete paleolandscape reconstruction, archaeologists first create a ground model of the formerly terrestrial continental shelf. The model delineates landforms and features that were available and attractive to human populations living there prior to marine transgression. These landforms can include rivers, streams, channels, topographic highs, and other terrestrial surfaces preserved below marine sediments. Using seismic data, geotechnical data, and geoarchaeological analyses, multiple subsurface features were carefully reconstructed within the Lease Area, the Falmouth offshore export cable corridor, and the Brayton Point offshore export cable corridor.

Landscape reconstruction indicates that intact landforms are potentially present within the Offshore Project Area and may potentially retain deposits that supported human occupation from the terminal Pleistocene until submergence. Evidence for such occupation is dependent on the preservation potentials of the study area. Overall, the Lease Area has a low to moderate probability for preserved landforms with the potential to contain cultural resources. Both of the export cable corridors have a low probability for preserved landforms with the potential to contain cultural resources.

Detailed information is provided in Appendix Q, Marine Archaeological Resources Assessment.

7.1.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cables, and onshore export cables), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020b). IPFs were adapted from BOEM's (2020b) *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build-out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

The proposed Project will either avoid to the extent practicable or mitigate any UCH identified within the APE. The IPFs will be associated with the installation and construction of the offshore Project components: the WTGs, OSPs, the inter-array cables, and offshore export cables extending from the Lease Area to the landfall locations.

Periodic maintenance and repairs of offshore Project components will not directly affect additional known UCH outside the APE, as these activities are limited to the APE.

Similarly, any decommissioning activities will be limited to already disturbed areas, and thus, will not directly affect known UCH, although indirect effects may arise from the sediment suspension and deposition produced by decommissioning activities. See Section 3.3, Project Components and Project Stages, for further information on decommissioning of offshore components.

Table 7-2 provides a summary of the potential effects from the proposed Project on UCH, and discussions of these effects are presented below. Proposed avoidance, minimization, and mitigation measures to reduce potential effects on UCH are summarized in Section 16, Summary of Avoidance, Minimization, and Mitigation Measures.

TABLE 7-2. IPFS AND POTENTIAL EFFECTS ON UNDERWATER CULTURAL HERITAGE IN THE OFFSHORE PROJECT AREA

IPF	Potential Effect		Period of Potential Effect		
	Project Component		Construction	O&M	Decomm.
	Lease Area	Export Cable Corridors			
Seabed (or ground) Disturbance	Unanticipated discovery of UCH	Unanticipated discovery of UCH	X	-	-
Sediment Suspension and Deposition	Unanticipated discovery of UCH	Unanticipated discovery of UCH	X	X	X

7.1.2.1 Seabed (or Ground) Disturbance

The proposed Project may affect UCH where offshore infrastructure (WTGs, OSPs, and offshore export cables) are installed in the horizontal and vertical APE of the Lease Area and offshore export cable corridors.

7.1.2.1.1 Construction

Project activities that could affect UCH include seabed preparation, foundation construction, inter-array and export cable installation, placement of scour protection, as well as vessel anchoring and vessel jack-up legs. See Section 3.3, Project Components and Project Stages, for detailed information on Project infrastructure and installation and construction activities. To prevent potential direct effects, all delineated UCH within the APE will either be avoided to the extent practicable or mitigated in accordance with best practices and federal guidance.

Appendix Q, Marine Archaeological Resources Assessment, will be updated in early 2022 with additional survey data and interpretations once the full APE is surveyed. Additional data review and research is necessary to determine if any UCH are eligible for listing on either the National Register of Historic Places (NRHP) or Massachusetts' State Register of Historic Places. Mayflower Wind will continue consultation with the relevant authorities and stakeholders to determine if additional mitigation measures are required.

Any areas with UCH or significant paleolandscapes that could be affected by the proposed Project will be marked and avoided as practicable. The precise dimensions of the avoidance zones will be determined once all data collection and analysis are complete in accordance with state and federal guidance. In addition, radiocarbon dating of additional borehole samples from the 2021 geophysical and geotechnical survey campaign may lead to the identification of sensitive landforms that should be marked for avoidance or mitigation.

Mayflower Wind anticipates further consultations with the Tribes, BOEM, MHC, BUAR, RIHPHC, and other consulting parties to assist in BOEM's determination of effects under NEPA (42 U.S.C. §§ 4321 *et seq.*, 1969) and any appropriate mitigation measures to avoid, minimize, or mitigate potential affects to UCH. Mayflower Wind will develop an Unanticipated Discovery Plan in the unlikely event unidentified and unanticipated UCH are encountered during dredging or construction activities. This process will include consultation with the Tribes and all applicable federal and state agencies.

7.1.2.2 Sediment Suspension and Deposition

Although unlikely, sediment suspension and deposition may affect known UCH during the installation, maintenance, and decommissioning of offshore infrastructure (WTGs, OSPs, inter-array cables, and offshore export cables) in the horizontal and vertical APE of the Lease Area and offshore export cable corridors.

7.1.2.2.1 Construction, Operations and Maintenance, and Decommissioning

Sediment suspension and deposition may occur during Project-related activities requiring the disturbance of the seabed. Deposition of suspended sediment is anticipated to be localized around seabed disturbances. The low energy deposition of sediments over UCH buried beneath the seabed is not expected to disturb or otherwise affect the integrity of those UCH. Furthermore, the avoidance buffers around potential shipwreck and obstruction sites, and paleolandscapes will further reduce any Project-related effect. See Appendix F1, Sediment Plume Impacts from Construction Activities and Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment, for results of sediment plume modeling for Project installation activities.

7.2 TERRESTRIAL ARCHAEOLOGY

Cultural resources include archaeological sites, above-ground buildings and structures, objects, districts, and other properties that illustrate important aspects of pre-Contact or post-Contact or that have important and long-standing cultural associations with established communities or social groups. This section describes the terrestrial archaeological resources in areas that may be affected by the proposed Project.

Appendix R, Terrestrial Archaeological Resources Assessment (TARA) of the Onshore Project Areas, was conducted according to the BOEM *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR 585* (BOEM, 2020a).[6] The information and recommendations in the TARA are intended to assist BOEM, MHC, BUAR, RIHPHC and other interested stakeholders and consulting parties, in their review of the proposed Project's potential impact on archaeological resources. Communications and engagements have been initiated and are ongoing with the MHC, the BUAR, and RIHPHC.

The TARA included a review of the environmental context and a discussion of the cultural context from the early Paleoindian occupation through European colonization to the modern period. The APE, as defined by 36 CFR § 800.16(d), is "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 2020a). The Terrestrial Archaeological Preliminary APE (PAPE) includes all areas of possible temporary and permanent physical disturbances. Within the Falmouth Onshore Project Area, a larger Terrestrial Archaeological Study Area was identified to include 1.0 mi (1.6 km) around all onshore Project components in Falmouth (see **Figure 7-2**). This allows for a greater understanding of the general area and a more informed archaeological sensitivity model. Within the Falmouth Onshore Project Area, a PAPE was established consisting of the top two preferred potential upland landfall HDD sites at Worcester Avenue (preferred landfall) and Central Park (alternate landfall), either of the alternate onshore substation locations at Lawrence Lynch (preferred) and Cape Cod Aggregates (alternate), and all onshore underground export and transmission cables from the landfall to the Lawrence Lynch site and from the landfall to Cape Cod Aggregates site. Construction laydown areas will be confined to the PAPE of these Project components. Within the Brayton Point Onshore Project Area, a PAPE was established, consisting of the site of the former coal-fired Brayton Point Power Station south of Interstate I-195 and west of Brayton Point Road in Somerset, Massachusetts (see **Figure 7-3**). A PAPE was established for the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island, consisting of the open cut cable duct alternates on Anthony Road and Boyds Lane and the Sakonnet River, Roger Williams University Property, TNEC/PPL ROW, Montaup Country Club, and Mount Hope Bridge HDD sites in Portsmouth (see **Figure 7-4**). The Terrestrial Archaeological APE includes areas where ground disturbance is proposed as defined in **Table 7-3**. Since a final determination for the location(s) of the O&M facility has not yet been made, the Terrestrial Archaeological PAPE for the O&M facility will be defined using a process of phased identification and evaluation, in consultation with BOEM and the SHPO, as defined in 36 CFR § 800.4(b)(2).

---

[6] Appendix R, TARA has been revised to include all Project components related to both the Falmouth Onshore Project Area and the Brayton Point Onshore Project Area. The current TARA includes the Falmouth Phase IA Report, Falmouth Phase IB Intensive Archaeological Survey Permit, Brayton Point Phase IA Report, and Aquidneck Island Phase IA/IB Report.

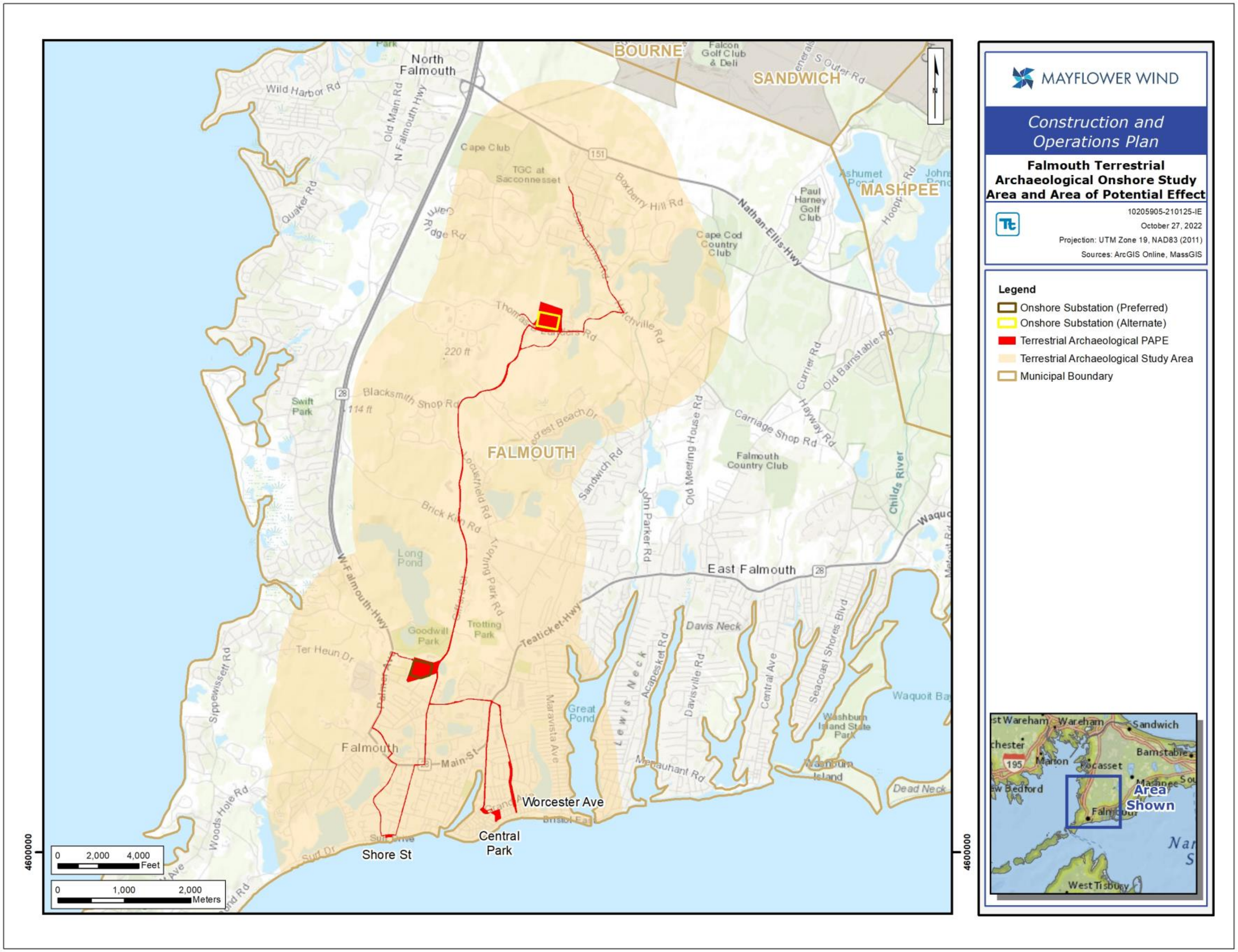


FIGURE 7-2. TERRESTRIAL ARCHAEOLOGICAL STUDY AREA AND PAPE—FALMOUTH

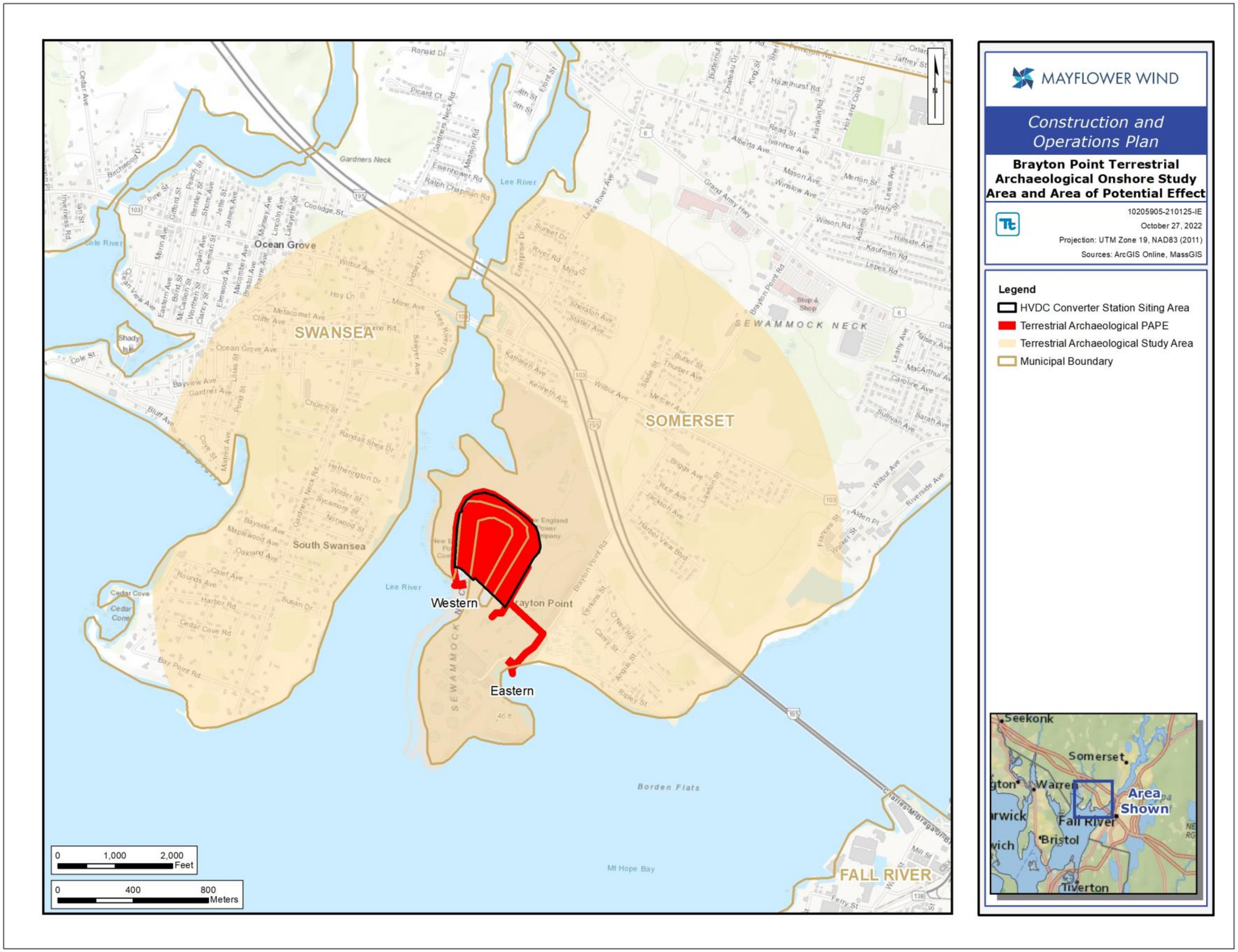


FIGURE 7-3. TERRESTRIAL ARCHAEOLOGICAL STUDY AREA AND PAPE—BRAYTON POINT

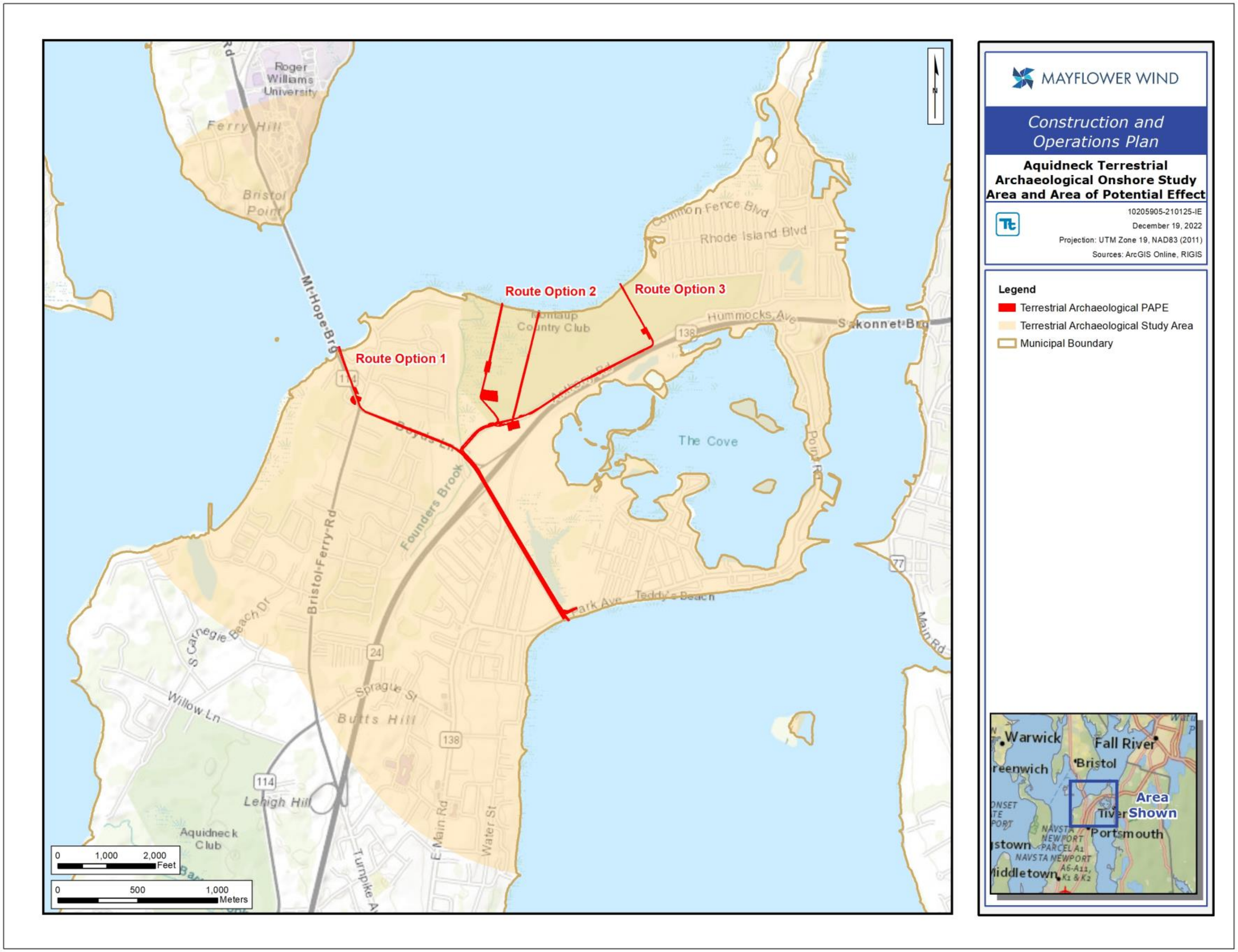


FIGURE 7-4. TERRESTRIAL ARCHAEOLOGICAL STUDY AREA AND PAPE—AQUIDNECK ISLAND

TABLE 7-3. TERRESTRIAL ARCHAEOLOGICAL PAPE

Project Component	Max. Horizontal Area of Disturbance	Max. Vertical Depth of Disturbance	Length	Breadth
	(ac)	(ft)	(ft)	(ft)
Falmouth Project Components				
Falmouth export cable landfall (HDD)	2.5	90	500 a/	500 a/
Falmouth onshore cable installation area (export & interconnection)	36.2	25	44,880	50 a/
Falmouth onshore substation	31.0	60	1,200	1,200
Aquidneck Project Components				
Aquidneck export cable landfall (HDD)	1.6	90	500 a/	500 a/
Aquidneck onshore export cable installation area	8.5	25	11,616	50 a/
Aquidneck export cable route departure (HDD)	1.8	90	500 a/	500 a/
Brayton Point Project Components				
Brayton Point export cable landfall (HDD)	1.2	90	500 a/	500 a/
Brayton Point onshore export cable installation area	2.2	25	3,168	50 a/
Brayton Point converter station	10.0	60	800 a/	700
Brayton Point onshore interconnection cable installation area	2.2	25	2,640	50 a/

a/ conservative dimension method

Known archaeological sites within the Terrestrial Archaeological Study Area and previous archaeological studies conducted within 1 mi (1.6 km) of the proposed Onshore Project Areas are presented in the TARA. The TARA includes a modeled archaeological sensitivity based on environmental factors and cultural context. A walkover survey was completed in the accessible portions of the Falmouth Onshore Project Area and the Brayton Point Onshore Project Area to document the current extent of disturbance and to adjust the archaeological sensitivity. A Phase IA/IB assessment including Phase I site identification archaeological testing was undertaken for the Aquidneck Island components of the Project. The archaeological sensitivity of the Onshore Project Areas has been presented with particular attention to areas of “high” sensitivity for potential occurrence of archaeological sites (Appendix R). The individual Phase IA and Phase IA/IB assessments within the TARA provide recommendations for additional investigations, as well as proposed avoidance, minimization, and mitigation measures (see Appendix R, TARA).

Technical appendices related to terrestrial archaeology include:

- Appendix R, TARA

7.2.1 Affected Environment

Based on MHC files, 18 pre-Contact archaeological sites and four post-Contact archaeological sites were identified within the Falmouth Terrestrial Archaeological Study Area. In addition to archaeological sites identified within the Falmouth Terrestrial Archaeological Study Area, 27 standing post-Contact structures have been inventoried in the greater vicinity of the Falmouth Terrestrial Archaeological Study Area; these sites were also evaluated to further characterize archaeological sensitivity. Nine of these standing structures, all pre-dating 1915, may have a direct impact on the archaeological sensitivity of Project components. While all the sites were locations of isolated finds, their occurrence indicates the presence of pre-Contact activity near the Falmouth Onshore Project Area.

Eleven previous archaeological surveys have been conducted within 1 mi (1.6 km) of the Falmouth Terrestrial Archaeological Study Area between 1980 and 2018. Additionally, one study of submerged landforms suggests the possible presence of buried pre-Contact archaeological sites within the vicinity of the shore-land interface in Nantucket Sound (Robinson et al., 2004). See Appendix R, TARA, for additional detail on these surveys.

MHC files research identified a total of 52 aboveground inventoried historic properties and 23 historic resources, districts, or archaeological sites recorded within 1 mi (1.6 km) of the preliminary APE established for Brayton Point. The identified archaeological sites include 16 pre-Contact and Contact Period Native American archaeological sites and four post-Contact archaeological sites.

RIHPHC files record four pre-Contact, three post-Contact, and three pre- and post-Contact archaeological sites within 1 mile (1.6 km) of the preliminary APE established for the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island. A total of fifteen aboveground inventoried historic properties are located within the preliminary APE, including two National Register listed properties. See Appendix R, TARA, for additional detail on these surveys.

7.2.1.1 Landfall Locations and HDD Sites

There are five landfall locations under consideration, three of which are located in Falmouth and two of which are at Brayton Point in Somerset, Massachusetts (**Figure 7-2** and **Figure 7-3**). Each landfall location has corresponding HDD sites located within the identified landfall footprint. Additional HDD sites are located at the brief underground onshore portion of the Brayton Point export cable corridor at Aquidneck Island, Rhode Island (**Figure 7-4**). The land use in proximity to the landfall locations is discussed in Section 12, Zoning and Land Use.

A detailed description of the landfall locations with regard to terrestrial archaeological resources and the evaluation of the site sensitivity is provided in Appendix R, TARA.

7.2.1.1.1 Falmouth Landfall Location Option A: Falmouth Heights Beach - Worcester Avenue

The preferred sea-to-shore transition in Falmouth is located at Falmouth Heights Beach just south of Worcester Avenue. The beach is bordered by Grand Avenue, which separates it from a low-density residential district and a 4.8-ac (1.94-ha) grassy median dividing the north and south lanes of Worcester Avenue for several blocks (a.k.a., Worcester Park). There are public parking areas approximately 165 ft (50 m) east and 900 ft (275 m) west. **Figure 7-5** overlays the proposed location on aerial imagery.

Source: Adapted from Google Earth

FIGURE 7-5. FALMOUTH LANDFALL LOCATION OPTION A WITH REPRESENTATIVE HDD ENTRY POINTS: FALMOUTH HEIGHTS BEACH – WORCESTER AVENUE

The landfall location and HDD entry points are located within Worcester Park, a 0.6-ac (0.2 ha) lot of manicured lawn surface with smaller ornamental plantings and park benches set in pavers near its northern and southern end. It is located near the shore and inland bodies of water, which are valuable resources when considering both pre-Contact and post-Contact sensitivity. Appropriately, it is within a locus of known, dense post-Contact settlement. Some areas in the vicinity of the landfall location appear likely to have been disturbed by previous road and utility work, while other areas along the beach itself are potentially undisturbed.

7.2.1.1.2 Falmouth Landfall Location Option B: Central Park

A second potential sea-to-shore transition is located at Central Park at Falmouth Heights Beach north of Grand Avenue. The landfall location is located within Central Park (see **Figure 7-6**), which is a public park that includes a baseball diamond and a basketball court, as well as manicured field space. There are restaurants and parking facilities in proximity to this landfall location. HDD entry points for the Central Park landfall will be determined if this landfall location is chosen.

Source: Adapted from Google Earth

FIGURE 7-6. FALMOUTH LANDFALL LOCATION OPTION B: CENTRAL PARK

7.2.1.1.3 Falmouth Landfall Location Option C: Surf Drive Beach – Shore Street

The third potential sea-to-shore transition in Falmouth, which is not a preferred option, is located at Surf Drive Beach south of Shore Street. The beach is bordered by Surf Drive, which separates it from a low-density residential district to the north. The Falmouth Beach Department operational facility, the Ellen T. Mitchell Bath House, is located approximately 492 ft (150 m) to the west. **Figure 7-7** overlays the proposed location on aerial imagery.

Source: Adapted from Google Earth

FIGURE 7-7. FALMOUTH LANDFALL LOCATION OPTION C WITH REPRESENTATIVE HDD ENTRY POINTS: SURF DRIVE BEACH - SHORE ST

The landfall location and HDD entry points are within the Shore Street Parking Lot, a 0.9-ac (0.4 ha) lot that has been completely paved with asphalt. Additionally, because it has been positioned out onto the existing beach, there is greater likelihood of deeper subsurface disturbance in order to stabilize the ground.

Areas within and beneath the roadways are likely previously disturbed by utility and roadwork. This disturbance has the potential to extend to the road margins where evidence of utilities was also present, including an existing utility-owned cable landfall. However, without positive evidence of the location for such utilities along the entire shoulder of the route from as-built drawings or similar documentation, there is still potential for the presence of intact portions of subsurface archaeological resources along the road's margin. Mayflower Wind is conducting ongoing desktop studies for the existing utility lines.

7.2.1.1.4 Brayton Point Location Option 1: Brayton Point—Western

The preferred location for the Brayton Point landfall is located on the western portion of the former Brayton Point Power Station adjacent to where the two former cooling towers were located. The entire parcel of the former Brayton Point Power Station consists of previously substantially disturbed, industrial land. The landfall is not adjacent to any public roads or private lands not owned by the facility. **Figure 7-8** overlays the proposed location on aerial imagery.

Source: Adapted from Google Earth

FIGURE 7-8. BRAYTON POINT LANDFALL LOCATION OPTION 1 WITH REPRESENTATIVE HDD ENTRY POINTS: WESTERN

7.2.1.1.5 Brayton Point Landfall Location Option 2: Brayton Point—Eastern

The second option for the Brayton Point landfall is located on the eastern portion of the former Brayton Point Power Station southeast of Brayton Point Road. The entire parcel of the former Brayton Point Power Station consists of previously substantially disturbed, industrial land. However, the eastern side of the property sits adjacent to a residential district (Town of Somerset, 2021). **Figure 7-9** overlays the proposed location on aerial imagery.

Source: Adapted from Google Earth

FIGURE 7-9. BRAYTON POINT LANDFALL LOCATION OPTION 2 WITH REPRESENTATIVE HDD ENTRY POINTS—EASTERN

7.2.1.2 Intermediate Landfall

The Brayton Point export cable corridor includes an onshore underground component on Aquidneck Island in Portsmouth, Rhode Island. Mayflower Wind is currently considering three potential routes through Aquidneck Island; each of these routes has a landfall at the southern terminus of Boyds Lane on Island Park Beach and transitions through Aquidneck Island to Mount Hope Bay. **Figure 7-10** overlays the proposed entry landfall location on aerial imagery.

Phase I subsurface archaeological testing of portions of the intermediate landfall onshore underground export cable routes resulted in identifying two pre-Contact archaeological sites potentially eligible for listing in the NRHP and recommended for avoidance on Route Option 1 over Aquidneck Island. If avoidance is not possible, archaeological monitoring during construction is recommended.

Additionally, monitoring is recommended of Aquidneck Island Route Option 2 and 3 during boring for the HDDs and Phase I site identification archaeological testing is recommended for Aquidneck Island Route Option 1, pending which route is selected as the preferred onshore export cable route over the island.

A detailed description of the onshore underground export cable component on Aquidneck Island with regard to terrestrial archaeological resources, the evaluation of the site sensitivity, and the results of the archaeological assessment including Phase I site identification archaeological testing are provided in Appendix R, TARA.

FIGURE 7-10. INTERMEDIATE LANDFALL ENTRY HDD—AQUIDNECK ISLAND

7.2.1.2.1 Aquidneck Route 1

The onshore underground Aquidneck Route 1 makes landfall at the southern terminus of Boyds Laneand follows along the existing roadway of Boyds Lane until it turns into the Mount Hope Bridge. Aquidneck Route 1 then remains underground alongside the bridge and exits Aquidneck Island into Mount Hope Bay on the northeastern side of the Mount Hope Bridge. **Figure 7-11** overlays the proposed exit location (HDD Option 4) for Aquidneck Route 1 on aerial imagery.

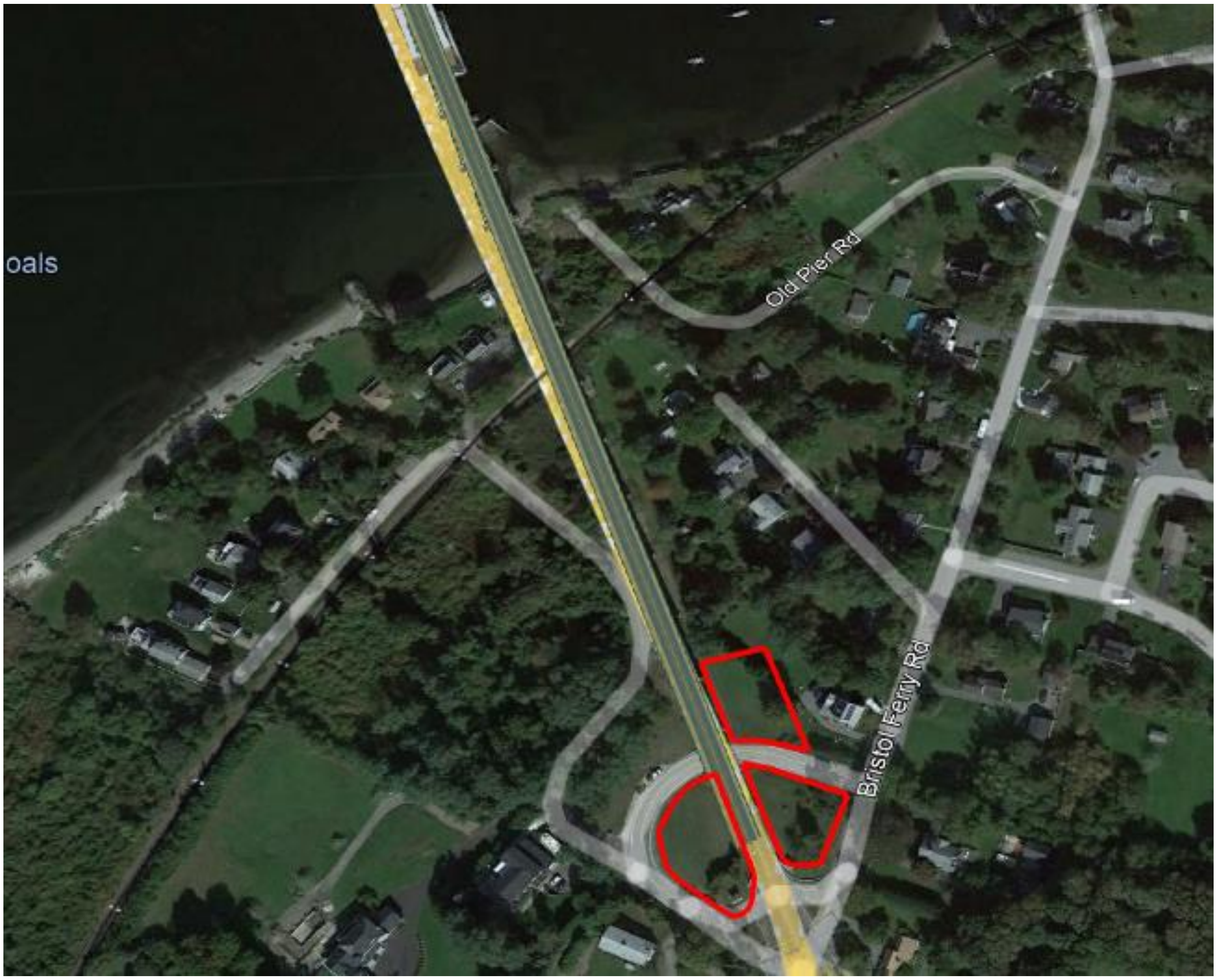


FIGURE 7-11. INTERMEDIATE LANDFALL EXIT HDD—ROUTE 1, AQUIDNECK ISLAND; HDD OPTION 4

7.2.1.2.2 Aquidneck Route 2

The onshore underground Aquidneck Route 2 makes landfall at the southern terminus of Boyds Lane and follows along the existing roadway until turning towards the northeast onto Anthony Road, another existing roadway. Aquidneck Route 2 then follows Anthony Road towards the east. Aquidneck Route 2 has two exit HDD options. The first option turns north onto an existing utility corridor service/access road and then exits Aquidneck Island into Mount Hope Bay. **Figure 7-12** overlays the proposed exit location (HDD Option 2) for the northern HDD option of Aquidneck Route 2 location on aerial imagery. The southern exit HDD option along Aquidneck Route 2 is located in the parking lot of the Roger Williams University Baypoint Residence Hall along Anthony Road. **Figure 7-13** overlays the proposed exit location for the southern option (HDD Option 1) of Aquidneck Route 2 location on aerial imagery.

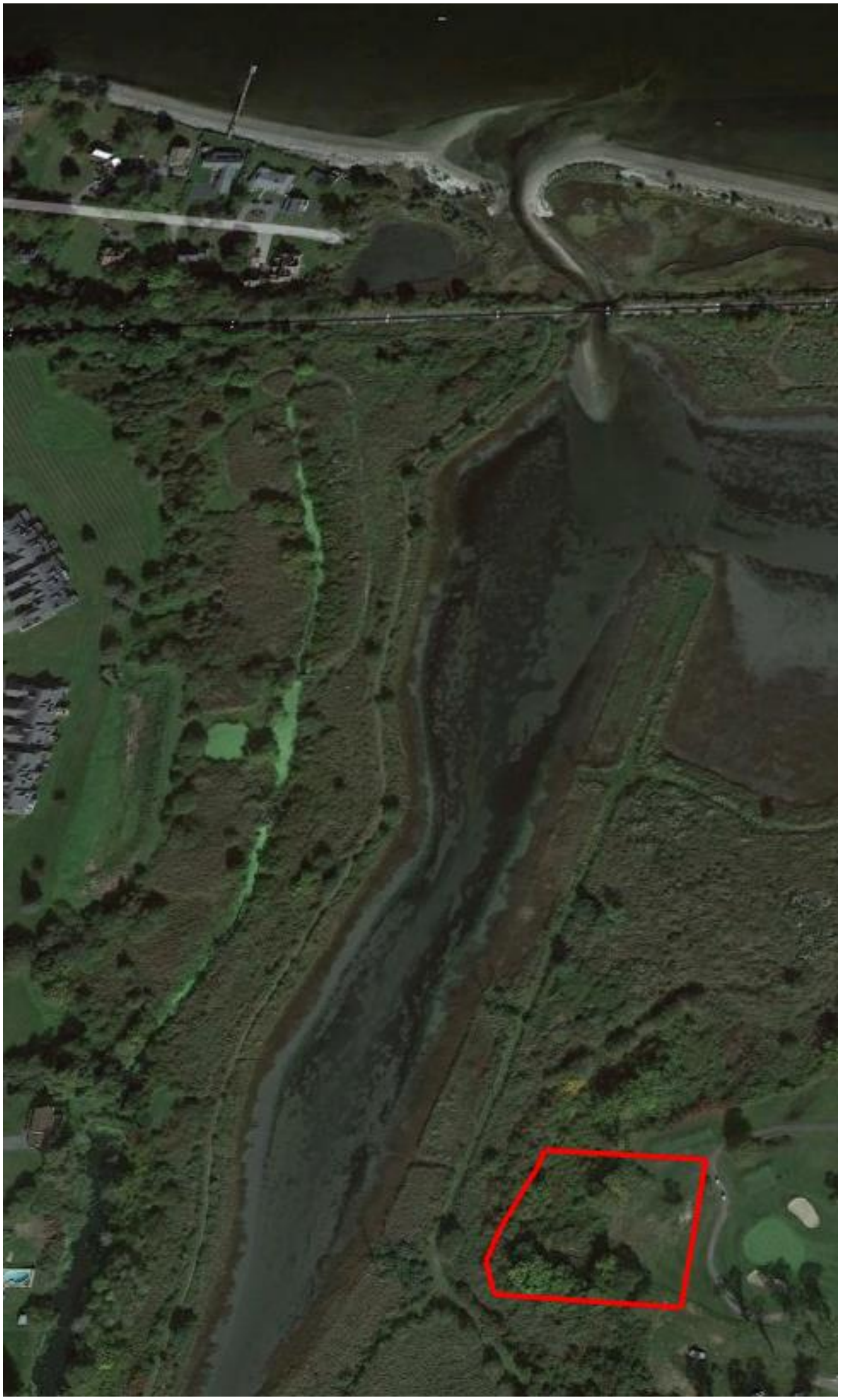


FIGURE 7-12. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 2, AQUIDNECK ISLAND; HDD OPTION 2

FIGURE 7-13. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 2, AQUIDNECK ISLAND; HDD OPTION 1

7.2.1.2.3 Aquidneck Route 3

The onshore underground Aquidneck Route 3 makes landfall at the southern terminus of Boyds Lane and follows along the existing roadway until turning towards the northeast onto Anthony Road, another existing roadway. Aquidneck Route 3 then follows Anthony Road until turning north and exits Aquidneck Island into Mount Hope Bay. **Figure 7-14** overlays the proposed exit location (HDD Option 3) for Aquidneck Route 3 on aerial imagery.

FIGURE 7-14. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 3, AQUIDNECK ISLAND; HDD OPTION 3

7.2.1.3 Onshore Export Cable Routes

There are four Falmouth onshore export cable route options, two Brayton Point onshore export cable route options at Brayton Point and three onshore export cable route options on Aquidneck Island, one Falmouth alternate underground transmission route, and one Brayton Point underground transmission route under consideration by the Project.

The majority of the export cable route options between the landfall locations and the onshore substation and converter station locations are located within existing ROWs, i.e., state and town roadway layouts. Areas on either side of the roads in Falmouth are predominantly residential with manicured landscapes or commercial with storefronts. The Brayton Point onshore Project components are located on previously substantially disturbed, industrial land associated with the former Brayton

Point Power Station. As such, the land is generally disturbed by previous industrial activity and/or roadwork (pavement and sidewalks) and, in many cases, modern utility installations (utility poles, sewers, waterworks, etc.) either beneath or adjacent to the roadwork. However, until evidence is obtained that utilities are located along the shoulder of the route, there is still potential for intact soil strata along the road margins that may contain undisturbed archaeological resources.

Phase I subsurface archaeological testing of portions of the intermediate landfall underground onshore export cable routes resulted in identifying two pre-Contact archaeological sites potentially eligible for listing in the NRHP and recommended for avoidance on Aquidneck Route 1. If avoidance is not possible, archaeological monitoring during construction is recommended. Additional Phase I site identification archaeological testing is recommended for the northern portion of Aquidneck Route 1, if selected.

A detailed description of the onshore export cable routes with regard to terrestrial archaeological resources and the evaluation of sensitivity is provided in Appendix R, TARA.

7.2.1.4 Onshore Substation and Converter Station Sites

There are two onshore substation locations under consideration, both of which are located in Falmouth, Massachusetts (**Figure 7-2**). There is one converter station area under consideration, located at Brayton Point in Somerset, Massachusetts. The land use in proximity to the landfall locations is discussed in Section 12, Zoning and Land Use.

A detailed description of the onshore substation and converter station locations with regard to terrestrial archaeological resources and the evaluation of the site sensitivity is provided in Appendix R, TARA.

7.2.1.4.1 Onshore Substation Option 1: Lawrence Lynch Gifford Street Pit (396 Gifford Street, Falmouth, MA)

This preferred onshore substation would be located on a private parcel used as a sand and gravel quarry (see **Figure 7-15**). The parcel has been substantially disturbed by ongoing mining activities. The area is bordered to the north by the Falmouth Department of Public Works facility and a public park. There is low-density residential housing to the northwest and a religious building to the west. The land across Gifford Street to the southeast hosts the Atria Woodbriar senior home. Properties to the south include a utility-owned 115-kV substation.

Source: Adapted from Google Earth

FIGURE 7-15. ONSHORE SUBSTATION OPTION 1—LAWRENCE LYNCH GIFFORD STREET PIT

7.2.1.4.2 Onshore Substation Option 2: Cape Cod Aggregates (469 Thomas B Landers Road, Falmouth, MA)

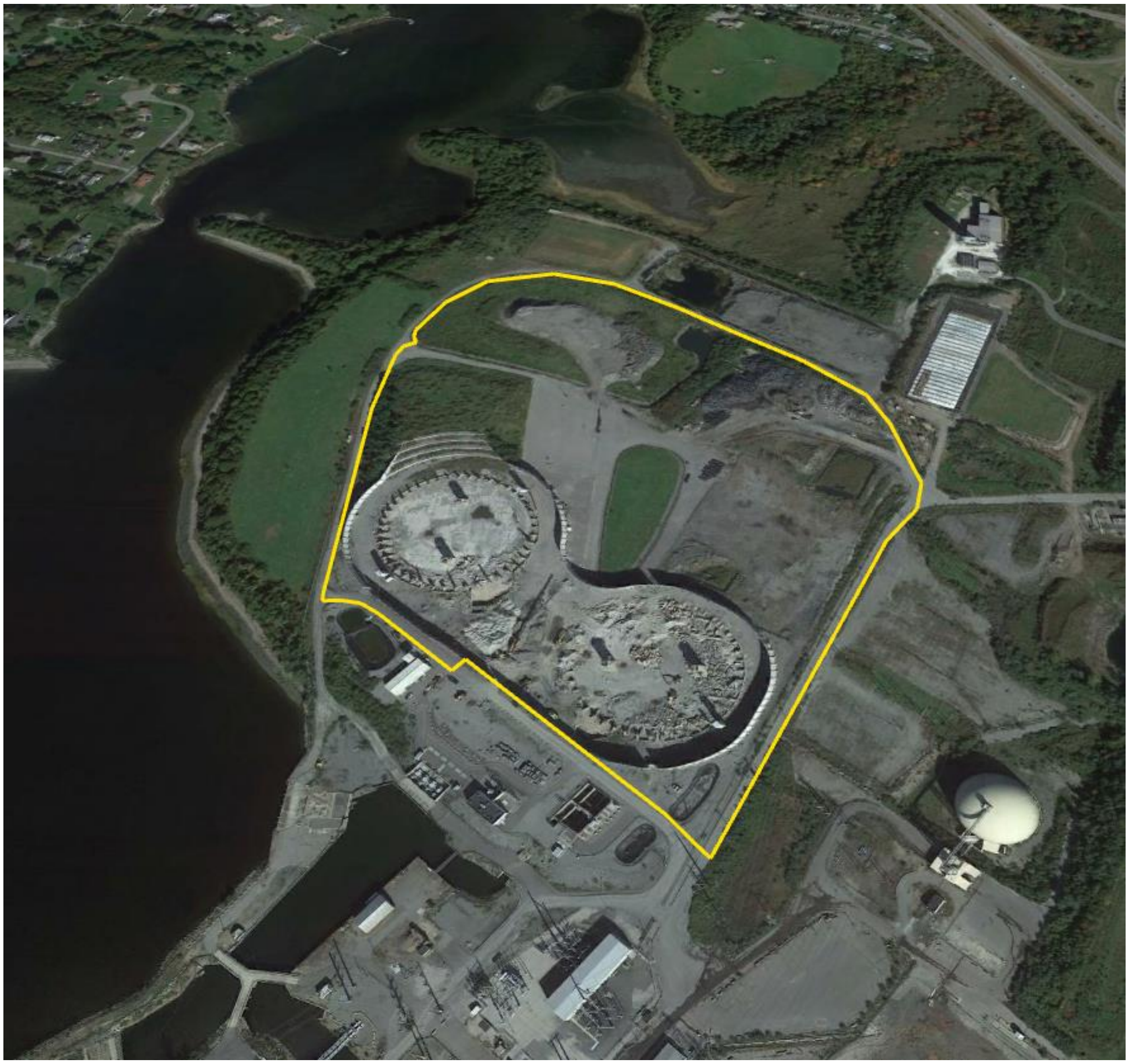
This proposed onshore substation would be located on the eastern half of three private parcels currently used as a single sand and gravel quarry. The center of this site appears to have been substantially disturbed in its current use as a sand and gravel mining site. The existing ROW with an overhead 115 kV transmission line runs south to north in the middle of the parcels and along the western border of the proposed substation location. The parcels are bordered to the north and east by wooded land. Thomas B Landers Road borders the parcels to the south from east to west. Most land across the road also belong to Cape Cod Aggregates. The parcel directly south of the proposed substation is wooded and parcels south of Thomas B Landers Road and east of Blacksmith Shop Road are used for low-density residential housing. The parcel to the west is used for commercial purposes. The parcel to the northwest is wooded. **Figure 7-16** overlays the proposed location on aerial imagery.

Source: Adapted from Google Earth

FIGURE 7-16. ONSHORE SUBSTATION OPTION 2—CAPE COD AGGREGATES NORTHEAST

7.2.1.4.3 Brayton Point HVDC Converter Station

The proposed converter station will be located on a maximum footprint of 7.5 ac (3 ha) in Somerset, off Mount Hope Bay on the south coast of Massachusetts on a site that formerly housed the Brayton Point Power Station (see **Figure 7-17**). The former Brayton Point Power Station was a 1,500-megawatt power plant that was decommissioned in 2017. The proposed uses for this parcel are consistent with the historical uses and zoning ordinances (see Section 12, Zoning and Land Use).



Source: Adapted from Google Earth

FIGURE 7-17. HVDC CONVERTER STATION SITING AREA

7.2.2 Potential Effects

Impact producing factors (IPFs) are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020b). IPFs were adapted from BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)* (BOEM 2020b). The full build-out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3.3, Project Components and Project Stages, is considered for the analysis of potential effects.

The majority of IPFs will occur in the local communities, specifically in Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island. The effects will essentially be associated with the installation and construction of the onshore Project components: the landfall locations, onshore export cables, the onshore substation, converter station, and underground transmission lines.

Periodic maintenance and repairs of onshore components will not directly affect archaeological resources as these activities will be limited to already disturbed areas; however, accidental releases from Project activities may indirectly affect archaeological resources.

Similarly, any decommissioning activities will also be limited to already disturbed areas, and thus, will not affect archaeological resources. Furthermore, it is envisioned that the onshore components will be left in place for possible future reuse. If necessary, decommissioning of the onshore components would be coordinated closely with the host town and aim to have the fewest environmental effects. Refer to Section 3.3, Project Components and Project Stages, for detailed information regarding decommissioning.

Table 7-4 provides a summary of the potential effects from the proposed Project on terrestrial archaeological resources, and full discussions of these effects are presented below.

TABLE 7-4. IPFS AND POTENTIAL EFFECTS ON TERRESTRIAL ARCHAEOLOGICAL RESOURCES IN THE TERRESTRIAL ARCHAEOLOGICAL PAPE

IPF	Potential Effect		Period of Potential Effect		
	Project Component				
	Landfall Location, Onshore Export Cables, and Transmission Lines	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Ground Disturbance	Unanticipated discovery of terrestrial archaeological resources	Unanticipated discovery of terrestrial archaeological resources	X	—	—
	Damage to unanticipated archaeological resources	Damage to unanticipated archaeological resources	X	X	X
Accidental Events	Damage to unanticipated archaeological resources	Damage to unanticipated archaeological resources	X	X	X

7.2.2.1 Ground Disturbance

The proposed Project may affect unanticipated terrestrial archaeological resources where onshore infrastructure is installed, namely within Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island.

7.2.2.1.1 Construction, Operations and Maintenance, and Decommissioning

The effects on terrestrial archaeological resources would primarily occur by inadvertently damaging or removing undiscovered resources during ground disturbance. Mayflower Wind plans to avoid impacts to identified terrestrial archaeological resources by micro-siting prior to construction to the extent practicable.

It is anticipated that an additional assessment of potential Project-related effects will be developed through future surveys if requested by the MHC and RIHPHC. BOEM may also require additional assessment of effects and avoidance/minimization/mitigation measures pending the completion of remaining Phase IB fieldwork, as necessary. This will be done following review of the pending Phase IB of the Falmouth Onshore Project Area. The Phase IA for the Falmouth onshore Project components has been reviewed by MHC. The Phase IA for the Brayton Point onshore Project components has been provided to MHC and it was determined that no Phase IB surveys were required. The Phase IA/IB for the Aquidneck Island Project components has been provided to RIHPHC for review. Additional detail is provided in Appendix R, TARA. State and federal requirements to identify, assess, avoid, and/or mitigate effects on cultural resources as part of NEPA and the National Historic Preservation Act (NHPA), will limit the effects on archaeological resources. Avoidance, minimization, and mitigation measures for terrestrial archaeological resources within the Onshore Project Areas will be determined in consultation with the affected Tribes, MHC, RIHPHC, BUAR, and BOEM through the Section 106 and NEPA process. Communications and consultation with the affected Tribes, MHC, RIHPHC, BUAR, and BOEM and are ongoing.

Pending the completion of the Phase IB survey activities, avoidance, minimization, and/or mitigation measures will be developed. Furthermore, Mayflower Wind will conduct archaeological monitoring, as necessary, during construction in areas determined to have a moderate to high potential for undiscovered archaeological resources. A detailed Terrestrial Unanticipated Discovery Plan identifying which areas will be monitored, professional qualifications of the monitor(s), a description of regular reporting requirements and report content, and a commitment to align the proposed monitoring plan with relevant SHPO standards can be found under Appendix R.1. If the monitoring identifies any significant cultural resources, Mayflower Wind will implement avoidance, minimization, and/or mitigation aligned with the Commonwealth of Massachusetts, the State of Rhode Island, and NHPA requirements. The Terrestrial Unanticipated Discovery Plan includes stop-work and notification procedures to be followed if a cultural resource is encountered during installation. See Appendix R.1 for more details.

7.2.2.2 Accidental Events

Accidental releases from onshore construction activities could damage terrestrial archaeological resources in areas not directly affected by the construction activities.

7.2.2.2.1 Construction, Operations and Maintenance, and Decommissioning

Accidental releases of fuel, oil, or other hazardous materials from Project activities may affect terrestrial archaeological resources in proximity to the infrastructure footprint. The proposed Project will implement best management practices and implement a Safety Management System (Appendix Z) as well as an Oil Spill Response Plan (Appendix AA) to avoid, control, and address any accidental releases during all proposed Project activities.

7.3 ABOVE-GROUND HISTORIC PROPERTIES

This section considers the above-ground historic properties in areas that may be affected by the introduction of visual elements from the proposed Project.

An Analysis of Visual Effects to Historic Properties (AVEHP) (Appendix S and Appendix S.1), was completed to evaluate the proposed Project's potential to visually affect above-ground historic properties that are listed in or eligible for listing in the NRHP or as a National Historic Landmark (NHL), including resources that have been identified, but not formally evaluated for eligibility. For the purposes of this study, identified resources within the Offshore and Falmouth and Brayton Point Onshore APE with a view of the Project components without a formal NRHP status, are considered eligible for listing in the NRHP and therefore, are historic properties for the purposes of Section 106. Due to the visibility of Project components, the Project has the potential to affect above-ground historic properties. The information and recommendations in the AVEHP are intended to assist BOEM, MHC, RIHPHC, and the Tribal Historic Preservation Offices in their review of the proposed Project's potential effects on above-ground historic properties. As the proposed Project continues to develop, additional studies may be required to comply with Section 106 and Section 110 of the NHPA, as coordination and consultation is ongoing.

The AVEHP for the Project Area was conducted according to BOEM's *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR 585* (BOEM, 2020a) and the *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (NPS, 1990). This analysis included a program of viewshed modeling, background research, field investigation, desktop review, and data analysis. The AVEHP was conducted in close coordination with the separate Visual Impact Assessment (VIA, Appendix T and Appendix T.1) and draws upon the VIA findings to evaluate to potential for visual effects on historic properties according to the Criteria of Adverse Effect as outlined in 36 CFR § 800.5 of Section 106 of the NHPA. The AVEHP included a review of MHC's Massachusetts Cultural Resource Information System database and RIHPHC's Historic Property Search to identify previously recorded above-ground historic properties within the Preliminary Area of Potential Effect (PAPE), and available documentation (inventory forms, NRHP nominations, and reports). Due to the significant number of parcels in the Brayton Point PAPE with the potential to contain unrecorded NRHP-eligible historic resources, a desktop review of parcel data to identify parcels containing buildings or structures with an unknown construction date or that are at least 50 years old or older (pre-1972) was conducted. The desktop review was followed by a cursory windshield survey of these parcels to ensure that both previously recorded and unknown resources were considered.

The AVEHP draws upon the viewshed analysis completed for the Visual Impact Assessment (Appendix T and Appendix T.1) which used maximum design heights and bare-earth topography to establish preliminary viewsheds, or areas which have maximum potential visual exposure to the Project.[7] Using digital surface models (DSMs) the preliminary viewshed was refined, taking into consideration the potential screening from vegetation and buildings. The resultant mapped area of theoretical visibility is

---

[7] The maximum extent of the offshore viewshed modeling was set at 43 mi (69.2 km), the limit of visibility based on the curvature of the earth at sea level with a viewer perspective of 6.6 ft (2 m). The maximum extent of the onshore viewshed modeling was set a 3.5 mi (5.6 km).

defined as the Area of Potential Visual Impact (APVI). For the purposes of the AVEHP, the PAPEs were delineated based on field assessment of verified visibility for Key Observation Points (KOPs) within the APVI. The KOPs from or near historic properties in the PAPE, were identified, validated, and used to prepare visual simulations which informed the assessment of effects to above-ground historic properties located within the PAPEs. A detailed description of the methodology is presented in Appendix S and Appendix S.1.

The APE, as defined by 36 CFR § 800.16(d), is "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, 2020a). The following describes how the Above-Ground Historic Properties Offshore and Onshore PAPEs were identified for various Project components. Additional detail is provided in Appendix S and Appendix S.1.

Above-Ground Historic Properties Offshore PAPE. The maximum extent of the offshore viewshed modeling was set at 43 mi (69.2 km), the limit of visibility based on the curvature of the earth at sea level with a viewer perspective of 6.6 ft (2 m). The offshore PAPE was delineated assuming a PDE with WTGs or OSPs occupying all possible positions in the 1 x 1 nm (1.9 x 1.9 km) grid layout within the Lease Area. Separate DSMs were evaluated for the WTG hub center and blade edge tip based on a maximum WTG hub center elevation of 607.0 ft (185 m), and WTG blade edge tip of 1,066.3 ft (325.0 m) above MLLW. Following the field investigation (which included capturing detailed photos from KOP locations), desktop analysis, and review of the photograph simulations, it was determined that the area from where the offshore Project components would most likely be visible is Martha's Vineyard and Nantucket. The landward extent of the offshore PAPE was generally limited to 1 mi (1.6 km) of the southern shorelines of both islands. This is consistent with the findings of the Vineyard Wind VIA which found that Project visibility for Vineyard Wind was limited to 0.6 mi (1 km) from the southern shorelines of Martha's Vineyard and Nantucket. Therefore, the landward extent of the offshore PAPE is defined as the portion of the APVI that falls within 1 mi (1.6 km) of the southern shorelines of the islands. The offshore PAPE also includes those offshore portions of the TCPs located within the APVI. **Figure 7-18**, illustrates the resultant offshore PAPE.

Above-Ground Historic Properties Onshore PAPE. The Lawrence Lynch substation site (preferred) was delineated assuming a maximum height of 85 ft (26 m) for the substation lightning protection masts. The resultant PAPE reflects the maximum visibility of the substation structures which considers screening associated with intervening topography, vegetation and structures.

Similarly, the Cape Cod Aggregates substation site (alternate) PAPE was delineated assuming a maximum height of 85 ft (26 m) for the substation lightning protection masts. The Cape Cod Aggregates PAPE includes most of the town of Falmouth, but also small slivers of Mashpee, Sandwich, and Bourne.

As with the offshore Project components, the areas of visibility within the APVIs were used to ground-truth visibility from historic properties during the field investigation. Visibility was limited by changes in elevation, vegetation, and the built environment. Through the field investigation and desktop analysis, it was determined that substantial areas within the 3.5 mi (5.6 km) limit of the viewshed analysis of the Falmouth preferred and alternate onshore substations, do not have visibility because of intervening topography and/or screening by vegetation and other structures, and are excluded from the PAPE (**Figure 7-19** and **Figure 7-20**). The final onshore PAPE for each substation is based on actual field verified visibility and is limited to a 0.1-mile (0.16 km) area extending from the substation boundary, a substantial reduction from the area of the APVI. Visual impacts to above-ground historic properties from the underground onshore export cable and transmission route would be limited to temporary impacts during the construction phase. These components are therefore not included in this analysis.

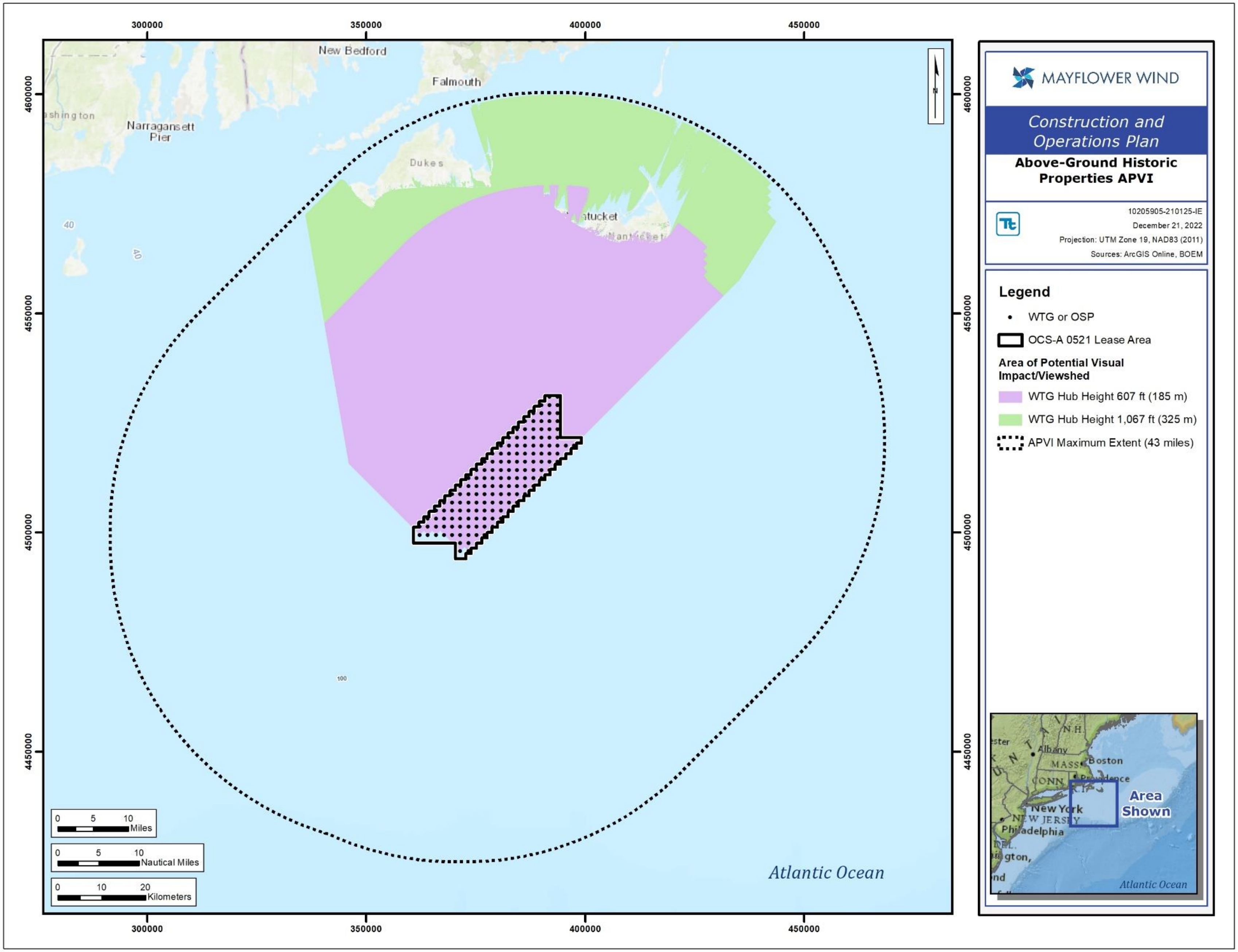


FIGURE 7-18. ABOVE-GROUND HISTORIC PROPERTIES OFFSHORE PAPE

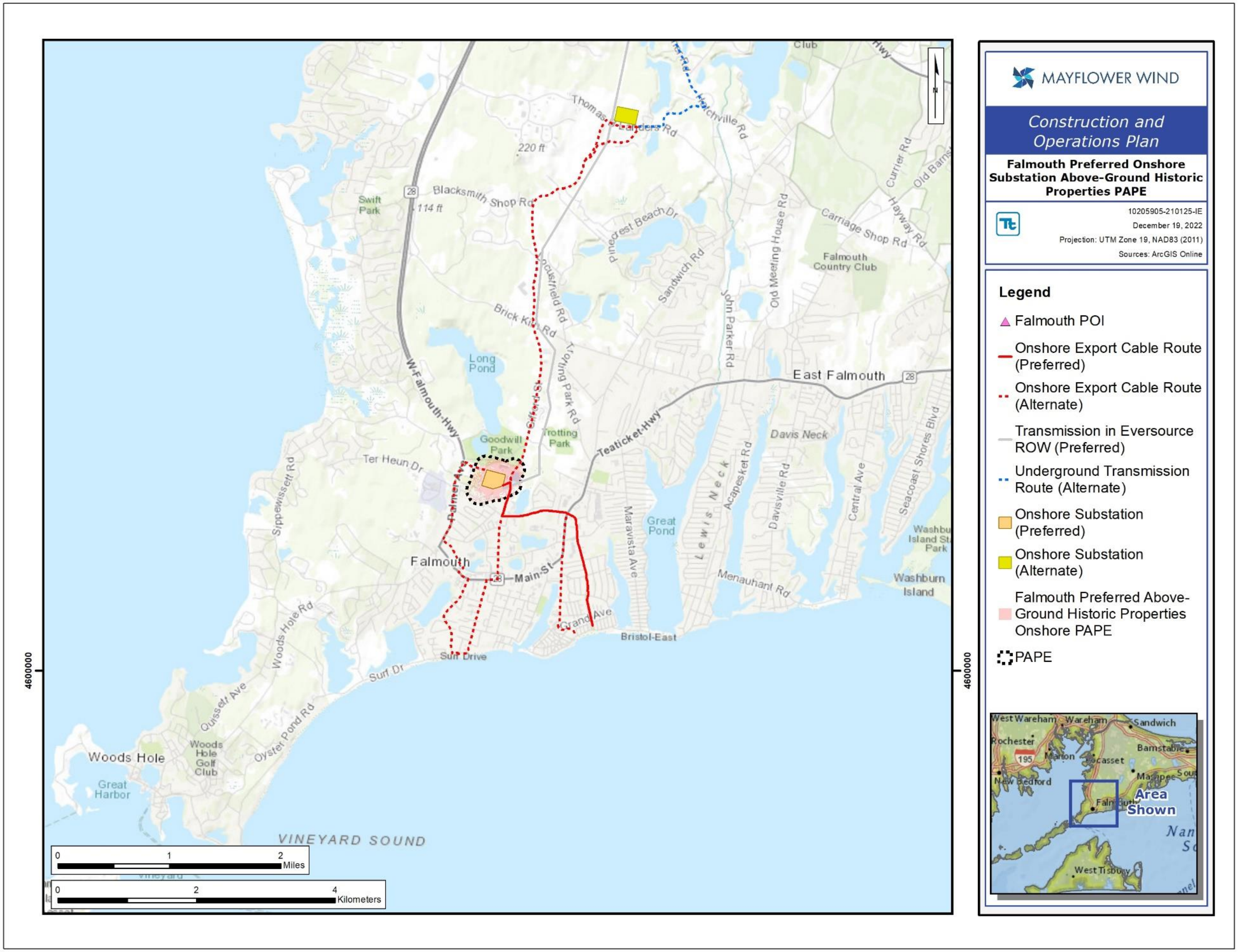


FIGURE 7-19. FALMOUTH PREFERRED ONSHORE SUBSTATION ABOVE-GROUND HISTORIC PROPERTIES PAPE

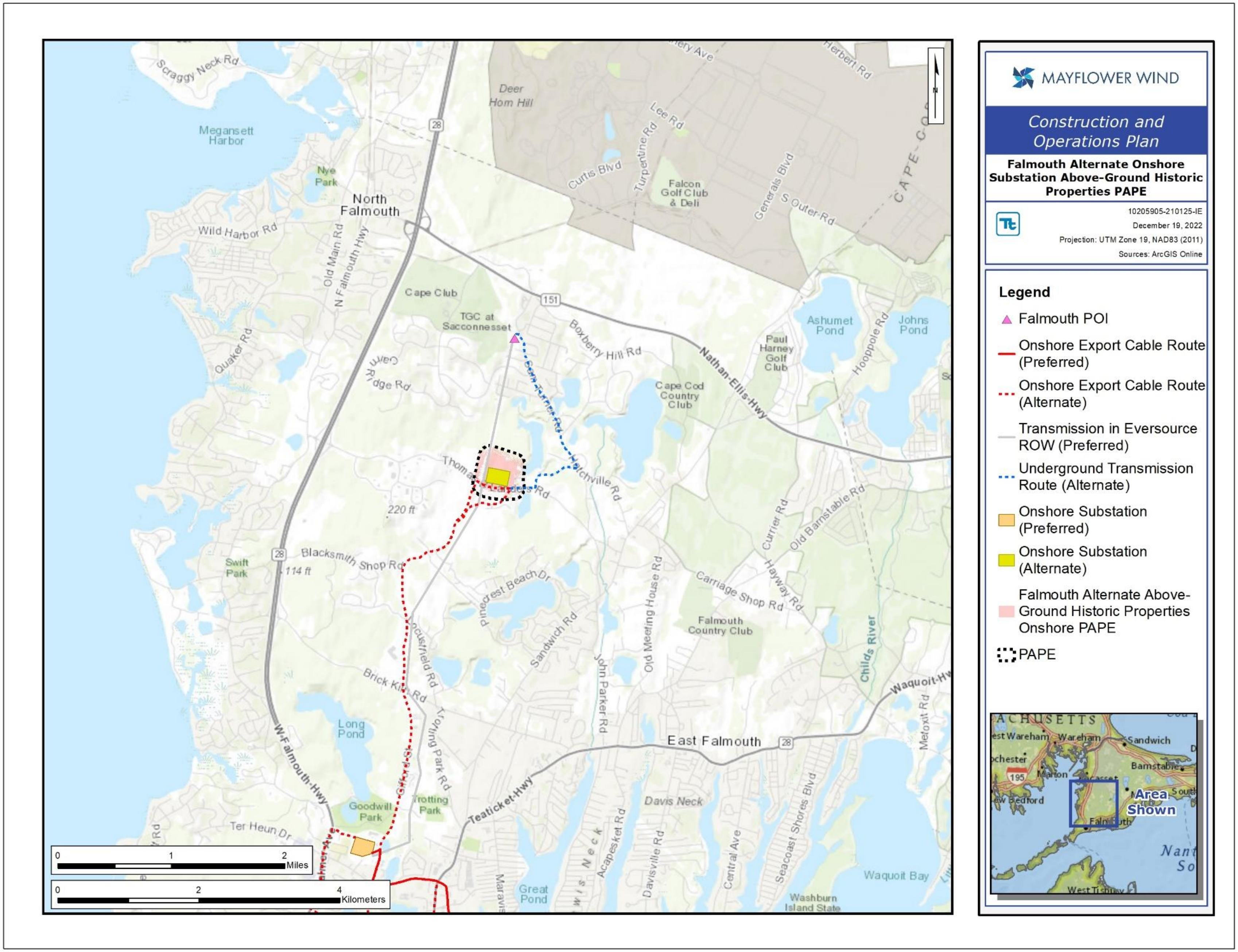


FIGURE 7-20. FALMOUTH ALTERNATE ONSHORE SUBSTATION ABOVE-GROUND HISTORIC PROPERTIES PAPE

The Brayton Point converter station site DSM was based on a maximum APVI of 3 mi (4.8 km) in all directions from the center point of the converter station site. The DSM assumes a conservative maximum height of 85 ft (26 m) for the lightning masts.

In addition to Somerset, the Brayton Point APVI included portions of Fall River and Swansea, Massachusetts, and Warren, Rhode Island. The landscape surrounding Brayton Point is characterized by low elevation, level terrain notable for its irregular inland shoreline of bays, estuaries, islands, and peninsulas. Much of the Brayton Point APVI comprises the open water of Mount Hope Bay, while the upland portions comprise residential areas of varying types, from rural areas to dense, low-rise urban centers with historic roots. Privately owned undeveloped areas, transportation corridors, and industrial properties are also present within the APVI. As **Figure 7-21** illustrates, visibility of the Project components at Brayton Point from the surrounding landscape is constrained by multiple factors. Its isolated location on the Brayton Point peninsula physically separates the Project from other land uses and viewpoints. Topographic features also constrain visibility (a tall earthen berm stretches some 500 ft [150 m] along the eastern edge of the Project and screening vegetation exists between the Project and nearby development). At a distance of over 3.3 miles (5.3 km), views of the Project components at Brayton Point from across Mount Hope Bay in Bristol may be possible, but given the scale of the onshore Project components, at this distance they could not introduce a point of focus or dominance. This resulted in an APVI for Brayton Point that was 0.5 mile (0.8 km) smaller than the 3.5-mile APVI for the Falmouth substation locations.

Based on BOEM's Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585 (BOEM, 2020a), the proposed PAPE for Brayton Point is the viewshed from which onshore renewable energy structures (including temporary or permanent construction or staging areas) would be visible. Effects are only assessed to historic properties within the PAPE. As such, the PAPE was defined by refining and field verifying the modeled visibility of the APVI to exclude areas that do not have actual visibility of the Project. This ensured that only those historic properties subjected to actual visual impacts would be assessed for effects. As illustrated in **Figure 7-21**, the onshore area with actual visibility, although negligible, is limited to areas within 0.5 mile (0.8 km) of the converter station siting area. Those areas within the 3 mi (4.8 km) limit of the APVI for the converter station that do not have visibility due to factors including the physical isolation of the site at Brayton Point, topography, and screening vegetation were excluded from the PAPE.

Appendix S, Analysis of Visual Effects to Historic Properties addresses the Above-Ground Historic Properties Offshore PAPE and the Falmouth Above-Ground Historic Properties Onshore PAPE. Appendix S.1, Analysis of Visual Effects to Historic Properties – Brayton Point addresses the Brayton Point Above-Ground Historic Properties PAPE.

Technical appendices related to above-ground historic properties include:

- Appendix S, Analysis of Visual Effects to Historic Properties
- Appendix S.1, Analysis of Visual Effects to Historic Properties – Brayton Point
- Appendix T, Visual Impact Assessment
- Appendix T.1, Onshore Visual Impact Assessment – Brayton Point

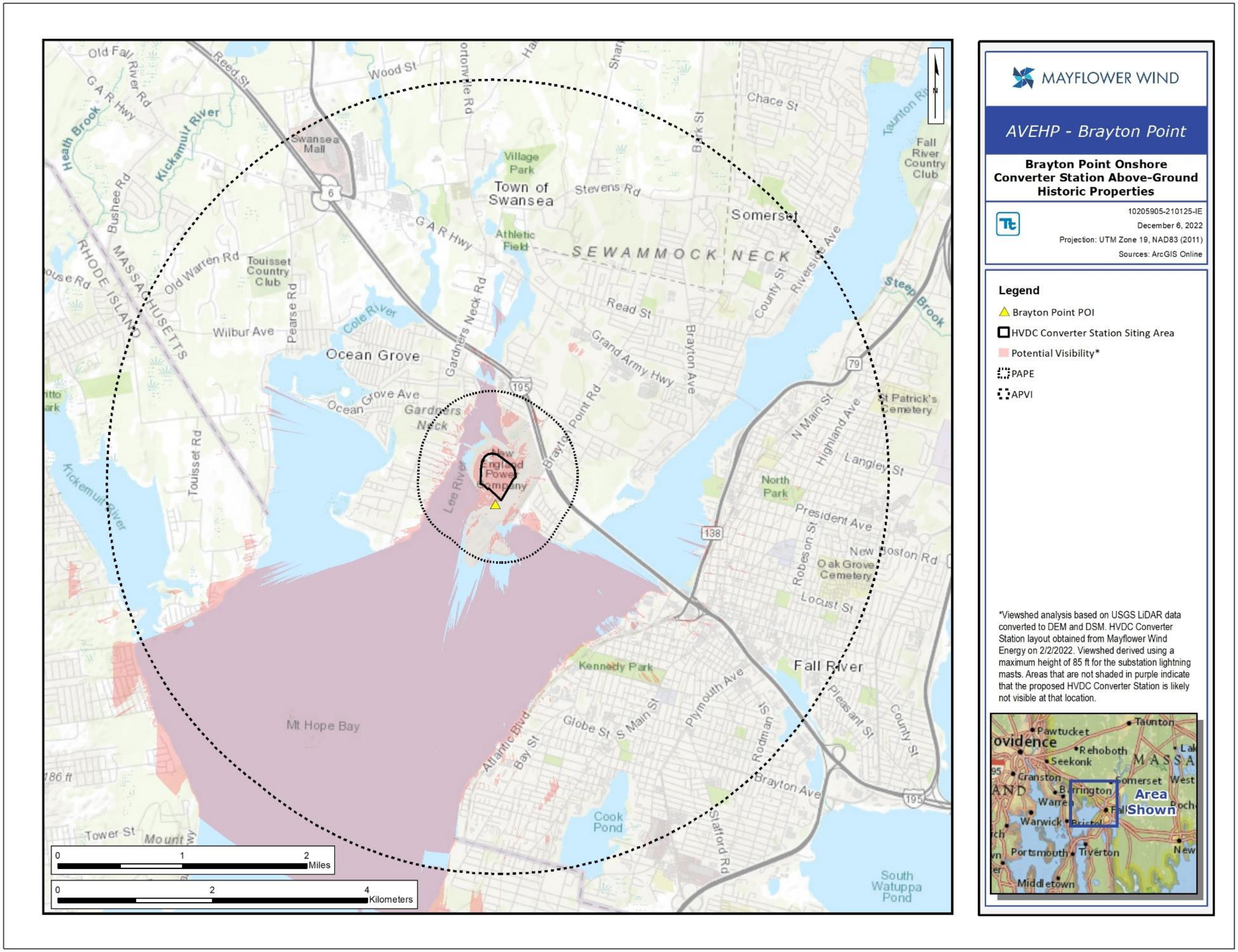


FIGURE 7-21. BRAYTON POINT ONSHORE CONVERTER STATION ABOVE-GROUND HISTORIC PROPERTIES APVI AND PAPE

7.3.1 Affected Environment

7.3.1.1 Offshore PAPE

Based on historical property background research, 13 previously recorded above-ground historic properties were identified within the Offshore area of theoretical visibility or APVI . This includes three Traditional Cultural Properties (TCP). Additional background research to identify resources not previously recorded was performed. The search was focused on previously unrecorded resources on Martha's Vineyard and in the Town of Falmouth; no search was conducted for previously unrecorded resources on Nantucket because all properties on Nantucket Island, Tuckernuck Island, and Muskeget Island have been documented by the Nantucket Historical Commission and are categorized as contributing or non-contributing to the NHL-listed Nantucket Historic District. The list contains 13,687 properties contained on the three islands. Research to locate previously unrecorded resource on Martha's Vineyard focused on identifying historic architectural resources that are locally significant or identified as worthy of preservation by local historic preservation and planning commissions, historical groups and societies, and other local preservation and planning agencies.

The PAPE is limited to a one mile (1.6 km) area of ground-truthed visibility extending inland from the shoreline of the islands. The PAPE covers the southeast portion of the southern shore of the island of Martha's Vineyard, and the southern shore of Nantucket. Fourteen historic properties were located within the PAPE. **Table 7-5** provides a summary description of the 14 above-ground historic properties in the offshore PAPE with a potential view of the Project components. A detailed description of each resource is presented in Appendix S, Analysis of Visual Effects to Historic Properties.

TABLE 7-5. ABOVE-GROUND HISTORIC PROPERTIES WITHIN THE OFFSHORE PAPE

Resource Name	Town, County	Summary Description	NHRP Status
Nantucket Historic District	Nantucket, Nantucket	Includes Nantucket Island, Tuckernuck Island, and Muskeget Island. Significant for its association with the whaling industry in New England, for the array of well-preserved resources reflecting a range of architectural styles and eras, and for important cultural and historical data.	NHL, NRHP-Listed
Sankaty Head Light a/	Nantucket, Nantucket	Cylindrical brick and granite lighthouse. Significant for its association with maritime navigation in the Commonwealth of Massachusetts, and for its architecture.	NRHP-Listed
Skiff-Mayhew-Vincent House	Chilmark, Dukes	A farmhouse, barn, gable roofed shed, and seven one-room frame cabins. Significant for its architecture and association with the agricultural past of Martha's Vineyard.	NRHP-Listed
Gay Head Light a/	Aquinnah, Dukes	Brick and sandstone lighthouse. Significant for its association with maritime navigation in the Commonwealth of Massachusetts, and for its architecture.	NRHP-eligible
10 Crackatuxet	Edgartown,	A circa 1920 main dwelling, a barn, and a shed. Significant	NRHP-eligible

Resource Name	Town, County	Summary Description	NHRP Status
Road	Dukes	for its Greek Revival-style architecture.	
7 Butler's Cove Road	Edgartown, Dukes	A circa 1810 main dwelling and mature trees along boundary. Significant for its example vernacular dwelling architecture.	NRHP-eligible
31 Butler's Cove Road	Edgartown, Dukes	A circa 1910 main dwelling and mature trees along boundary. Significant for its example vernacular dwelling architecture.	NRHP-eligible
208 Middle Point Road	West Tisbury, Dukes	Waldron/Moore Hunting Camp with a circa 1920 dwelling and shed. Significant for its example hunting shack architecture.	NRHP-eligible
160 Quansoo Road	Chilmark, Dukes	A circa 1900 dwelling and shed. Significant for its example turn of the century vernacular dwelling architecture.	NRHP-eligible
218 South Road	Chilmark, Dukes	The Captain Matthew Poole-King-Blaut House. Significant for its example mid-nineteenth century dwelling architecture and possible association with notable owners such as Captain Matthew Poole.	NRHP-eligible
Martha's Vineyard American Revolution Battlefield	Chilmark, Tisbury, West Tisbury, Dukes	Linear historic district following South Road southwest-northeast through the island. Significant as the most important event of the American Revolution to occur on the island of Martha's Vineyard. Also significant for its collection of intact eighteenth-century architecture.	Inventoried, Treated as NRHP-eligible
Chappaquiddick Island TCP	Edgartown, Dukes	Island at the eastern end of Martha's Vineyard, historically inhabited by the Chappaquiddick branch of the Wampanoag Indian Tribe. Significant for its association with and importance in maintaining the continuing cultural identity of the community.	NRHP-eligible, TCP
Nantucket Sound TCP	N/A	Roughly triangular and shallow marine basin between the islands of Nantucket, Martha's Vineyard and Monomoy. Significant for its association with ancient and historic use by Maushop and Squant/Squannit, its importance in Wampanoag stories and traditions, and for its archaeological, historical and ethnographical resources.	NRHP-eligible, TCP
Vineyard Sound and Moshup's Bridge TCP	N/A	Lands and waters that encompass Vineyard Sound, the Elizabeth Islands, the Gay Head Cliffs, and Nomans Island. Significant for its association with ancient and historic Native American events including exploration and settlement of Aquinnah and formation of the land's character, as a significant figure in Aquinnah oral and written traditions, as a significant component of Aquinnah life and cultural practices, and for the potential information it may yield.	NRHP-eligible, TCP

Note:
a/ Individually listed in the NRHP, but also a part of the NRHP-eligible Lighthouses of Massachusetts Thematic Resource Area (BOU.F), 6/15/1987. A TRA or Multiple Resource Submission is a NRHP is a group listing of resources that share a common theme.

7.3.1.2 Falmouth Onshore PAPE

Based on review of the MHC files, there are 12 previously documented above-ground historic properties within the area of theoretical visibility or APVI for the Falmouth preferred and alternate substation sites. Additional background research to identify resources not previously recorded was performed, which focused on previously unrecorded resources in the Town of Falmouth. The PAPE is limited to a 0.10 mi (0.16 km) area surrounding the sites with ground-truthed visibility. **Table 7-6** provides a summary description of the two above-ground historic properties in the Falmouth Onshore PAPE with a view of the Project components. A detailed description of each resource is presented in Appendix S, Analysis of Visual Effects to Historic Properties.

TABLE 7-6. ABOVE-GROUND HISTORIC PROPERTIES WITHIN THE FALMOUTH ONSHORE PAPE

Resource Name	Town, County	Summary Description	NRHP Status
Oak Grove Cemetery	Falmouth, Barnstable	18.9-acre (7.6 ha) cemetery with 35 contributing resources. Significant for its association with the history of the Town of Falmouth as the Town's largest nineteenth century cemetery, and as a well-preserved example of both a nineteenth century rural and formal cemetery.	NRHP-eligible
Massachusetts National Guard Armory	Falmouth, Barnstable	3.4-acre (138 ha) property with a brick armory constructed in 1956 and a dense concentration of single-family dwellings. Significant for its association with Massachusetts military history and as example armory building constructed after WWII architecture.	Inventoried, Treated as NRHP-eligible

7.3.1.3 Brayton Point Onshore PAPE

Based on review of the MHC files, there are 43 previously documented above-ground historic properties within the Brayton Point Onshore APVI (theoretical viewshed) for the converter station site. No additional aboveground historic properties were identified during a desktop review and subsequent cursory windshield survey of unevaluated resources within the PAPE. A list of previously unevaluated resources reviewed via desktop and field survey is included in Appendix S.1 - Attachment 2. Only 11 of the 43 previously recorded resources are within the Brayton Point PAPE, defined as a 0.5-mile area with verified visibility within the 3-mile APVI (theoretical visibility). **Table 7-7** provides a summary description of the 11 above-ground historic properties in the Brayton Point Onshore PAPE with a view of the Project components. A detailed description of each resource is presented in Appendix S.1, Analysis of Visual Effects to Historic Properties – Brayton Point.

TABLE 7-7. ABOVE-GROUND HISTORIC PROPERTIES WITHIN THE BRAYTON POINT ONSHORE PAPE

Resource Name	Town, County	Summary Description	NRHP Status
Dwelling, 74 Angus St	Somerset, Bristol	The dwelling at 74 Angus Street in Somerset, Bristol County is a ca. 1925 single-family, Craftsman style structure. The property, inventoried with the MHC in 1984, has not been evaluated for listing in the NRHP, but for this Project is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files consisted of a brief statement noting the structure is an example of structures built in this area during the development of the O'Neil Beach Resort Area during the early twentieth century. The structure derives significance under Criterion C for Architecture.	Inventoried, Treated as NRHP-eligible
New England Power Company	Somerset, Bristol	This property consists of a mid-twentieth century electric power utility situated within an approximately 225-acre parcel between the Lee and Taunton Rivers and at the head of Mt. Hope Bay in Somerset, Bristol County. Operative in 1960, the New England Power Company property was inventoried with the MHC in 1984, but for this Project is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. This property served as the largest power plant in the Northeast and derives is significance under Criterion C for its Architecture and Engineering.	Inventoried, Treated as NRHP-eligible
Dwelling, 780 Brayton Point Rd	Somerset, Bristol	The dwelling at 780 Brayton Point Road in Somerset, Bristol County is single-family, Victorian Eclectic residence constructed in 1898. The property, inventoried with the MHC in 1984, has not been evaluated for listing in the NRHP, but for this Project is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files consisted of a brief description of the property and its former owners. The property consists of a simple rectangular house that was originally constructed to serve as a country retreat by its original owners. The property was later used as the primary residence of a family involved in the local dairy and grocery businesses. The structure derives significance under Criterion C for Architecture.	Inventoried, Treated as NRHP-eligible

Resource Name	Town, County	Summary Description	NRHP Status
Borden, Sarah House	Somerset, Bristol	The Sarah Borden House (1890) at 694 Brayton Point Road in Somerset, Bristol County was inventoried with the MHC in 1984 but has not been evaluated for listing in the NRHP. For this Project, it is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files note the single-family Gothic Revival residence is representative of the more substantial residential dwellings or country homes erected by middle class residents of Somerset or by mill investors from Fall River. The property is considered significant under Criterion C for its architecture.	Inventoried, Treated as NRHP-eligible
Slade, J. L. House	Somerset, Bristol	The J.L. Slade House (1835) at 731 Brayton Point Road in Somerset, Bristol County was inventoried with the MHC in 1984 but has not been evaluated for listing in the NRHP. For this Project, it is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files note the J.L. Slade House is one of several well-preserved Greek Revival farmsteads in the area. The house was constructed and/or occupied by the descendants of William Slade, an early landowner in Somerset. The property is considered significant under Criterion C for its architecture.	Inventoried, Treated as NRHP-eligible
Slade, Charles Cemetery	Somerset, Bristol	The Charles Slade Cemetery, located at the foot of Home Street in Somerset, Bristol County, was inventoried with the MHC in 1983 but has not been evaluated for listing in the NRHP. For this Project, it is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files note the small cemetery was composed of at least 22 headstones with dates of death ranging from 1700 to 1880. The mainly gray slate headstones exhibited a Cherub motif and were identified in an area delineated by a fieldstone wall. Ordinarily, cemeteries are not considered eligible for the National Register. However, such properties will qualify if they are a religious property deriving primary significance from historical importance. This cemetery is significant due to its association with religious themes.	Inventoried, Treated as NRHP-eligible

Resource Name	Town, County	Summary Description	NRHP Status
Dwelling, 952 Gardner's Neck Rd	Swansea, Bristol	The dwelling at 952 Gardner’s Neck Road in Swansea, Bristol County is a ca. 1890 single-family, Victorian Eclectic style dwelling. The property, inventoried with the MHC in 1986, has not been evaluated for listing in the NRHP, but for this Project is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files noted the large structure was likely constructed for a Fall River mill owner and, unlike other structures nearby, was designed for year-round occupancy as opposed to use as a country house or seasonal retreat. The structure derives significance under Criterion C for Architecture.	Inventoried, Treated as NRHP-eligible
Fall River Yacht Club	Swansea, Bristol	The Fall River Yacht Club (1890) at 24 Shawmut Avenue in Swansea, Bristol County was inventoried with the MHC in 1986 but has not been evaluated for listing in the NRHP. For this Project, it is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files note the single-family, atypical four-square residence originally served as the main house of the Fall River Yacht Club. The structure was moved from the yacht club by barge to its present location on Shawmut Avenue sometime in the mid-twentieth century where it was converted into a residential dwelling. The property is considered significant under Criterion C for its architecture.	Inventoried, Treated as NRHP-eligible
Dwelling, Shawmut Ave	Swansea, Bristol	The dwelling located on Shawmut Avenue in Swansea, Bristol County is a colonial revival cottage constructed in 1930. The property, inventoried with the MHC in 1986, has not been evaluated for listing in the NRHP, but for this Project is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Documentation regarding the property found in MHC files noted the property is a typical four-square, summer colony cottage and is one of the few remaining seasonal cottages remaining in that area of Swansea. The structure derives its significance under Criterion C for Architecture.	Inventoried, Treated as NRHP-eligible
Johnson, J. V. House	Swansea, Bristol	The J.V. Johnson House (1813) at 36 Riverview Avenue in Swansea, Bristol County was originally inventoried with the MHC in 1978 and listed in the NRHP in 1990. Documentation regarding the property found in MHC files note the J.V. Johnson House is a well-preserved and unique example of Prairie style architecture. The one and one-half story dwelling is notable for its fieldstone walls and tile roof that contrast with the predominately wood-clad character of the local architecture. The property is considered significant under Criterion C for its architecture.	NRHP-listed

Resource Name	Town, County	Summary Description	NRHP Status
Gardner Neck	Swansea, Bristol	Gardner Neck consists of the portion of southern Swansea between the Lee River and Cole River that extends south of Wilbur Avenue to the head of Mt. Hope Bay. This area was inventoried as a potential historic district with the MHC in 1986 but has not been evaluated for listing in the NRHP. For this Project, it is treated as NRHP eligible for purposes of applying the Criteria of Adverse Effect and in complying with Section 106 of the NHPA. Significant for its architecture under Criterion C, the Gardner Neck area illustrates the development period from 1850-1930 with examples of residential structures and seasonal cottages exhibiting a variety of styles including Shingle, Queen Anne, Bungalow, and Colonial Revival.	Inventoried, Treated as NRHP-eligible

7.3.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020b). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects. The effects on cultural resources were evaluated according to the Definition of Effect and the Criteria of Adverse Effect established by Section 106 of the NHPA.

The majority of IPFs will occur in the local communities, specifically in Edgartown, Falmouth, Nantucket, Swansea, Fall River, and Somerset, Massachusetts and Warren, Rhode Island. The effects will essentially be associated with the presence of visible infrastructure, i.e., the onshore substation and onshore converter station, in the Onshore Project Areas as well as the WTGs and OSPs in the Lease Area, and their lighting. The offshore infrastructure will be present throughout the operations phase of the proposed Project, and the onshore infrastructure may stay in place beyond Project decommissioning.

Table 7-8 provides a summary of the potential effects from the proposed Project on above-ground historic properties, and discussions of these effects are presented below. Proposed measures to avoid, minimize, or mitigate potential effects on above-ground historic properties are summarized in Section 16.

TABLE 7-8. IPFS AND POTENTIAL EFFECTS ON ABOVE-GROUND HISTORIC PROPERTIES IN THE PAPES

IPF	Potential Effect			Period of Potential Effect		
	Project Component			Construction	O&M	Decomm.
	Lease Area Infrastructure	Landfall Location, Onshore Export Cables	Onshore Substation and Converter Station			
Altered Visual Conditions	Change in resource setting	Change in resource setting	Change in resource setting	X	X	X
Changes to Ambient Lighting	Change in resource setting	—	Change in resource setting	X	X	X

7.3.2.1 Altered Visual Conditions

The proposed Project may affect historic properties within the PAPE of offshore and onshore infrastructure, namely within Falmouth, Nantucket, and Somerset, Massachusetts.

7.3.2.1.1 Construction, Operations and Maintenance and Decommissioning

The AVEHP indicates that the presence of the WTGs and OSPs may adversely affect historic properties with a view of the offshore infrastructure by compromising the characteristics that make a historic property significant and eligible for listing in the NRHP. Of the 10 above-ground historic properties within the offshore APE that have a view of the Project components, only one has a Recommended Determination of Adverse Effect: the Nantucket Historic District. Based on the assessment provided in Appendix S, Analysis of Visual Effects to Historic Properties, introduction of the WTGs and OSPs may result in a change to the unobstructed ocean viewshed of the Nantucket Historic District, potentially compromising the setting of the resource. As this is one of the key character-defining features, the Project may result in an adverse visual effect upon the viewshed and setting.

Previously disturbed sites were chosen for the onshore substation and the converter station locations, and adverse effects will be reduced to the extent practicable. The AVEHP indicates that the Falmouth onshore infrastructure may adversely affect historic properties by introducing a new visual element that could be considered a visual intrusion to its historic setting. One above-ground historic property within the Falmouth Onshore PAPE has a Recommended Determination of Adverse Effect: Oak Grove Cemetery. Based on the assessment provided in Appendix S, Analysis of Visual Effects to Historic Properties, introduction of the preferred substation site in Falmouth may compromise the integrity of the cemetery given the immediate proximity and view of the building. As the view and setting are character-defining features of the cemetery, the Project may have an adverse effect if this onshore substation site is selected.

Based on the assessment provided in Appendix S.1, Analysis of Visual Effects to Historic Properties – Brayton Point, the introduction of the converter station has the potential to cause visual effects on historic properties. Applying the Criteria of Adverse Effect, it is anticipated that the Project would result in no adverse effect to the 11 historic properties in the Brayton Point PAPE. Historic properties, particularly those with designed landscapes, where setting is an integral part of the significance, may be visually affected by the introduction of a new converter station in the setting. However, introduction of the onshore converter station site at Brayton Point will not adversely affect previously identified or unrecorded historic properties. While the introduction of new visual elements may result in viewshed impacts, they will either be temporary in nature or negligible. Because all but the uppermost portions of the highest converter station components would be screened from view and the remaining visible lightning protection masts or other narrow, vertical components would be seen at a minimum distance of 0.44 mile (0.7 km) and interspersed with existing industrial infrastructure, screening vegetation, or both; potential visual impacts will not occur to an extent that would erode the historic integrity of setting for historic properties within the PAPE. Therefore, the Project will not result in an adverse effect to historic properties.

Mayflower Wind will consult with the Tribes, BOEM, MHC, RIHPHC, and Tribal Historic Preservation Offices on ways to resolve adverse effects to historic properties. This may include the preparation of a Memorandum of Agreement stipulating measures to provide a public benefit that balances the loss to the historic properties. Such measures must be tailored specifically for the historic property and to the degree of effect. Mayflower Wind will provide a plan to BOEM that details how mitigation measures will be developed in consultation with NHPA consulting parties to resolve effects if they occur. This plan will be written in a programmatic fashion for all potential outcomes to be considered, including construction of new buildings, modification of existing buildings, and use of existing buildings without modification. The plan will align with the Section 106 of the NHPA and its implementing regulations (36 CFR Part 800) and Section 110 and will be developed in consultation with BOEM and relevant SHPOs and Tribal Historic Preservation Offices.

7.3.2.2 Changes to Ambient Lighting

Ambient lighting from the proposed Project may affect historic properties within the APE of offshore and onshore infrastructure, namely within Falmouth, Nantucket, and Somerset, Massachusetts.

7.3.2.2.1 Construction, Operations and Maintenance, and Decommissioning

As discussed above, the proposed Project may adversely affect the setting of one historic property in the offshore APE and one property in the onshore Falmouth APE. Lighting of Project infrastructure (WTGs, OSPs, onshore substation, and converter station) implies that this effect may occur during nighttime as well as during daytime. Mayflower Wind will keep lighting at the onshore substation and converter station to a minimum, including security lighting. For the offshore Project structures, Mayflower Wind will implement an Aircraft Detection Lighting System (ADLS), which would activate the lighting system on the WTGs based on approaching air traffic, which would minimize the time aviation lights would be on in the Lease Area at night (see Appendix Y3, ADLS Efficacy Analysis for further details). Refer to Section 3, Description of Proposed Activities, for further details regarding marking and lighting of Project structures.

Additional mitigation measures for visual resources are discussed in Section 8, Visual Resources, and Mayflower Wind will consult with relevant federal and state agencies on ways to resolve any remaining adverse effects. This may include the preparation of a Memorandum of Agreement stipulating measures to provide a public benefit that balances the loss to the historic properties. Such measures would be tailored specifically for the historic property and to the degree of effect.

8 VISUAL RESOURCES

Visual resources include elements of the surrounding area that may be sensitive to changes to their visual setting; including historic sites, scenic landscapes, lighthouses, state parks/beaches, wildlife refuges, designated scenic areas, and other recreation and tourism areas. Effects to visual resources can be perceived by both residents (year-round and seasonal) and tourists.

Appendix T, Visual Impact Assessment and Appendix T.1, Onshore Visual Impact Assessment – Brayton Point, were completed to evaluate the proposed Project's potential to affect visual resources. The goal of a VIA is to evaluate the potential changes in visual resources that could result from the proposed Project in order to assist BOEM in meeting its obligations contained in Section 106 of the NHPA (36 CFR Part 800), and NEPA (42 U.S.C. §§ 4321 *et seq.*). BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)* guidance does not require the use of specific methods for the VIA. Therefore, Mayflower Wind submitted a memorandum describing the planned methodology for the VIA to satisfy the BOEM COP guidelines. The memorandum was revised based on comments received from BOEM. Therefore, this section provides a description of the methodology and results of the VIA for the proposed Project.

The VIA provides:

- A visibility analysis to determine from where the proposed Project can potentially be seen;
- A landscape/seascape and ocean character analysis to evaluate the underlying scenic attributes of the affected environment;
- Key views to determine important points or corridors from which people can view the proposed Project;
- A viewer sensitivity analysis to determine the degree to which people are concerned about visual change; and
- An effect measurement to determine the degree of adverse or beneficial visual change.

The VIA includes an analysis to identify the viewshed. Because of topography (among other reasons) the Project infrastructure may not be visible from all areas within the Offshore and Onshore Project Areas. The analysis to define the preliminary viewshed uses a conservative delineation digital elevation model (DEM) reflecting maximum design heights and bare earth topography to identify the portions of the Offshore and Onshore Project Areas from where the Project infrastructure may be visible. That is, the preliminary viewshed does not account for additional screening of views that may be provided by structures or vegetation located between a potential viewer and the Project infrastructure.

Consistent with recently released BOEM guidance for the conduct of Visual Impact Assessment (Sullivan, 2021), a refined viewshed which accounts for screening by vegetation and structures using available DSM data in combination with the DEM was completed. This refined viewshed, referred to as the APVI, is used to support the impact assessment for both the Offshore and Onshore Project Areas. The results of refined analyses using the DSM/DEM derived APVI are included in Appendix T and Appendix T.1.

The VIA also includes visual simulations to consider the effect of the built infrastructure and vegetation cover on the visibility of the Project infrastructure within the APVI. These visual simulations are completed by integrating computer-modeled Project infrastructure to measured, georeferenced photos taken from selected KOPs. These KOPs include historic structures and buildings, significant landscapes, recreation areas, scenic roads, overlooks and vistas, public beaches, town centers, residential communities, and estates. Further, these KOPs represent views of the proposed Project from multiple angles, distances, vantages, and types of viewers (residents, tourists, and economic interests). The visual simulations inform the evaluation of Project-related visual effects on visual resources. A detailed description of the methodology is presented in Appendix T and Appendix T.1.

Technical appendices related to visual resources include:

- Appendix S, Analysis of Visual Effects to Historic Properties
- Appendix S.1, Analysis of Visual Effects to Historic Properties – Brayton Point
- Appendix T, Visual Impact Assessment
- Appendix T.1, Onshore Visual Impact Assessment – Brayton Point

8.1 Affected Environment

The proposed Project can potentially cause changes to visual conditions onshore and offshore during construction, operation, and decommissioning, as Project components will be visible at different phases of the proposed Project.

8.1.1 Offshore Project Area

To capture the potential visual resources that may be visually affected by the Offshore Project Area, a bare earth viewshed analysis was conducted to define the Offshore APVI based on a maximum viewshed limit of 43 mi (69.2 km), which approaches the limit of visibility based on the curvature of the earth at sea level,[8] and the maximum development scenario – up to 147 WTGs and 5 OSPs. The viewshed analysis was completed using a WTG hub height of 607 ft (185 m) and a tip height of 1,066.3 ft (325 m), and accounts for topographic features between a viewer and the Project that would limit visibility. The Offshore APVI includes Martha's Vineyard, Nantucket, and associated smaller islands; including Nomans Land, Esther, Tuckernuck, and Muskeget.

These islands are highly valued for their scenic and historic attributes, and have long been popular destinations for tourists, as well as serving communities of both year-round and seasonal residents. Most of the Offshore APVI is comprised of saltwater ocean environments, including partly enclosed bays, inlets, salt marshes, Nantucket Sound, and the vast open Atlantic Ocean. Sandy beaches and coastal dunes border the oceanfront, particularly on the south and southwestern shores of the islands. The seascape/landscape and ocean character types found in the APVI are highly valued by inhabitants and visitors, reflected by the significant attention and resources dedicated to the conservation of lands and preservation of cultural resources located therein.

Based on the baseline inventory and characterization of the Offshore APVI, 57 KOPs, which represent common and sensitive views, were evaluated in the field. Referenced and/or measured, georeferenced photos were taken at 38 locations where potential visibility to the Project was confirmed. Photographed KOPs included 15 KOPs on Martha’s Vineyard and 23 KOPs on Nantucket. Seven KOPs on Martha’s

[8] The maximum limit of visibility based on the earth curvature varies depending on the maximum elevation of the structure and the elevation of the viewer.

Vineyard and 13 KOPs on Nantucket were chosen to prepare a total of 21 visual simulations (one KOP was simulated twice to depict both clear and overcast conditions) (**Figure 8-1**).

Figure 8-2 and **Figure 8-3** present the selected KOPs on Martha's Vineyard and Nantucket, respectively. **Table 8-1** and **Table 8-2** provide a summary description of the selected KOPs. Additional detailed information on these selected KOPs is presented in Appendix T, Visual Impact Assessment.

TABLE 8-1. SUMMARY OF OFFSHORE KOPS ON MARTHA'S VINEYARD SELECTED FOR VISUAL SIMULATIONS

KOP Number	Name	Municipality	Resource Type	Distance to Nearest WTGs
1-MV	Wasque Point	Edgartown	Open Space Conservation; Chappaquiddick Island TCP/NRHP Historic Property	31.2 mi (50.2 km)
2-MV	Wasque Reservation	Edgartown	Open Space Conservation; Chappaquiddick Island TCP/NRHP Historic Property	31.2 mi (50.2 km)
3-MV	Wasque Avenue	Edgartown	Public Road, Open Space Conservation; Chappaquiddick Island TCP/NRHP Historic Property	31.6 mi (50.8 km)
4-MV	South Beach	Edgartown	Public Open Space	32.5 mi (52.3 km)
6-MV	Long Point Beach	West Tisbury	Wildlife Refuge, Recreation	34.9 mi (56.2 km)
9-MV	322 South Road	Chilmark	Residential	37.2 mi (59.8 km)
16-MV	Squibnocket Beach	Aquinnah	Public Recreation	37.9 mi (61.1 km)

TABLE 8-2. SUMMARY OF OFFSHORE KOPS ON NANTUCKET SELECTED FOR VISUAL SIMULATIONS

KOP number	Name	Municipality	Resource Type	Distance to Nearest WTGs
2-N	NCF Sandford Farm Barn Overlook	Nantucket	Public Open Space Conservation	24.4 mi (39.2 km)
3-N	Madaket Beach- Haze	Nantucket	Public Recreation	24.4 mi (39.2 km)
6-N	Tom Nevers Beach	Nantucket	Public Recreation	26.6 mi (42.8 km)
8-N	Tom Nevers Field	Nantucket	Public Recreation	25.7 mi (41.3 km)
10-N	Nobadeer Beach	Nantucket	Public Recreation	23.3 mi (37.5 km)
11-N	Miacomet Beach and Pond	Nantucket	Public Recreation	23.5 mi (37.8 km)
12-N a/	Cisco Beach	Nantucket	Public Recreation	23.6 mi (38.0 km)
13-N	Hummock Pond Road Bike Path	Nantucket	Public Recreation	23.8 mi (38.3 km)
16-N	Head of Plains	Nantucket	Public Recreation	24.0 mi (38.6 km)
18-N	Ladies Beach	Nantucket	Public Recreation	23.0 mi (37.0 km)
20-N	Madaquecham 1	Nantucket	Public Recreation	24.9 mi (40.1 km)
21-N	Sankaty Head Lighthouse	Nantucket	Public Recreation; NRHP Historic Property	29.4 mi (47.3 km)
22-N	Madaket Beach Sunset	Nantucket	Public Recreation	24.2 mi (38.9 km)

Note:
a/ Two visual simulations completed from KOP

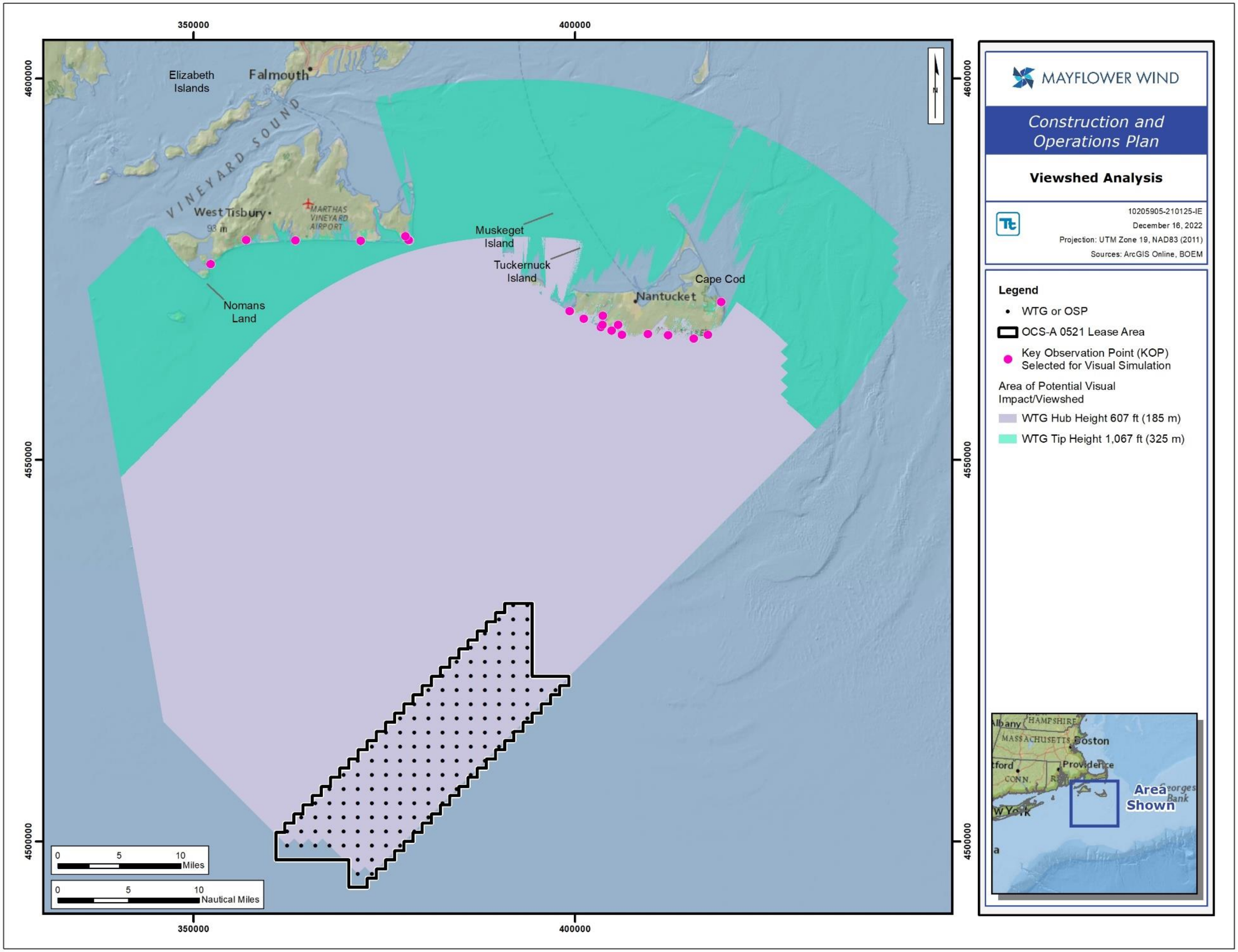


FIGURE 8-1. OFFSHORE APVI/VIEWSHED

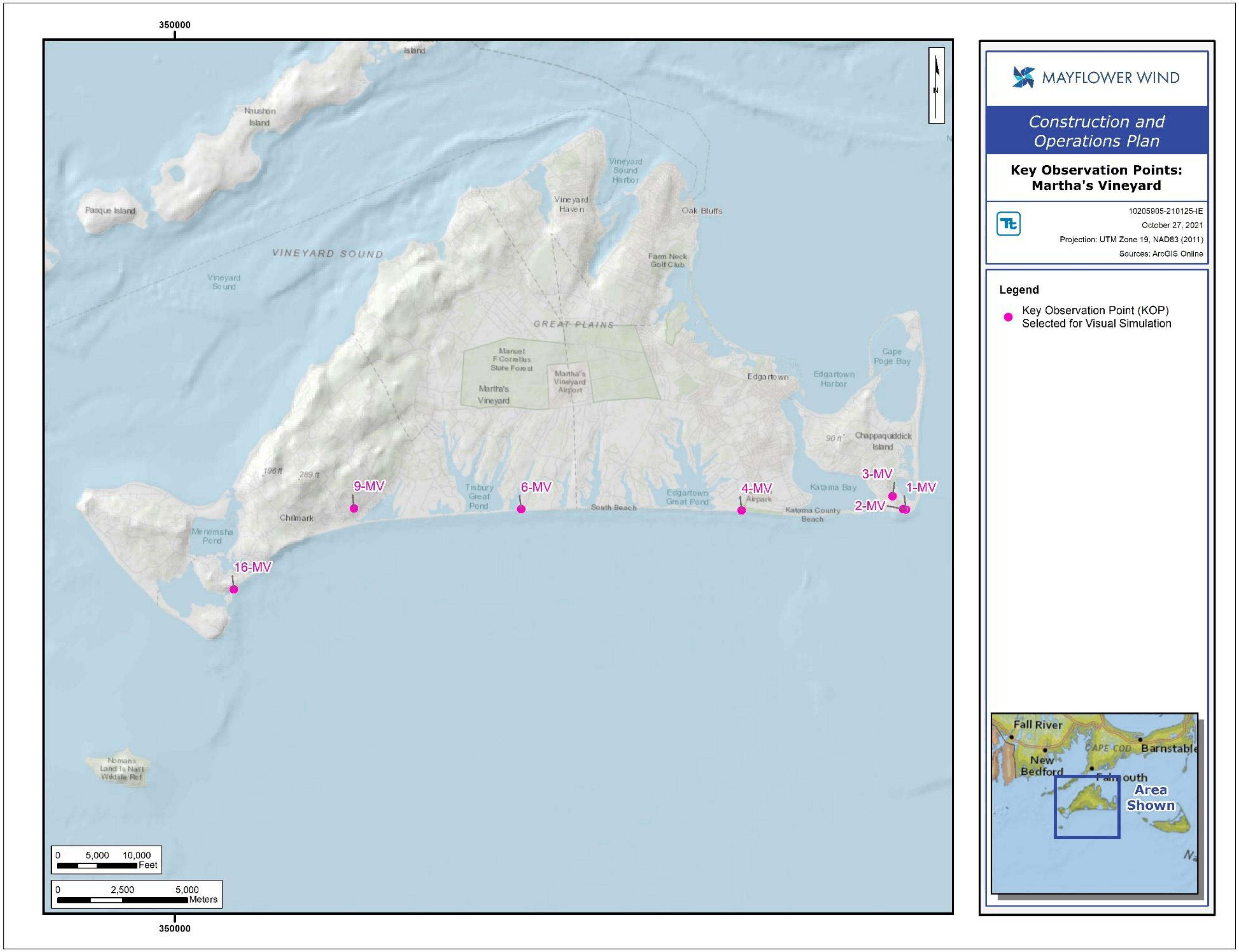


FIGURE 8-2. MARTHA'S VINEYARD KOPS

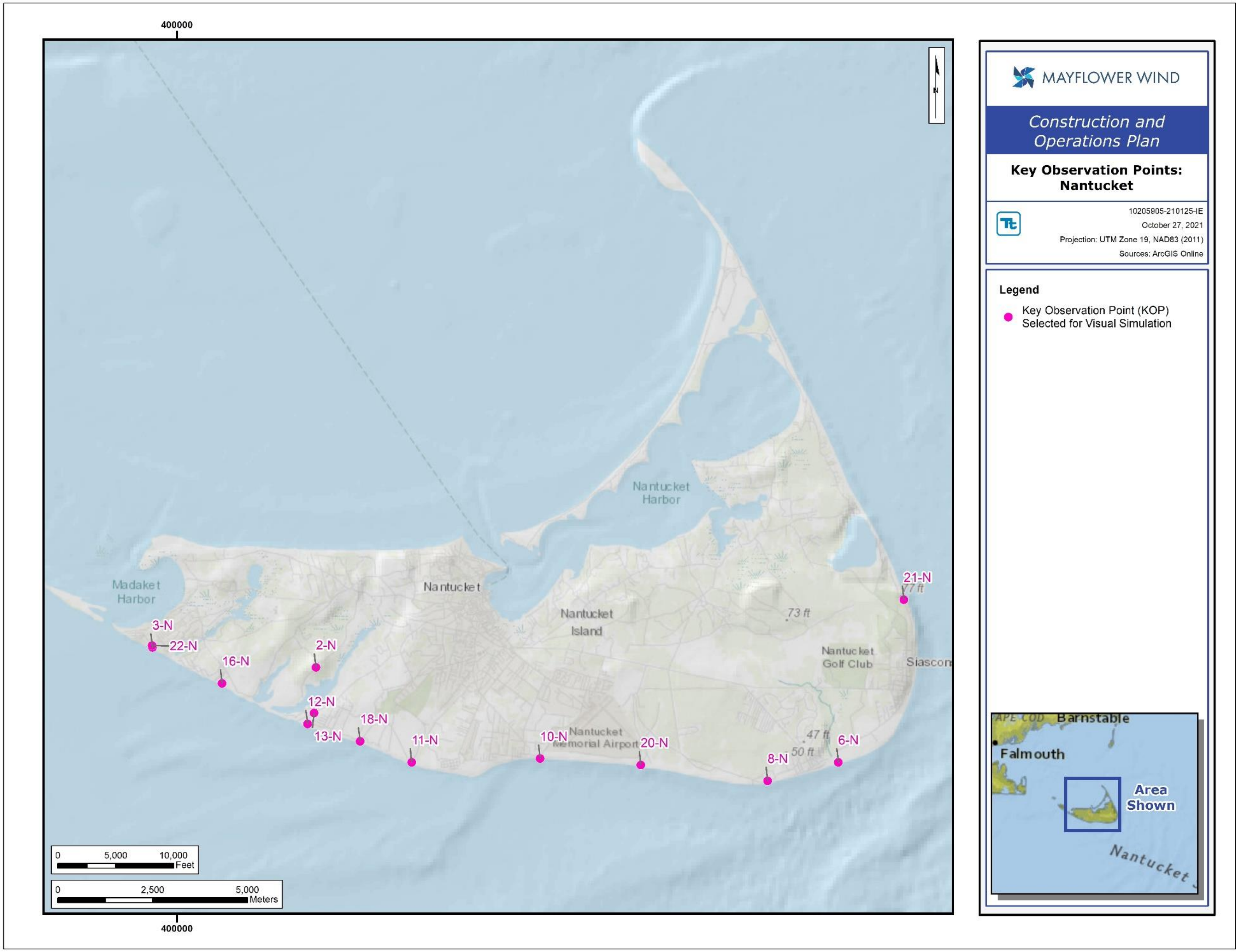


FIGURE 8-3. NANTUCKET KOPS

8.1.2 Onshore Project Area

8.1.2.1 Falmouth

In order to capture all of the possible visual resources that may be visually affected, the Falmouth Onshore Project Area (referred to as the Falmouth Onshore APVI) was defined as an area extending 3.5 mi (5.6 km) in all directions from the proposed onshore substation sites in Falmouth, Massachusetts. To delineate this area, a viewshed analysis was performed to establish the maximum area from which the substation may be visible, and where intervening topographic features may eliminate views of the substation (see **Figure 8-4**). The model used a conservative maximum height of 85 ft (26 m) for the lightning masts. The Falmouth Onshore APVI includes areas of upper Cape Cod in Barnstable County, including Falmouth, Massachusetts.

Upper Cape Cod is characterized by small towns comprising of roadways, residential areas, and public recreation spaces such as walking paths and biking trails, parks and beaches. The Falmouth Onshore APVI also includes a variety of undeveloped areas, including ocean sounds, freshwater ponds, forests/woodlands, as well as the Mashpee National Wildlife Refuge and the Waquoit Bay National Estuarine Research Reserve.

Following a baseline inventory and characterization of the Falmouth Onshore APVI, 23 KOPs, which represent common and sensitive views, were evaluated in the field to confirm visibility to the onshore substation locations under consideration. Referenced and/or measured, georeferenced photos were taken where potential visibility to the Project was confirmed. Four KOPs on upper Cape Cod with visibility to the alternate onshore substation were chosen to prepare visual simulations (**Figure 8-4**).

Table 8-3 provides a summary description of the selected KOPs. Detailed information on the selected KOPs is presented in Appendix T, Visual Impact Assessment. The visual simulations are attached to Appendix T.

TABLE 8-3. SUMMARY OF ONSHORE KOPS ON UPPER CAPE COD SELECTED FOR VISUAL SIMULATIONS

KOP Number	Name	Municipality	Resource Type	Distance to Preferred Onshore Substation Site
44-C	Oak Grove Cemetery	Falmouth	Public Cemetery, NRHP-eligible	0.14 mi (0.22 km)
46-C	Goodwill Park	Falmouth	Recreational walking trails	0.19 mi (0.30 km)
47-C	Lawrence Lynch Site - Gifford St. Substation	Falmouth	Public Road	0.17 mi (0.28 km)
49-C	Two Ponds	Falmouth	Public Recreation	0.26 mi (0.41 km)

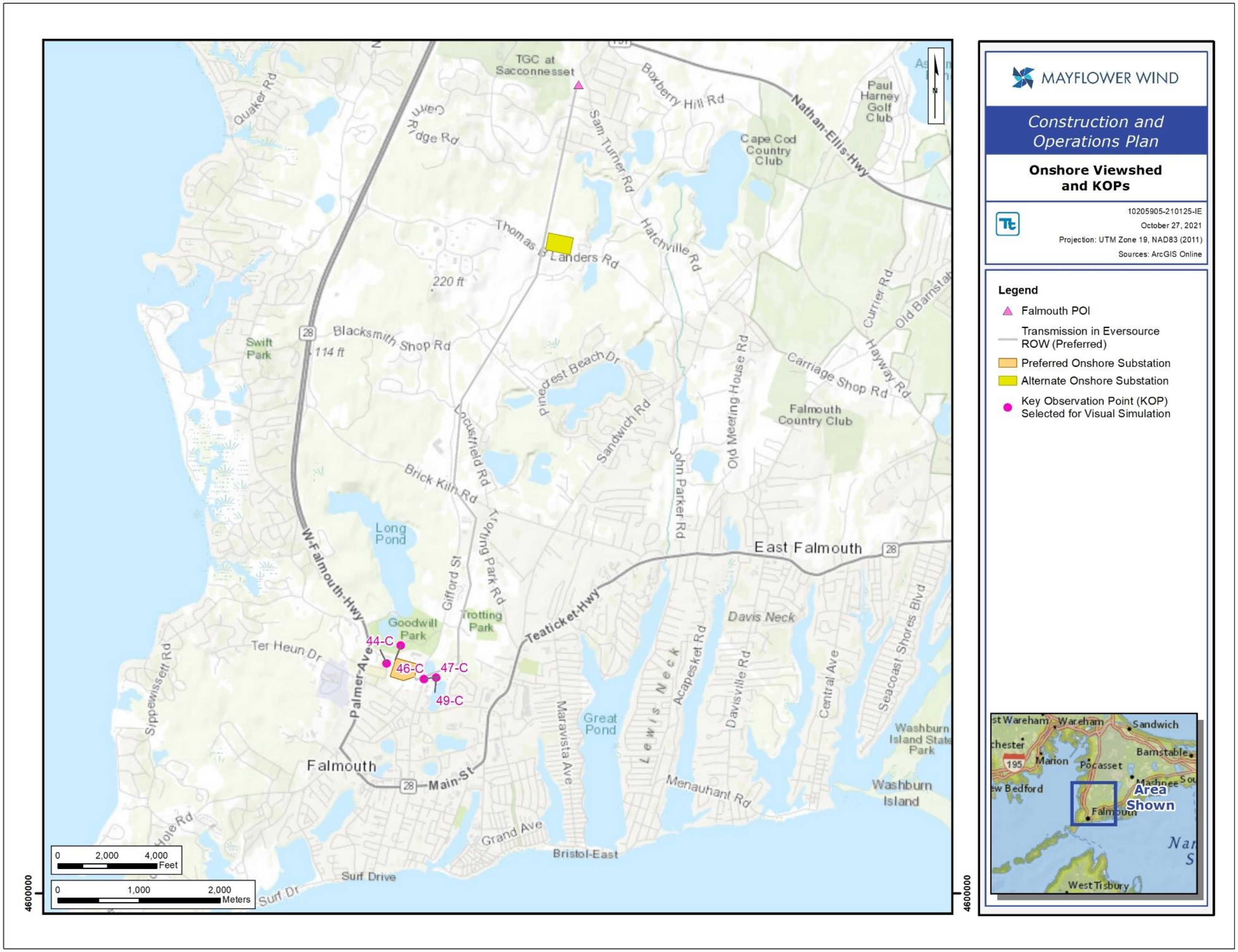


FIGURE 8-4. FALMOUTH ONSHORE KOPS

8.1.2.1 Brayton Point

As with the Falmouth onshore substation, the onshore HVDC converter station proposed at Brayton Point in Somerset, Massachusetts was analyzed for potential effects on scenic resources. Viewshed analyses were conducted within the onshore visual study area, which for Brayton Point was an area extending three miles in all directions from the HVDC converter station. The viewshed analyses used a DSM of the area within the Brayton Point Onshore Project Area (referred to as the Brayton Point Onshore APVI), which accounted for topography, vegetation, and structures and their influence on visibility. The analysis also used a conservative maximum height of 85 ft (26 m) for the lightning masts.

In addition to Somerset, the Brayton Point Onshore APVI included portions of Fall River and Swansea, Massachusetts, and Warren, Rhode Island. The landscape surrounding Brayton Point is characterized by low elevation, level terrain notable for its irregular inland shoreline of bays, estuaries, islands, and peninsulas. Much of the Brayton Point Onshore APVI is comprised of the open water of Mount Hope Bay, while the upland portions include residential areas of varying types, from rural areas to dense, low-rise urban centers with historic roots. Privately owned undeveloped areas, transportation corridors, and industrial properties are also present within the Brayton Point Onshore APVI.

The results of the viewshed analyses were used to determine the extent to which the HVDC converter station would potentially be visible from visually sensitive resources or other areas identified within the Brayton Point Onshore APVI. Field visits were then conducted to verify visibility of the Project from the sensitive viewpoints located in areas identified within the resulting viewshed.

After assessing the results of the viewshed analyses, seven KOPs were selected from among the visually sensitive resources and other identified sensitive viewing areas, such as residential neighborhoods, with potential visibility of the HVDC converter station (**Figure 8-5**). Field visits confirmed that visibility of the converter station from the surrounding landscape is highly constrained by multiple factors, including the physical isolation of the site on Brayton Point, topography, and screening vegetation. Three KOPs surrounding Brayton Point with potential visibility to the converter station were chosen to prepare visual simulations (**Table 8-4**). Detailed information on the selected KOPs is presented in Appendix T.1, Onshore Visual Impact Assessment – Brayton Point.

TABLE 8-4. SUMMARY OF ONSHORE KOPS AT BRAYTON POINT SELECTED FOR VISUAL SIMULATIONS

KOP Number	Name	Municipality	Resource Type	Distance to Onshore HVDC Converter Station Site
1-B	Brayton Point Beach	Somerset	Public Recreation (undeveloped)	0.44 mi (0.71 km)
3-B	Sycamore Street	Swansea	Residential Area	0.50 mi (0.80 km)
4-B	Route 103 at Anthony Bridge	Swansea	Public Road	0.17 mi (0.28 km)

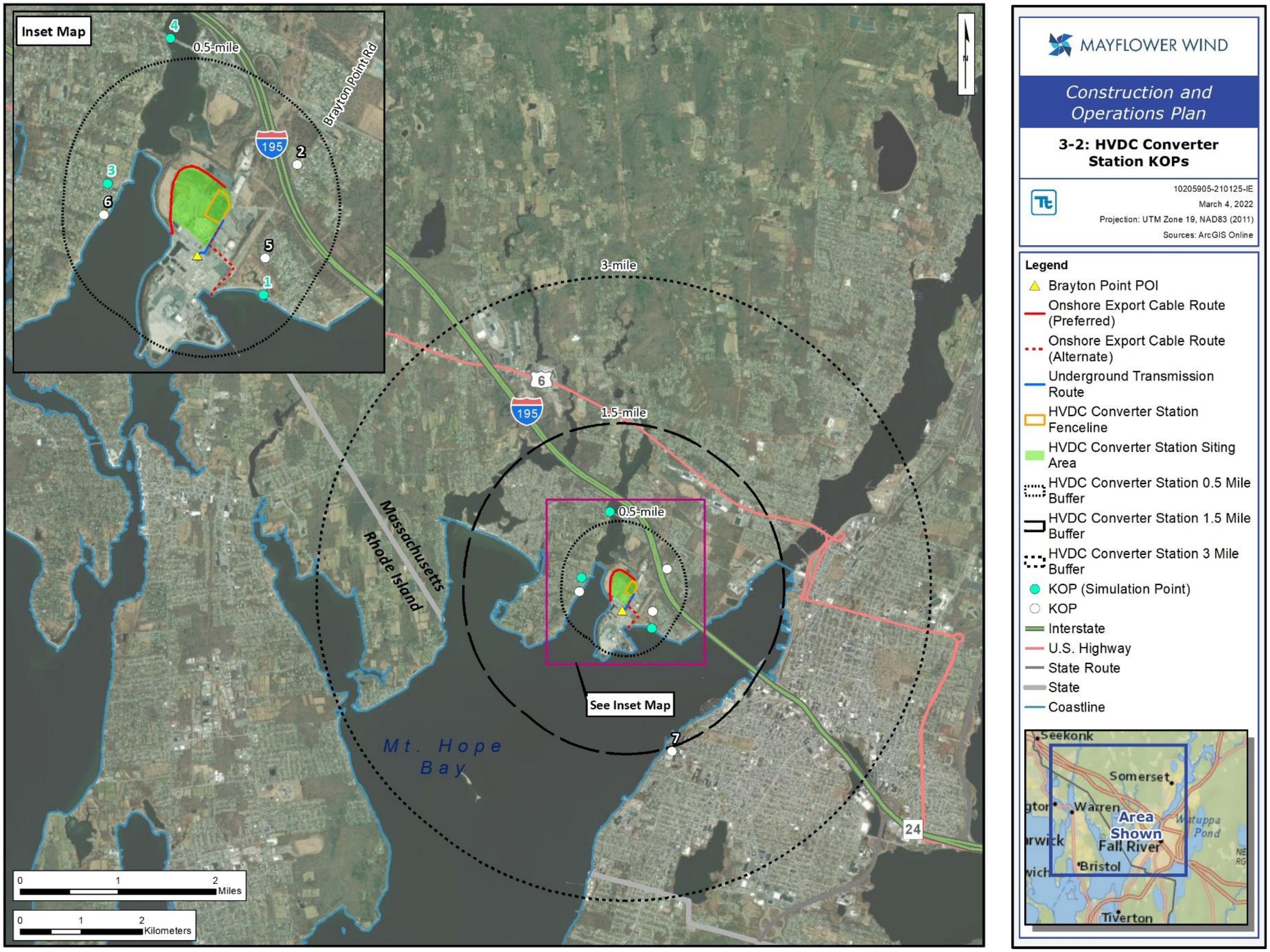


FIGURE 8-5. BRAYTON POINT ONSHORE KOPS

8.2 POTENTIAL EFFECTS

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

Visual effects may occur in the local communities, specifically in Falmouth and Somerset, Massachusetts, as well as locations on Martha's Vineyard and Nantucket. The effects will be associated with the presence of visible infrastructure, i.e., the WTGs and OSPs in the Lease Area, and their lighting, as well as the onshore substation and converter station in the Onshore Project Areas. The offshore infrastructure will be present throughout the operations phase of the proposed Project, and the onshore infrastructure may stay in place beyond Project decommissioning. **Table 8-5** provides a summary of the potential effects from the proposed Project on offshore and onshore visual effects, and discussions of these effects are presented below. Under the preferred scenario, the onshore export cables and underground transmission lines will be entirely underground. Therefore, no long-term visual impacts will occur for those Project components. Temporary disturbance to the visual environment occurring during installation of the onshore export cables and underground transmission lines is discussed below.

TABLE 8-5. IPFS AND POTENTIAL EFFECTS ON VISUAL RESOURCES

IPF	Potential Effect			Period of Potential Effect		
	Project Component					
	Lease Area Infrastructure	Landfall Locations and Onshore Export Cables	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Altered Visual Conditions	Change in seascape/ landscape or ocean character	Change in landscape	Change in landscape	X	X	X
Changes to Ambient Lighting	Change in seascape/ landscape or ocean character	-	-	X	X	X

As detailed in Appendix T, VIA, the process for analyzing visual impact for both onshore and offshore Project components is based on the evaluation of visual compatibility and contrast with viewer sensitivity and the view sensitivity (i.e., character of the existing setting/view).

Variables that influence visual effects of the Project (Sullivan et al., 2013) include:

- Visual Acuity: Human eyesight combined with the effect on visibility from atmospheric and meteorological conditions. The strength (or weakness) of the visual contrast of the Project from KOPs.
- Viewer Location and place: The number of KOPs from which the Project is visible, the position of the viewer at the KOP (superior, level, or subordinate) and the relationship of the viewer from their position at the KOP to the ocean.
- Sensitivity: Sensitivity includes the importance to the viewer of their experience and activity, the time of viewing (day or night), and/or season.
- Project Scale: The scale of the project related to the vertical and horizontal massing within the frame of view.
- Distance: How far is the project offshore and how does curvature of the earth effect how much of the feature can be seen.
- Time of day: Visibility varies based on how sunlight reflects off of the WTGs. Front lighting results in light, nearly white appearance. Back lighting results in a dark gray appearance. These are viewed differently depending on the background (sky) color.
- Atmospheric conditions: Visibility is highly dependent on the conditions of the atmosphere, including cloud cover, humidity, haze, and fog. Clear conditions with relatively low humidity likely create the most optimal conditions for seeing the WTGs and OSPs,
- For this VIA, Visual Change was characterized by aggregate Visibility Levels for each KOP where Visibility Levels 5 and 6 indicate strong contrast, Visibility Levels 3 and 4 indicate medium contrast, and Visibility Levels 1 or 2 indicate weak contrast. The Visibility Levels for the simulated KOPs were considered in the broader context as representative of other similar KOPs.

Visual Sensitivity was characterized as ranging from Low to Very High based on the sensitivity of the viewers as well as the view (i.e., visual resource) sensitivity.

The combination of Visual Change and Visual Sensitivity characterizes the potential for impact associated with the Project; the potential for impact is characterized as Low, Medium/Low, Medium, High/Medium, or High.

8.2.1 Altered Visual Conditions

The proposed Project may affect visual resources within the Offshore and Onshore APVIs.

Visual simulations were used to analyze the effects from KOPs using a modified Visual Contrast Rating system (see Appendix T, Visual Impact Assessment). Visual contrast is described as the extent to which a project appears different from the surrounding visual environment. It is measured using the four basic design elements of form, line, color, and texture (BLM, 1986). This analysis provides one metric for evaluating and characterizing the level of visual change to the characteristic landscape that could result from a project, along with how that change would be perceived at KOPs by viewers. The ratings or Visibility Levels are defined in **Table 8-6**.

With consideration of the visibility factors described above, visual contrast was assessed by comparing visual elements (form, line, color, and texture) of the existing natural characteristic landscape (and other built environmental features) with the elements of the proposed Project. Horizontal and vertical scale of the Project features, movement and lighting are also considered. Visual simulations inform this analysis by providing graphical depictions of the proposed Project under operational conditions.

TABLE 8-6. CRITERIA USED TO RANK EXPECTED VISIBILITY OF A PROJECT

Scale	Level	Definition
Weak	1	Visible only after extended, close viewing. Otherwise invisible.
	2	Visible when scanning in the general direction of the study subject, otherwise likely to be missed by casual observers.
Medium	3	Visible after a brief glance in the general direction of the study subject and unlikely to be missed by casual observers.
	4	Plainly visible, so could not be missed by casual observers, but does not strongly attract attention or dominate the view because of its apparent (small) size.
Strong	5	Strongly attracts the visual attention of views in the general direction of the study subject. Attention may be drawn by strong contrast in form, line, color, texture, luminance, or motion.
	6	Dominates the view because the study subject fills most of the visual field for views in its general direction. Strong contrasts in form, line, color, texture, luminance, or motion may contribute to view dominance.
None	N/A	Not Visible

Source: BLM, 1986.

The potential for visual impact (defined as Low, Medium or High) represents the measure of visual change described above, combined with the visual sensitivity. Visual Sensitivity is defined based on viewer group sensitivities, as well as the sensitivity of the visual resource to change. For purposes of the VIA, visual sensitivity was classified as High for the Offshore APVI, and Medium to High for the Onshore APVIs.

8.2.1.1 Construction, Operations and Maintenance, and Decommissioning

8.2.1.1.1 Offshore APVI

The primary components affecting the Offshore APVI are the WTGs and OSPs located within the Lease Area. The presence of these Project components may alter the seascape from the nearby islands from which the KOPs were photographed.

A total of 21 visual simulations were completed from the selected KOPs (7 on Martha's Vineyard and 13 on Nantucket [one KOP was simulated twice to depict both clear and overcast conditions]). As presented in **Table 8-7**, among all the simulations, none showed that Project infrastructure was not visible. The visibility ranking was weak for three KOPs, weak-medium for six KOPs, medium for seven KOPs, and medium-strong for five KOPs. No KOPs were assigned a visibility ranking of strong.

Landscape character types on the islands are not directly impacted by offshore Project components due to distance. However, viewsheds are impacted, and viewers will (conditions permitting) experience some change to their experience on shore where they are visually connected to the ocean horizon. The only landscape/seascape character type that is directly affected by the Project is the open ocean character type, over 20 nm (37 km) from the nearest onshore character area. Boaters will experience closer views of the Project if they approach it, with visual dominance, particularly vertical dominance, increasing the nearer a boater gets to the Project. Beaches are the landscape character type most impacted from the standpoint of visual linkage; that is, the beaches are more directly connected to the open ocean unit by proximity and the unobstructed view.

TABLE 8-7. SUMMARY OF CONTRAST RATING FOR VISUAL SIMULATIONS FROM OFFSHORE KOPS WITHIN THE APVI

Visibility Level Ranking	KOPs		Municipality
Not visible			
Weak [1] - [2]	9-MV	322 South Road	Chilmark
	16-MV	Squibnocket Beach	Aquinnah
	21-N	Sankaty Head Lighthouse	Nantucket
Weak-Medium [2] - [3]	1-MV	Wasque Point	Edgartown
	2-MV	Wasque Reservation	Edgartown
	4-MV	South Beach	Edgartown
	6-MV	Long Point Beach	West Tisbury
	8-N	Tom Nevers Field	Nantucket
	16-N	Head of Plains	Nantucket
Medium [3] - [4]	2-N	NCF Sandford Farm Barn Overlook	Nantucket
	3-MV	Wasque Avenue	Edgartown
	3-N	Madaket Beach- Haze	Nantucket
	6-N	Tom Nevers Beach	Nantucket
	10-N	Nobadeer Beach	Nantucket
	11-N	Miacomet Beach and Pond	Nantucket
	20-N	Madaquecham 1	Nantucket
Medium-Strong [4] - [5]	12-N	Cisco Beach - Clear Sky	Nantucket
	12-N	Cisco Beach – Overcast	Nantucket
	13-N	Hummock Pond Road Bike Path	Nantucket
	18-N	Ladies Beach	Nantucket
	22-N	Madaket Beach Sunset	Nantucket
Strong [5] - [6]	-		-

All of the parameters of the selected WTGs will fall within the range described in the WTG PDE (see Section 3, Description of Proposed Activities). The paint color of the WTGs will be selected from those available, based on BOEM and other relevant regulatory guidance, to minimize WTG visibility.

8.2.1.1.2 Onshore APVI

The primary component affecting the Falmouth Onshore APVI is the onshore substation. Onshore export cables and underground transmission lines will be installed primarily within existing ROWs and minimal visual effects will occur as a result. Visual effects associated with the installation of onshore export cables and underground transmission cables will occur during construction, as a result of the temporary presence of construction equipment. Any impacted roads will be repaved and returned to their previous state after installation is complete, when possible. Visible evidence of the underground export and underground transmission cables will be at grade manhole covers at splice vault locations.

An addendum to the VIA, including simulations and analysis of the new HVDC converter station in Somerset, Massachusetts is included in Appendix T.1 Onshore Visual Impact Assessment – Brayton Point. A total of seven visual simulations were performed from the selected onshore KOPs within

Falmouth, Massachusetts and at Brayton Point, in Somerset, Massachusetts. **Table 8-8** presents the visibility ranking for each of the simulated KOPs without considering proposed mitigation.

TABLE 8-8. SUMMARY OF CONTRAST RATING FOR VISUAL SIMULATIONS FROM ONSHORE KOPS WITHIN THE APVI

Visibility Level Ranking	Onshore KOPs		Municipality
Not visible/ Negligible	1-B 3-B 4-B	Brayton Point Beach Sycamore Street Route 103 at Anthony Bridge	Somerset Swansea Swansea
Weak [1] - [2]	49-C	Two Ponds	Falmouth
Weak-Medium [2] - [3]	46-C	Goodwill Park	Falmouth
Medium [3] - [4]	47-C	Lawrence Lynch Site - Gifford St. Substation	Falmouth
Medium-Strong [4] - [5]	44-C	Oak Grove Cemetery	Falmouth
Strong [5] - [6]	-		-

For Falmouth, when the above measures of visual change are taken with a Medium to Strong visual sensitivity, the potential for visual impact will be Weak for one, Weak to Medium for one, Medium for one, and Medium to Strong for one KOP due to the introduction of the onshore substation into the upper Cape Cod setting. Visual effects are mostly due to moderate visual contrast of the onshore substation, partial vegetative screening from KOPs, and limited Project extent associated with the single substation site.

For Brayton Point, when the above measures of visual change are taken with a Medium to Strong visual sensitivity (due to its predominantly residential setting), the potential for visual impact will be negligible for the three simulated KOP locations, because all but the uppermost portions of the highest converter station components would be screened from view. The remaining visible lightning masts or other narrow, vertical components would be seen at a minimum distance of 0.44 miles (0.71 km) and interspersed with existing industrial infrastructure, screening vegetation, or both.

Mayflower Wind will design the substation and converter station to mitigate visual effects to the extent feasible. Where practicable, this will include:

- Improving site aesthetics by adhering to landscape codes and edge treatments; and
- Improving onshore substation and converter station building architecture to better fit local context.

8.2.2 Changes to Ambient Lighting

The proposed Project may affect visual resources within the Offshore and Onshore APVIs, due to changes in ambient lighting. Changes in ambient lighting are discussed in Section 3, Description of Proposed Activities, along with how Mayflower Wind intends to mitigate the effects from changes in lighting offshore and onshore.

8.2.2.1 Construction and Decommissioning

Visual impact during construction and installation of the offshore Project components would be limited to partially built WTGs or OSPs and vessels working out in the Atlantic Ocean and travelling back and forth between mainland ports.

The larger construction vessels will be a visible feature within the maximum theoretical area of nacelle visibility. The majority of construction is expected to occur during daylight hours, but nighttime activity may also occur. Construction vessels will have nighttime lights in accordance with USCG regulations. Work lights are generally downward directed and would not typically be oriented horizontally where visibility on shore would be increased. Visual impact associated with construction and installation operations, in general, would be minor as construction equipment would only be in use temporarily during the construction and decommissioning periods. Construction-related visual impacts will be relatively brief and are not expected to result in adverse prolonged visual change nor impact. The analysis of offshore Visual Change and Visual Sensitivity in the sections below is limited to the operational and maintenance phase of the Project. Additional details regarding visual impact during construction and installation can be found in Appendix T, Visual Impact Assessment.

Lights from equipment and vessels used during construction and installation activities will be visible. Further information on ambient lighting is discussed in Section 3, Description of Proposed Activities. During construction and decommissioning activities, marine vessel traffic could potentially increase in Buzzards Bay, Narragansett Bay, Rhode Island Sound, and the open ocean. However, the construction vessels will not represent a significant increase over the existing vessel traffic in the area, and will result in only short-term and limited visual impacts.

Equipment and vessels will be present for a short period at any given location as installation of the equipment progresses. The Project construction schedule is presented in Section 3, Description of Proposed Activities. Effects on visual resources associated with onshore construction will be similar to those from work related to any other utility infrastructure project.

8.2.2.2 Operations and Maintenance

Lighting of Project infrastructure (WTGs, OSPs, onshore substation, and converter station) may have effects to visual resources during nighttime as well as daytime. Project operation is not anticipated to result in a noticeable increase in vessel traffic. The WTGs will be equipped with USCG navigation warning lights on the platform near the tower base, as well as aviation lighting, which will operate in accordance with FAA and BOEM requirements.[9]

Mayflower Wind will implement ADLS on offshore Project components in the Lease Area to mitigate visual effects from nighttime activation of FAA aviation lighting. An ADLS uses a localized radar on the perimeter of a wind project to detect aircraft flying within a pre-defined detection zone around the project and activates aviation lights accordingly, as opposed to keeping them permanently lit. A flight path survey, as part of an ADLS Efficacy Analysis, was conducted for the proposed Project (see Appendix Y3, Aircraft Detection Lighting System Efficacy Analysis). Historical flight path data in proximity to the proposed Project for the period between February 1, 2019 and January 31, 2020 was analyzed. This data

[9] FAA Advisory Circular 70: Obstruction Marking and Lighting (FAA AC 70/7460-1M)

set, in conjunction with analysis of standard ADLS activation parameters and local sunrise and sunset times, indicated that ADLS controlled obstruction lights would have been activated in the Lease Area for a total of only 4 minutes and 46 seconds over a one-year period.

As described in Section 3.4, Summary of Impact-Producing Factors, Mayflower Wind will work with Falmouth and Somerset, Massachusetts to ensure the lighting scheme for the onshore substation and converter station complies with Town requirements. Outdoor light fixtures are typically light-emitting diode holophane-type fixtures, equipped with light shields to prevent light from encroaching into adjacent areas. Light shields may be rotated within fixtures to the most effective position for keeping light overflow from leaving the site. The design will work to comply with night sky lighting standards to the extent practicable. It is noted that under certain ground cover conditions (i.e., snow cover), down-shielded lighting would increase light dome and atmospheric (clouds, haze, fog) reflections. There are typically a few lights illuminated for security reasons on dusk–to-dawn sensors, as well as a few on motion-sensing switches, depending on the application needed for the site. The majority of lights will be switched on for emergency situations only and would not be used on a regular basis. Task lighting during construction and maintenance activities will only be used as needed and manually switched on.

9 ACOUSTIC RESOURCES

9.1 IN-AIR ACOUSTICS

This section describes the in-air (airborne) noise expected to be generated due to construction and operation of the proposed Project. The Onshore Project Areas, including the Falmouth Onshore Project Area and Brayton Point Onshore Project Area, include the landfall locations in Falmouth and Somerset, Massachusetts, and Portsmouth, Rhode Island, where the export cables and underground transmission routes will be installed. Noise modeling of onshore HDD equipment and operation of the onshore substation was conducted to analyze potential effects of the proposed Project. Potential effects were also considered for WTGs and OSPs during operations, and it was determined that the in-air noise levels generated by offshore components will not cause impacts to onshore receptors. It is expected that noise levels from decommissioning will be similar to the noise levels from construction shown in Section 9.1.4.2, HDD Activities. See Section 3, Description of Proposed Activities, for further detail regarding decommissioning.

Technical appendices related to in-air acoustics include:

- Appendix U1, In-Air Acoustic Assessment Report[10]

9.1.1 Acoustics Fundamentals

In-air acoustics refers to sound which can be described as vibrations traveling through the air as pressure waves and received by a hearing organ such as the human ear. Sound resulting from construction or operation of infrastructure projects is generally referred to as noise.

Due to the many orders of magnitude involved in measuring sound pressure waves in Pascals, sound is generally measured in the decibel scale (dB). The decibel scale is a logarithmic scale with a reference pressure of 20 micropascals corresponding to 0 dB, the threshold of sound perception for people 20 years aged or less. Environmental sound levels are usually a time varying source and are typically averaged using the Equivalent Sound Level (L_{eq}). The L_{eq} is the steady-state sound level containing the same acoustical energy as the time-varying sound that occurs during the same period.

Acoustical energy originating from a point in space can be described as sound power. The sound power level is independent of distance and is a measure of how much energy is emanating from a source in decibels.

When background sound levels are required to be estimated in the presence of a time-varying noise source, the L_{90} metric is commonly utilized. L_{90} is the sound level exceeded during 90 percent of the specified time interval and is a statistical approximation of the background sound level without the presence of the time-varying noise source.

[10] At this time, Appendix U1, In-Air Acoustic Assessment Report, addresses the in-air acoustics relating to the Falmouth onshore Project components. Once an in-air acoustic assessment and modeling for the Brayton Point onshore Project components is completed, Appendix U1, In-Air Acoustic Assessment Report will be updated.

When referring specifically to the human ear, sound levels are often expressed as decibels in the A-weighting scale (dBA). Since the human ear perceives "loudness" differently at different frequencies, the A-weighting scale adjusts the sound levels at different distinct frequencies to more accurately approximate the auditory response of healthy human hearing. **Table 9-1** describes typical A-weighted noise levels for various noise sources and environments; a full description can be found in Appendix U1, In-Air Acoustic Assessment Report.

TABLE 9-1. TYPICAL A-WEIGHTED NOISE LEVELS

Noise Source (at a Given Distance)	Scale of A-Weighted Sound Level (dB)	Description
Military Jet Take-off with After-burner (50 ft, 15 m)	140	Can Cause Hearing Loss
Commercial Jet Take-off (200 ft [61 m])	120	Threshold of Pain
Ambulance Siren (100 ft [30 m]) Power Lawn Mower (3 ft [0.9 m])	100	Very Loud
Garbage Disposal (3 ft [0.9 m])	80	High Urban Ambient Sound
Normal Conversation (5 ft [1.5 m]) Air Conditioning Unit (100 ft [30 m])	60	Average Urban Ambient Sound
Bird Calls (distant) Library	40	Quiet Lower Limit of Urban Ambient Sound
	0	Threshold of Hearing

9.1.2 Noise Modeling Methodology

Noise modeling was conducted to assess the expected noise levels at the proposed Project against applicable in-air acoustics regulations, as presented in Appendix U1, In-Air Acoustic Assessment Report. All noise modeling has been performed using CadnaA software, which uses International Organization for Standardization (ISO) 9613-2 standard outdoor sound propagation calculation methods to calculate noise at specific points and generate noise contour maps. As required by ISO 9613-2, noise modeling includes the effect of ground elevation, weather conditions, atmospheric attenuation, shielding effects from objects, and ground reflection in three dimensions.

9.1.3 Affected Environment

As stated above, the Onshore Project Areas include the landfall locations in Falmouth and Somerset, Massachusetts, and Portsmouth, Rhode Island, where the export cables and underground transmission routes will be installed. A description of the noise sensitive receptors and a summary of the regulatory environment are included in this section.

9.1.3.1 Description of Noise Sensitive Receptors

Noise sensitive receptor locations adjacent to the Falmouth Onshore Project Area include residential properties and hotel properties (see **Figure 9-1** through **Figure 9-4**).

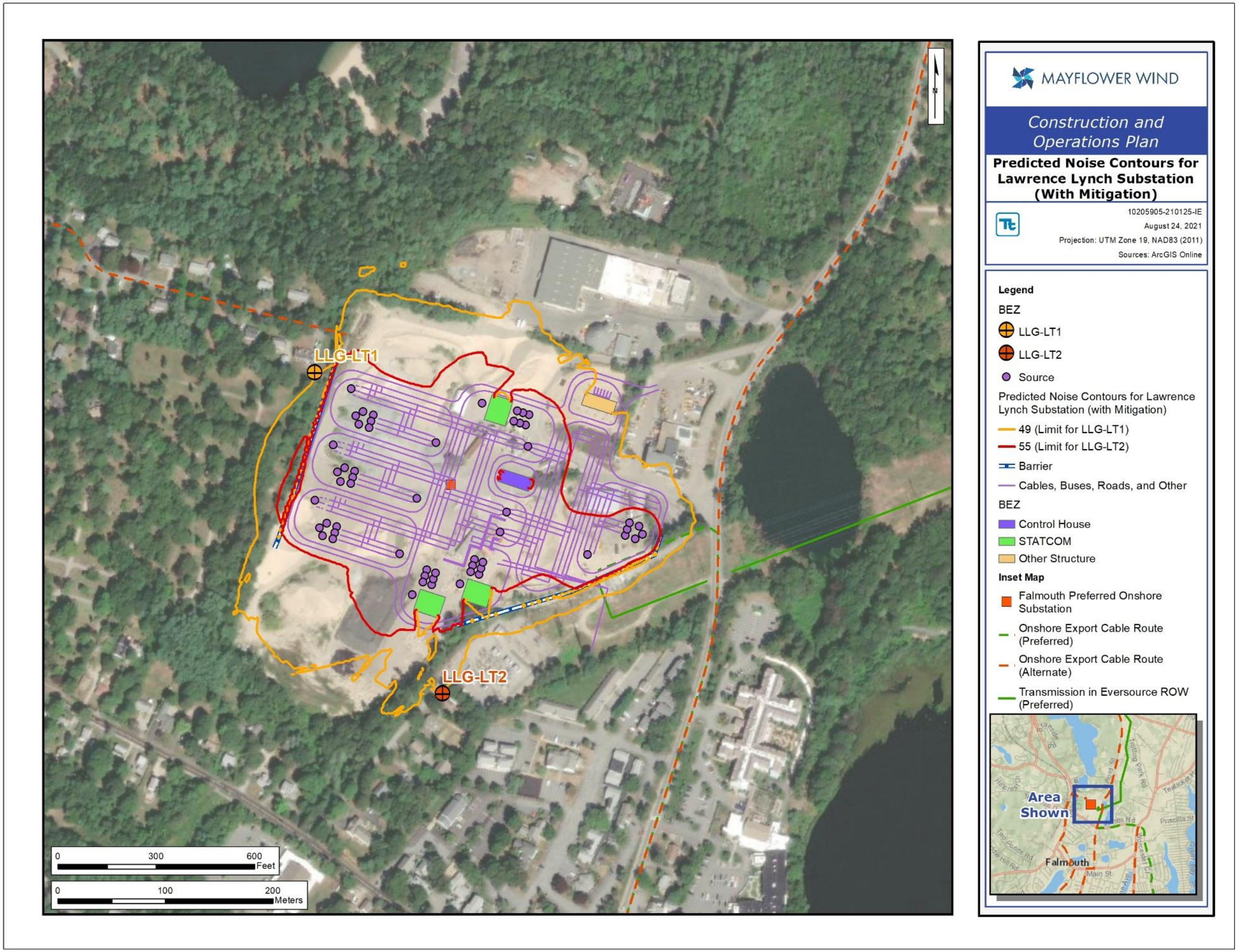


FIGURE 9-1. PREDICTED NOISE CONTOURS WITH NOISE BARRIERS FOR THE FALMOUTH PREFERRED ONSHORE SUBSTATION WITH MITIGATION MEASURES

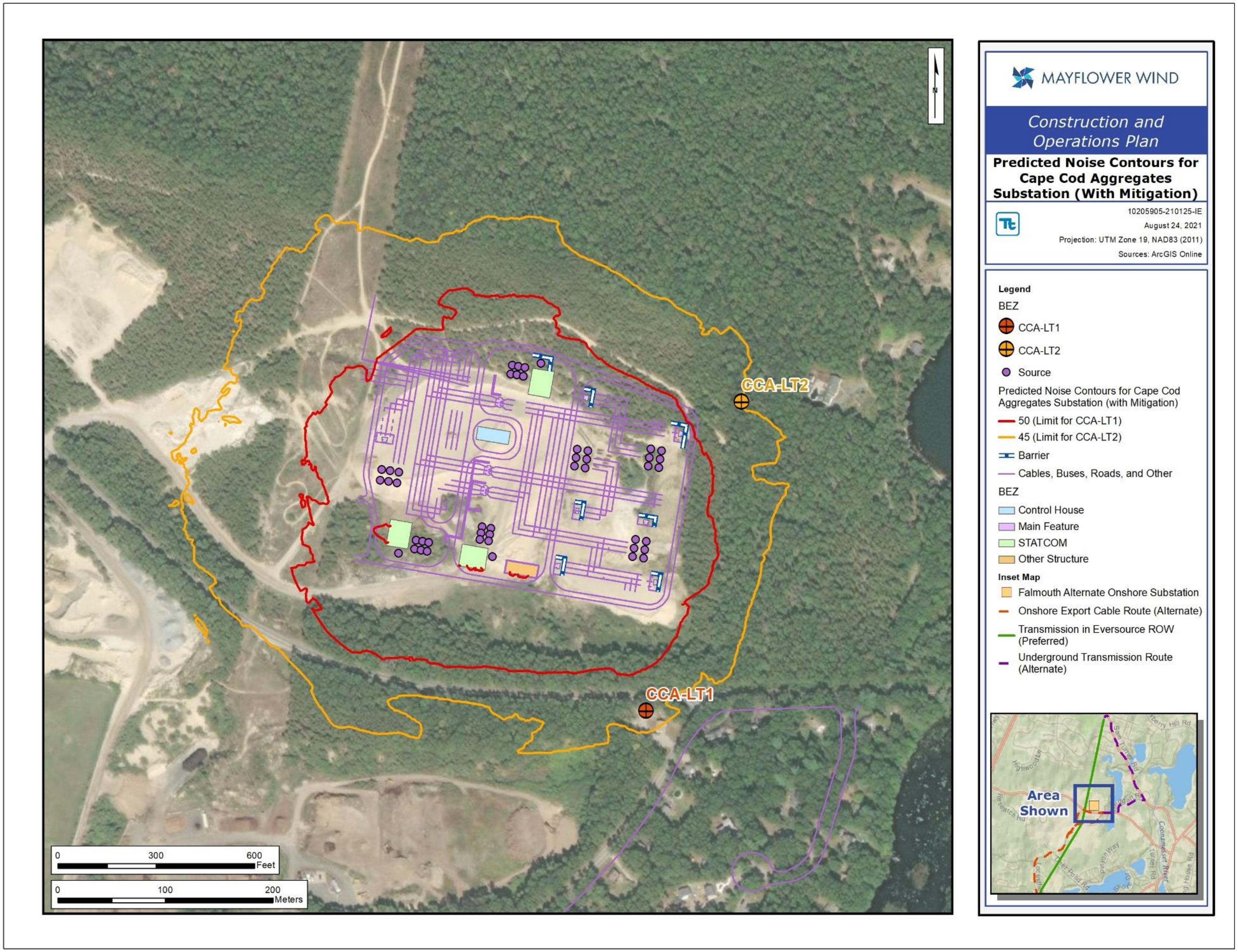


FIGURE 9-2. PREDICTED NOISE CONTOURS WITH NOISE BARRIERS FOR THE FALMOUTH ALTERNATE ONSHORE SUBSTATION WITH MITIGATION MEASURES

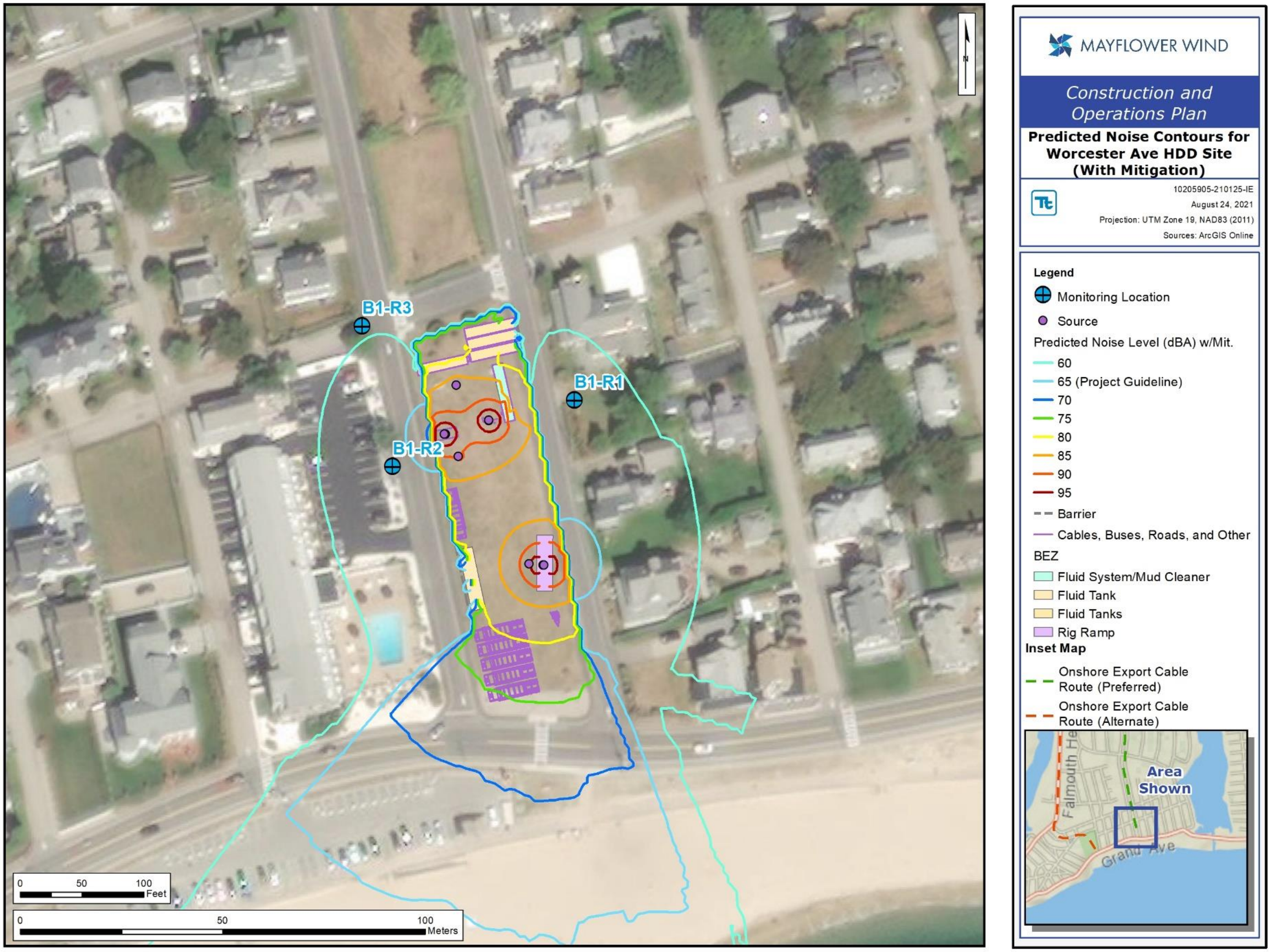


FIGURE 9-3. PREDICTED NOISE CONTOURS WITH NOISE BARRIERS FOR WORCESTER AVENUE HDD SITE WITH MITIGATION MEASURES

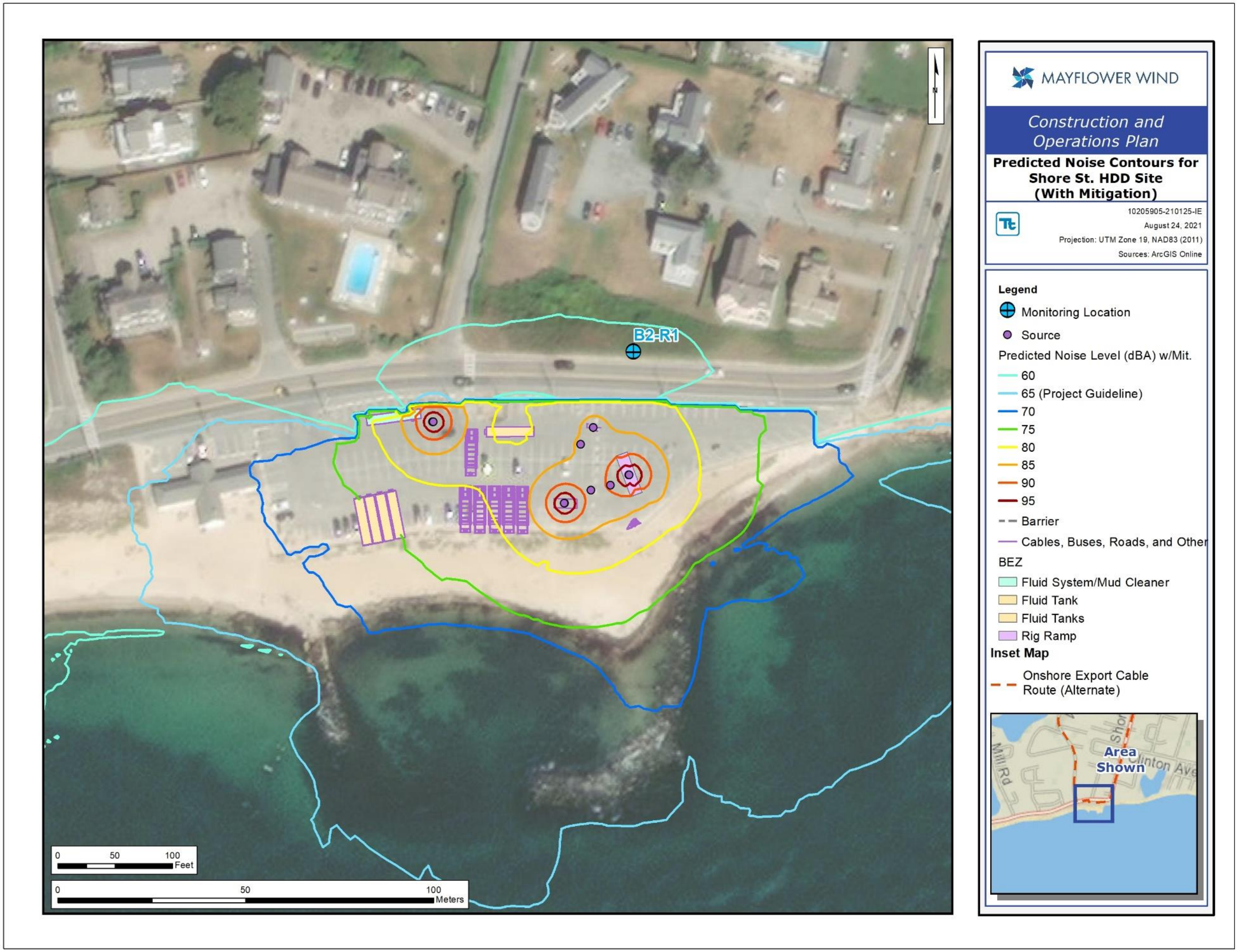


FIGURE 9-4. PREDICTED NOISE CONTOURS WITH NOISE BARRIERS FOR SHORE STREET HDD SITE WITH MITIGATION MEASURES

Additionally, receptors are located adjacent to the ten proposed landfall HDD locations under consideration (Worcester Avenue, Shore Street, and Central Park in Falmouth, Massachusetts; Boyds Lane entry, Mount Hope Bridge exit, utility corridor exit, Roger Williams University parking lot exit, and Northeast exit on Aquidneck Island in Portsmouth, Rhode Island; and the Brayton Point Eastern and Western landfall sites in Somerset, Massachusetts), the two onshore substation locations under consideration (Lawrence Lynch and Cape Cod Aggregates) and the converter station at Brayton Point. Noise-related impacts for the Falmouth onshore Project components have been quantified in Appendix U1, In-Air Acoustic Assessment Report, using noise modeling for two of the three Falmouth HDD locations (Worcester Avenue and Shore Street) and both of the onshore substation locations.

Since the WTGs and OSPs are planned to be more than 20 mi (32 km) from any onshore noise-sensitive locations, it is assumed that noise generated by any of these sources will attenuate significantly and therefore not cause impacts to nearby noise sensitive receptors.

At this time, Appendix U1, In-Air Acoustic Assessment Report, addresses the in-air acoustics relating to the Falmouth onshore Project components. Once an in-air acoustic assessment for the Brayton Point onshore Project components is completed, Appendix U1, In-Air Acoustic Assessment Report will be updated.

9.1.3.2 In-Air Acoustics Regulations

There are no federal noise regulations applicable to the in-air acoustic aspect of the proposed Project. In terms of local regulations, the Towns of Falmouth and Somerset, Massachusetts, and the Town of Portsmouth, Rhode Island, each have a noise ordinance but none of the regulations in these ordinances apply to the proposed Project. Regulations for proposed Project operations are imposed at the state level and applicable to onshore substation or converter station operational noise.

9.1.3.2.1 Massachusetts Department of Environmental Protection

The MassDEP administers its noise regulation, 310 CMR 7.10, through a Noise Pollution Policy, Division of Air Quality Control Policy 90-001. MassDEP regulates any source of "sound of sufficient intensity and/or duration as to cause a condition of air pollution." The MassDEP Noise Policy is typically used as a basis for review by the Energy Facilities Siting Board and may be used in other state or regional reviews. The MassDEP noise policy states the following:

A source of sound will be considered to be violating the MassDEP's noise regulation if the source:

- Increases the broadband sound level by more than 10 dBA above ambient, or
- Produces a "pure tone" condition—when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 dB or more.

These conditions are for both the property line and the closest inhabited residence to the sound source, with the ambient being defined as the lowest hourly L_{90} (in dBA) measured during the period of source operation. The limits described above are not applicable to construction and have been used to assess substation operational noise only.

To establish the existing ambient sound levels in areas adjacent to the potential onshore substation locations in Falmouth, Massachusetts, noise measurements were conducted in each area for a duration of 48 hours. Two locations at both of the potential onshore substation sites were selected to represent the adjacent residential properties. The minimum hourly L_{90} was selected as the baseline metric for each site, which conservatively represents ambient sound levels in the area without the proposed Project operating. The baseline sound levels measured at each location in Falmouth, Massachusetts and the corresponding MassDEP noise limits are shown in **Table 9-2**. Sound levels of the converter station will be evaluated during the Brayton Point onshore Project component acoustic assessment.

TABLE 9-2. MINIMUM HOURLY L_{90} NOISE MONITORING RESULTS

Onshore Substation Site	Receptor	Measured Sound Pressure Level (Minimum Hourly L_{90} dBA)	MassDEP Noise Limit (dBA)
Lawrence Lynch	LLG-LT1	39	49
	LLG-LT2	45	55
Cape Cod Aggregates	CCA-LT1	40	50
	CCA-LT2	35	45

9.1.3.2.2 Construction Noise Project Guidelines

In terms of construction noise, there are no relevant local regulatory limits for the proposed Project. Therefore, a generally accepted guideline limit of 65 dBA L_{eq} (Cowan, 1994) for daytime noise exposures at residential buildings was used as the applicable limit for these activities. For comparison, the Federal Transit Administration noise assessment guidelines recommend a daytime L_{eq} limit of 80 dBA and a nighttime L_{eq} limit of 70 dBA for construction noise at residential properties to avoid adverse community reactions. A Project guideline of 65 dBA L_{eq} was therefore used as a conservative value to assess noise from onshore HDD activities associated with offshore export cable installation at landfall.

9.1.4 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3.3, Project Components and Project Stages, is considered for the analysis of potential effects. IPFs are shown in **Table 9-3** which result from specific changes to the acoustic environment.

The potential noise impacts associated with onshore construction activities will be further evaluated after a detailed construction plan has been developed.

TABLE 9-3. IPFS AND POTENTIAL EFFECTS TO IN-AIR NOISE FROM THE PROPOSED PROJECT

IPF	Potential Effect	Period of Potential Effect		
	Project Component	Project Phase		
	Onshore Project Areas	Construction	O&M	Decomm.
Activities that Introduce Sound into the Environment: In-Air Noise	HDD activities; Presence of onshore substation and converter station	X	X	X

9.1.4.1 Onshore Substation and Converter Station

The proposed Project's operation of the onshore substation and converter station will affect the acoustic environment, but with proper mitigation measures detailed in **Table 9-8**, will comply with the proposed Project's guidelines. At this time, noise sources have been modeled for the proposed Falmouth onshore substations, and noise sources for the converter station will be provided when available.

9.1.4.1.1 Operation and Maintenance

Operation of the onshore substation was evaluated at both of the locations under consideration in the Falmouth Onshore Project Area: Lawrence Lynch and Cape Cod Aggregates. Noise sources used in the noise modeling are shown in **Table 9-4**. Operation of the converter station will be evaluated during the Brayton Point onshore Project component acoustic assessment and results will be provided in Appendix U1, In-Air Acoustic Assessment Report.

TABLE 9-4. NOISE SOURCES FOR ONSHORE SUBSTATION OPERATION

Source	Quantity in Layout	Relative Height	Sound Power, LwA (dBA)
Harmonic Filter Capacitor	4	16 ft (4.8 m)	79
Harmonic Filter Reactor	4	12 ft (3.7 m)	85
90 MVAR Reactor	3	8 ft (2.4 m)	95
200 MVAR Reactor	1	8 ft (2.4 m)	95
236 MVAR Reactor	3	8 ft (2.4 m)	95
430 MVA Autotransformer	3	11 ft (3.4 m)	95
150 MVA STATCOM Phase Reactor	18	12 ft (3.7 m)	85
STATCOM Heat Exchanger Cooling Fan	3	6 ft (1.8 m)	97
STATCOM Building	3	25 ft (7.6 km)	N/A
Control House Building	1	15 ft (4.6 km)	N/A

A summary of the modeled sound pressure level results at each receptor for each site is shown in **Table 9-5**. No "pure tones" as defined by the MassDEP Noise Policy are expected due to operation of the proposed Project. It is anticipated that mitigation may be required at both sites in order to meet the MassDEP limit of 10 dBA above the measured minimum background sound levels at the closest noise-sensitive locations. Mitigation details are provided in Section 9.1.5, Mitigation Measures, for both sites.

TABLE 9-5. ONSHORE SUBSTATION OPERATION NOISE MODELING RESULTS WITHOUT MITIGATION MEASURES

Onshore Substation Site	Receptor	Modeled Sound Pressure Level (Leq dBA)	MassDEP Noise Limit (dBA)
Lawrence Lynch	LLG-LT1	50	49
	LLG-LT2	48	55
Cape Cod Aggregates	CCA-LT1	45	50
	CCA-LT2	**51**	45

*Note: Exceedances are shown in **bold***

9.1.4.2 HDD Activities

The landfall HDD equipment will affect the acoustic environment temporarily during the construction phase of the proposed Project, but with proper mitigation measures detailed in Section 9.1.5, Mitigation Measures, will comply with the proposed Project's guideline of 65 dBA. There are no noise impacts expected from the export cables during the operation phase. If repair of the export cables is required, some noise may be generated, but will only be present for a short duration.

At this time, HDD activities associated with two landfall locations for the Falmouth export cable route have been modeled and studied. A quantitative evaluation has been done for the Worcester Avenue and Shore Street locations. The Central Park landfall location is located approximately 800 ft (244 m) to the west of the Worcester Avenue landfall location. HDD activities associated with the Brayton Point export cable corridor will be evaluated during the Brayton Point onshore Project component acoustic assessment and results will be provided in Appendix U1, In-Air Acoustic Assessment Report.

9.1.4.2.1 Construction

HDD equipment is planned to be used for construction activities related to offshore export cable installation at landfall. Noise emitted from HDD equipment was evaluated at two landfall locations under consideration: Worcester Avenue and Shore Street, in Falmouth, Massachusetts. The noise sources used in the analysis were provided by equipment manufacturers and are shown in **Table 9-6**.

TABLE 9-6. NOISE SOURCES FOR HDD ACTIVITIES

Source	Quantity in Layout	Relative Height (ft)	Sound Power, LwA (dBA)
Drilling Rig (2 Engines) Mechanical	1	6	113
Drilling Rig (2 Engines) Exhaust	1	12	135
Mud Cleaner Generator Mechanical	1	6	113
Mud Cleaner Generator Exhaust	1	12	135
Mud Pump Mechanical	1	6	113
Mud Pump Exhaust	1	9	135
Light Plant	1	6	93
Crane	1	8	95
Silenced Drilling Rig (2 Engines) Exhaust	1	15	105
Silenced Mud Cleaner Generator Exhaust	1	15	105
Silenced Mud Pump Exhaust	1	15	105

A summary of the modeled sound pressure level results at each receptor are shown in **Table 9-7**. Mitigation is required for the assessed HDD locations to meet the proposed Project's guideline of 65 dBA. Mitigation details are provided in Section 9.1.5 for the Worcester Avenue and Shore Street landfall HDD locations.

For HDD trajectories in Falmouth see Appendix P1. Note that HDD trajectory details will be refined (and may change slightly within the PDE) as the Project progresses.

TABLE 9-7. HDD NOISE MODELING RESULTS WITHOUT MITIGATION MEASURES

Landfall Location	Receptor	Modeled Sound Pressure Level (Leq dBA)	Project Guideline (dBA)
Worcester Avenue	B1-R1	99	65
	B1-R2	**104**	65
	B1-R3	**97**	65
Shore Street	B2-R1	**101**	65

Note: Exceedances are shown in ***bold***

9.1.5 Mitigation Measures

Mitigation measures were discussed and analyzed in Appendix U1, In-Air Acoustic Assessment Report to ensure that the proposed Project complies with the MassDEP noise limits for onshore substation operation and Project construction noise guidelines for HDD activities in Falmouth, Massachusetts. Mitigation measures in the form of noise barriers were evaluated for the Lawrence Lynch and Cape Cod Aggregates substation sites. For the Lawrence Lynch site, modeled mitigation measures included a 6 ft (1.8 m) tall barrier along the northwestern retaining wall. For the Cape Cod Aggregates onshore substation site, modeled mitigation measures included multiple 16 ft (4.9 m) tall and one 22 ft (6.7 m) tall close-on equipment barriers throughout the eastern portion. These mitigation measures will reduce sound levels enough to comply with the MassDEP 10 dBA above ambient limit at the closest residential property lines. For the landfall HDD sites in Falmouth, Massachusetts, modeled mitigation measures included a combination of 16 ft (4.9 m)-tall temporary construction noise barriers and equipment silencers for each location. In all cases, predicted levels are less than the 65 dBA guideline at the closest noise-sensitive properties.

The modeled sound pressure levels as a result of the mitigation measures at the alternate onshore substation site and the Falmouth landfall HDD sites are shown in **Table 9-8** and **Table 9-9**, respectively. Noise contour maps, including modeled mitigation measures for the alternate onshore substation site and the Falmouth landfall HDD sites, are shown in **Figure 9-1** to **Figure 9-4.** Mayflower Wind will employ avoidance, minimization, and mitigation measures to limit potential effects of airborne noise from the proposed Project.

TABLE 9-8. ONSHORE SUBSTATION OPERATION NOISE MODELING RESULTS WITH MITIGATION MEASURES

Site	Receptor	Modeled Sound Pressure Level (L_{eq} dBA) a/	MassDEP Noise Limit (dBA)
Lawrence Lynch	LLG-LT1	48	49
	LLG-LT2	48	55
Cape Cod Aggregates	CCA-LT1	46	50
	CCA-LT2	45	45

Note:
a/ It is assumed that mitigation includes the installation of the permanent barriers. Which are illustrated in the following figures.

TABLE 9-9. HDD NOISE MODELING RESULTS WITH MITIGATION MEASURES

Site	Receptor	Modeled Sound Pressure Level (L_{eq} dBA) a/	Project Guideline (dBA)
Worcester Avenue	B1-R1	61	65
	B1-R2	63	65
	B1-R3	59	65
Shore Street	B2-R1	61	65

Note:

a/ It is assumed that mitigation includes the installation of the temporary barriers. Silencers are assumed to be installed on construction equipment and are included in the model as mentioned in ***Table 9-6****.*

9.2 Underwater Acoustic Environment

The underwater acoustic environment refers to the ambient noise present at any given time under baseline conditions in the marine environment. JASCO Applied Sciences (JASCO) performed the underwater acoustic environment study for the proposed Project (Appendix U2, Underwater Acoustic Assessment). Major findings from the underwater acoustic environment effect modeling completed by JASCO are summarized in this section.

The primary sound source affecting the underwater acoustic environment associated with the proposed Project is the impact (impulsive) pile driving expected to occur during construction. Secondary sound sources expected to occur over the lifecycle of the Project include potential vibratory and suction pile installation and activities associated with cable-laying and construction, O&M, and decommissioning vessels that may contribute non-impulsive sound (e.g., dredging, DP thrusters, vessel propulsion) to the environment.

Technical appendices related to underwater acoustic include:

- Appendix U2, Underwater Acoustic Assessment

9.2.1 Affected Environment

The Lease Area is located on the continental shelf characterized by predominantly sandy seabed sediments. Water depths in the Lease Area vary between 121.7 and 208.3 feet (37.1 and 63.5 m). The degree of temperature and salinity stratification in the water column plays an important role in the way sound propagates at different times of year. While short-term anomalies may occur, the water column is typically more stratified during the summer months, and more uniform during the winter months, as a result of seasonal variations in wind mixing and solar energy. The average summer sound speed profile for the area was chosen for the acoustic analysis because it is the most representative sound propagation environment for the proposed activities.

Project substructure designs under consideration include monopiles, piled jackets, suction-bucket jackets, and gravity-based structures. Installation of monopile and piled jacket substructures will require pile driving of the substructures into the seabed with impact hammers. More detailed information on substructure specifications and installation can be found in Section 3, Description of Proposed Activities. The noise from the installation of monopiles or piled jackets (as a result of impact hammers) will affect the acoustic environment within the vicinity of the Lease Area.

Presently, underwater noise in the vicinity of the Lease Area and offshore export cable corridors is predominantly generated from commercial and recreational vessel traffic. Current vessel traffic patterns in the vicinity of the proposed Offshore Project Area show higher volumes of vessel traffic near the southern portions of the offshore export cable corridors, and to the south of the Lease Area in a vessel traffic separation scheme (TSS). Further detail regarding vessel traffic patterns within and surrounding the proposed Offshore Project Area are discussed in Section 13, Navigation and Vessel Traffic, as well as in Appendix X, Navigation Safety Risk Assessment.

9.2.2 Secondary Sound Sources

There are several secondary sources of anthropogenic sound associated with the proposed Project during offshore construction, operation and maintenance, and decommissioning. However, these sound sources were not modeled, as the acoustic effects are expected to be much less than that of impact pile driving.

Sounds from vessels associated with the proposed Project are anticipated to be similar in frequency to existing levels of commercial traffic present in the region. Vessel sound would be associated with cable installation vessels and operations, piling installation vessels, and general transit to and from WTG or OSP locations during construction and O&M.

Other activities associated with the proposed Project that may introduce additional noise include using vibracores and drilling boreholes. Field studies conducted offshore New Jersey, Virginia, and Alaska indicate that the noise generated from utilizing vibracores and drilling boreholes diminishes below the NMFS behavioral response thresholds (120 dB for continuous sources) relatively quickly and is unlikely to cause harassment to marine mammals (NMFS, 2009; Reiser et al., 2010, 2011; Tetra Tech, 2014).

During construction, it is estimated that multiple vessels may operate concurrently at different locations throughout the Lease Area or offshore export cable corridor. Some of these vessels may maintain their position (using DP thrusters) during pile driving or other construction activities. The dominant underwater sound source on DP vessels arises from cavitation on the propeller blades of the thrusters (Leggat et al., 1981). The noise power from the propellers is proportional to the number of blades, propeller diameter, and propeller tip speed. Sound levels generated by vessels using DP are dependent on the operational state and weather conditions.

All vessels emit sound from propulsion systems while in transit. Non-Project vessel traffic in the vicinity of the proposed Project includes recreational vessels, fishing vessels, cargo vessels, tankers, passenger vessels, and others. As such, marine life in the general region is regularly subjected to vessel activity and would potentially be habituated to the associated underwater noise as a result of this exposure (BOEM, 2014b). Because noise from vessel traffic associated with construction activities is likely to be similar to background vessel traffic noise, the potential risk of impacts from vessel noise to marine life is expected to be low relative to the risk of impact from pile-driving sound.

9.2.3 Underwater Acoustic Modeling

Piles deform when driven with impulsive 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 receivers through the water, 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 type and energy of the hammer.

JASCO's physical model of pile vibration and near-field sound radiation (MacGillivray, 2014) was used in conjunction with the GRLWEAP 2010 wave equation model (GRLWEAP Pile Dynamics, 2010) to predict the source signature for the realistic and maximum diameter monopiles and piled jacket foundations. GRLWEAP 2010 (GRLWEAP Pile Dynamics, 2010) assumed direct contact between the representative hammers, helmets, and piles (i.e., no cushion material).

Decidecade spectral source levels for each pile type, hammer energy, and modeled location, using an average summer sound speed profile are provided in Section 9.2.4, Results. The sound radiating from each pile was then propagated through the environment by assuming a vertical array of discrete point sources. See Section 2 of Appendix U2, Underwater Acoustic Assessment, for further details on the underwater acoustic modeling methodology.

9.2.3.1 Assumptions

Location-specific acoustic propagation modeling was conducted for the installation of WTG and OSP substructures within the PDE. Both realistic and maximum scenarios were modeled, assuming WTGs and OSPs would be supported by either monopile or piled jacket foundations. The realistic and maximum substructure diameters were modeled at two representative locations in the Lease Area (L01 and L02; **Figure 9-5**). Location L01 was selected to represent a relatively deep-water scenario and location L02 was selected to represent a relatively shallow water scenario.

The realistic scenario monopile has a 36-foot (11 m) diameter and would be driven to a penetration depth of up to 115 feet (35 m) and the maximum scenario monopile has a 52.4-foot (16 m) diameter and is also assumed to be driven to a depth of up to 115 feet (35 m) in representatively very stiff soil. The maximum substructure penetration in the PDE of 164 feet (50 m) would only be encountered in the event of significantly weaker soil, which would be expected to require less energy to install than the stiff soil scenario. The lower drivability of stiff soil results in much lower penetration required. More penetration is only required in weak soil, which would not need such a large hammer or blow count.

The realistic jacket substructure is a three-legged WTG jacket substructure with 9.5-foot (2.9 m) diameter pin piles. The maximum jacket substructure is a four-legged WTG jacket substructure with 14.7-foot (4.5 m) diameter pin piles. The realistic and maximum jacket cases are modeled at a penetration depth of 167 feet (51 m) and 197 feet (60 m) respectively. The modeled jacket substructure configurations used for the OSPs are a four-legged, eight pile substructure (two piles per leg) and a six-legged, twelve pile substructure (two piles per leg). These OSP jacket substructures are modeled with 14.7-foot (4.5 m) diameter pin piles. The maximum number of piles modeled for one day of installation is four piles, thus regardless of OSP design, the modeled scenario of four piles per day will remain an appropriate metric for timing and acoustics for OSP installation. More information regarding substructures and their installation specifications can be found in Section 3.3.1, Substructures. Assumptions for monopile and piled jacket substructures and cases are listed in **Table 9-10**.

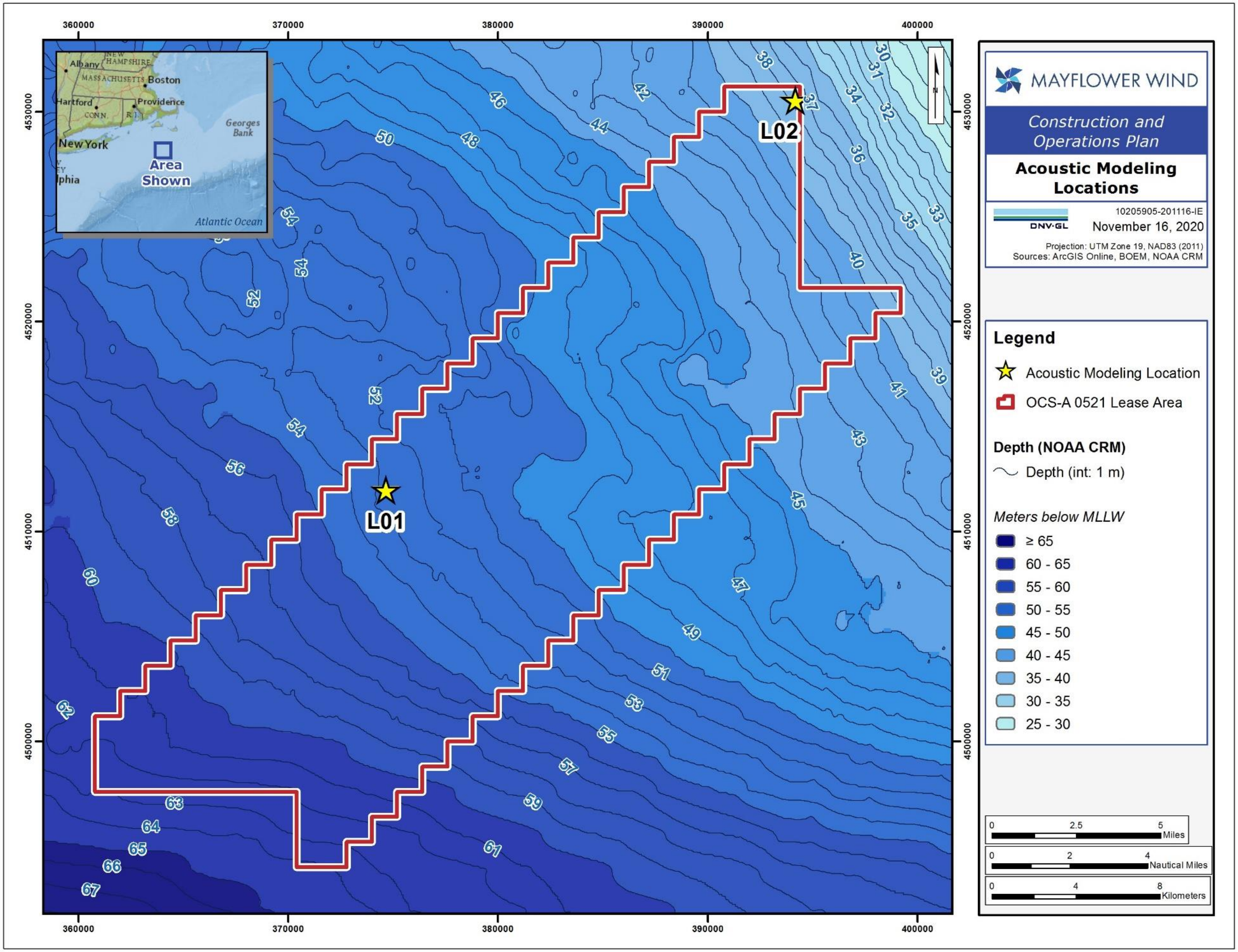


FIGURE 9-5. LEASE AREA WITH ACOUSTIC MODELING LOCATIONS L01 AND L02

TABLE 9-10. REALISTIC AND MAXIMUM CASE MODELED PARAMETERS AND ASSUMPTIONS FOR MONOPILE AND PILED JACKET SUBSTRUCTURES

Parameter	Monopile		Jacket			
	Realistic	Maximum	Realistic WTG	Maximum WTG	Realistic OSP	Maximum OSP
Pile Diameter	36 ft (11 m)	52.5 ft (16 m)	9.5 ft (2.9 m)	14.8 ft (4.5 m)	14.8 ft (4.5 m)	14.8 ft (4.5 m)
Penetration Depth	115 ft (35 m)	115 ft (35 m)	167 ft (51 m)	197 ft (60 m)	197 ft (60 m)	197 ft (60 m)
Number of Piles	1	1	3	4	12	8-12
Impact hammer energy	4,400 kilojoule (kJ)	6,600 kJ	1,900 kJ	3,500 kJ	2,000 kJ	3,500 kJ
Estimated number of strikes to drive pile	5,800	7,000	6,800	4,000	7,000	4,000

The amount of sound generated during pile installation varies with the energy required to drive the piles to the desired depth, which depends on the sediment resistance encountered. Sediment types with greater resistance require hammers that deliver higher energy strikes and/or an increased number of impact hammer strikes, relative to installations in softer sediment. Maximum sound levels from substructure installation usually occur during the last stage of pile driving (Betke, 2008).

9.2.4 Results

In order to represent different environmental conditions across the Offshore Project Area, acoustic fields were modeled at two locations within the Lease Area for monopile and piled jacket substructures. This analysis showed that the acoustic impacts arising from installation of the different foundation types depends on multiple factors, including the sound levels generated by a single strike, and the sound levels accumulated over all the strikes required to drive the pile. While there were slight differences in frequency content between the larger monopiles and the smaller pin piles, most of the sound energy for all modeled pile types was below 500 Hz. **Table 9-11** summarizes sound exposure levels (SEL) produced by both a single strike, and accumulated over all strikes, for each of the pile and hammer combinations considered in this study.

Table 9-11 shows that while the maximum sound produced for a single strike is generally higher for larger diameter piles and larger hammers, the cumulative sound energy generated to fully install a single pile is also strongly influenced by the number of strikes required to drive that pile. For example, the 4.5 m pile driven by a 3,500-kilojoule (kJ) hammer produces more sound energy for a single strike than the 2.9 m pile driven by a 1,900 kJ hammer. However, the total accumulated energy is similar between the two. The pile diameter and hammer energy are important factors in sound generation, but this table underscores the importance of the total number of strikes. The 2.9 m pile installed using a 1,900 kJ hammer requires almost twice as many strikes as the 4.5 m pile installed using a 3,500 kJ hammer.

TABLE 9-11. MAXIMUM MODELED SOUND LEVEL FOR EACH SUBSTRUCTURE SCENARIO

Pile type	Case	Diameter (ft [m])	Hammer energy (kJ)	Estimated number of strikes to drive the pile	Single-strike SEL (dB re $1 \mu Pa^2 m^2 s$) a/	Cumulative SEL (dB re $1 \mu Pa^2 m^2 s$) b/
WTG Piled Jacket	Realistic	9.5 (2.9)	1,900	6,800	220.34	253.62
	Maximum	14.8 (4.5)	3,500	4,000	221.76	253.00
OSP Piled Jacket	Realistic	14.8 (4.5)	2,000	7,000	225.45	259.13
	Maximum	14.8 (4.5)	3,500	4,000	223.76	255.00
Monopile	Realistic	36.1 (11)	4,400	5,800	226.10	262.71
	Maximum	52.5 (16)	6,600	7,000	229.14	263.91

Notes:
a/ The maximum broadband integrated sound energy at 1 meter from an equivalent hypothetical monopole source
b/ Single-strike SEL summed over all strikes required to install one pile

How marine life is exposed to these modeled sound sources is discussed in depth within Appendix U2, Underwater Acoustic Assessment by modeling sound exposure against simulated animal populations. Simulated animal populations were modeled at a higher density than observed real-world density. Exposure ranges, (ER95%), are the distances that account for 95 percent of the exposure around the source and were determined on a species-specific basis for marine mammals and sea turtles, to determine the maximum and realistic modeled animal scenarios. These exposure ranges to acoustic thresholds are the most biologically relevant for use in the establishment of exclusion and monitoring zones. The exposure ranges for the maximum scenario were larger than for the realistic scenario, and monopile substructures resulted in longer distances than the jacketed substructures in both the maximum and realistic scenarios The modeled results discussing the exposure range estimates and exposure estimates for marine mammals and sea turtles are discussed in Section 6.8, Marine Mammals, and Section 6.9, Sea Turtles, respectively.

9.2.5 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

The potential effects of the proposed Project on the existing underwater acoustic environment are summarized in **Table 9-12**.

TABLE 9-12. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON THE UNDERWATER ACOUSTIC ENVIRONMENT

IPF	Potential Effects		Period of Effect		
	Project Component		Project Phase		
	Lease Area	Export Cable Corridor	Construction	O&M	Decomm.
Introduced Sound into the Environment	Displacement; Harassment; Potential injury; Avoidance	Displacement; Harassment; Potential injury; Avoidance	X	-	X

9.2.5.1 Introduced Sound into the Environment

Introduced sound into the environment involves activities that change or increase the amount of sound present in an area as a direct result of activities performed during the construction, operations, and decommissioning of the proposed Project. More details regarding BOEM specifications and Project activities related to introduced sound can be found in Section 3.4, Summary of Impact-Producing Factors.

9.2.5.1.1 Construction

During construction of the proposed Project, introduced sound (predominantly from substructure installation and to a lesser extent vessel operation and equipment operation) will affect the underwater acoustic environment within the Lease Area and the offshore export cable corridor. The main introduced sound from substructure installation involves pile driving either monopile or piled jacket substructures into the subsurface via impact hammers. Mayflower Wind will employ soft-start measures allowing for a gradual increase in sound levels before the full pile driving hammer energy is reached. Modeled results indicate noise ranges from <100 to 200 Hz are anticipated for substructure installation. Monopile substructures resulted in longer sound propagation distances than jacket substructures in the realistic and maximum case models. The amount of sound propagation and range of effect for pile driving depends on pile dimensions, subsurface conditions, hammer type, penetration depth, and number of strikes required. The exposure ranges for the maximum scenario were larger than for the realistic scenario.

An increase in vessels during construction will introduce sound while the vessels are transiting and performing construction activities. These activities include seabed preparation, substructure installation, WTG and OSP installation, cable laying, and placement of scour protection. Vessels utilized for construction activities are listed in Section 3.3.14, Vessels, Vehicles, and Aircrafts. Introduced sound as a result of vessel traffic is anticipated to be comparable to existing sound from commercial and recreational vessels transiting within the vicinity of the Lease Area and offshore export cable corridor. Mayflower Wind will utilize noise abatement systems (NAS) to decrease the sound levels produced by Project activities in the water. Additional information regarding changes to vessel traffic and navigation patterns is listed in Section 13, Navigation and Vessel Traffic, and in Appendix X, Navigation Safety Risk Assessment. These sources of introduced sound are expected to stop once the proposed Project is operational.

9.2.5.1.2 Decommissioning

While pile driving is not required for decommissioning, the use of vessels and equipment to decommission the WTGs, OSPs, inter-array cables, and offshore export cables will introduce sound into the underwater acoustic environment. Sound-producing activities during decommissioning involve cutting substructures for removal, removing scour protection, disassembling the WTGs, removing the OSPs topside, vessel activity, and the potential de-burial of inter-array cables and offshore export cables. These sources of introduced sound are anticipated to stop once the Project has been fully decommissioned.

10 Socioeconomic Resources

10.1 Demographics, Employment, and Economics

This section describes the demographic, employment, and economic baseline characteristics of the jurisdictions affected by the proposed Project and includes an evaluation of potential Project-related effects, as well as proposed avoidance, minimization, and mitigation measures.

10.1.1 Affected Environment

The proposed Project has the potential to affect demographics, employment, and economics directly and indirectly at the local and regional levels. Offshore construction and installation activities will occur in the Lease Area approximately 26 nm (48 km) south of Martha's Vineyard and 20 nm (37 km) south of Nantucket, Massachusetts and along the offshore export cable corridors extending from the Lease Area to the landfall locations in Barnstable County (Town of Falmouth), Massachusetts and Bristol County (Town of Somerset), Massachusetts. From the landfall location in Falmouth, onshore export cables will connect to a new onshore substation in Falmouth. From the landfall location in Somerset at Brayton Point, onshore export cables will connect to the converter station. The Brayton Point Onshore Project Area also includes Portsmouth, Rhode Island, where the export cables will make intermediate landfall and traverse across Aquidneck Island for up to 3 miles (4.8 km). The New Bedford Marine Commerce Terminal (MCT) located in Bristol County, Massachusetts will serve as a staging area for Project components. Mayflower Wind will likely use more than one port for the proposed Project. Ports under consideration are discussed in Section 3.3.13, Port Facilities. O&M activities are expected to be concentrated in the Lease Area and at the onshore substation/converter station in Falmouth and Somerset.

The area of interest for this section includes the Commonwealth of Massachusetts and the State of Rhode Island, specifically Barnstable, Dukes, Nantucket, Plymouth and Bristol Counties in Massachusetts and Newport and Bristol Counties in Rhode Island. **Figure 10-1** illustrates the areas of interest.

10.1.1.1 Demographics

Information on populations was obtained from publicly available U.S. Census Bureau (USCB) data (USCB, 2019a, 2019b). Population numbers were available for 2019, education rates and housing statistics were available for 2018, and population densities were available for 2010. The most recent data for each parameter is summarized in **Table 10-1.**

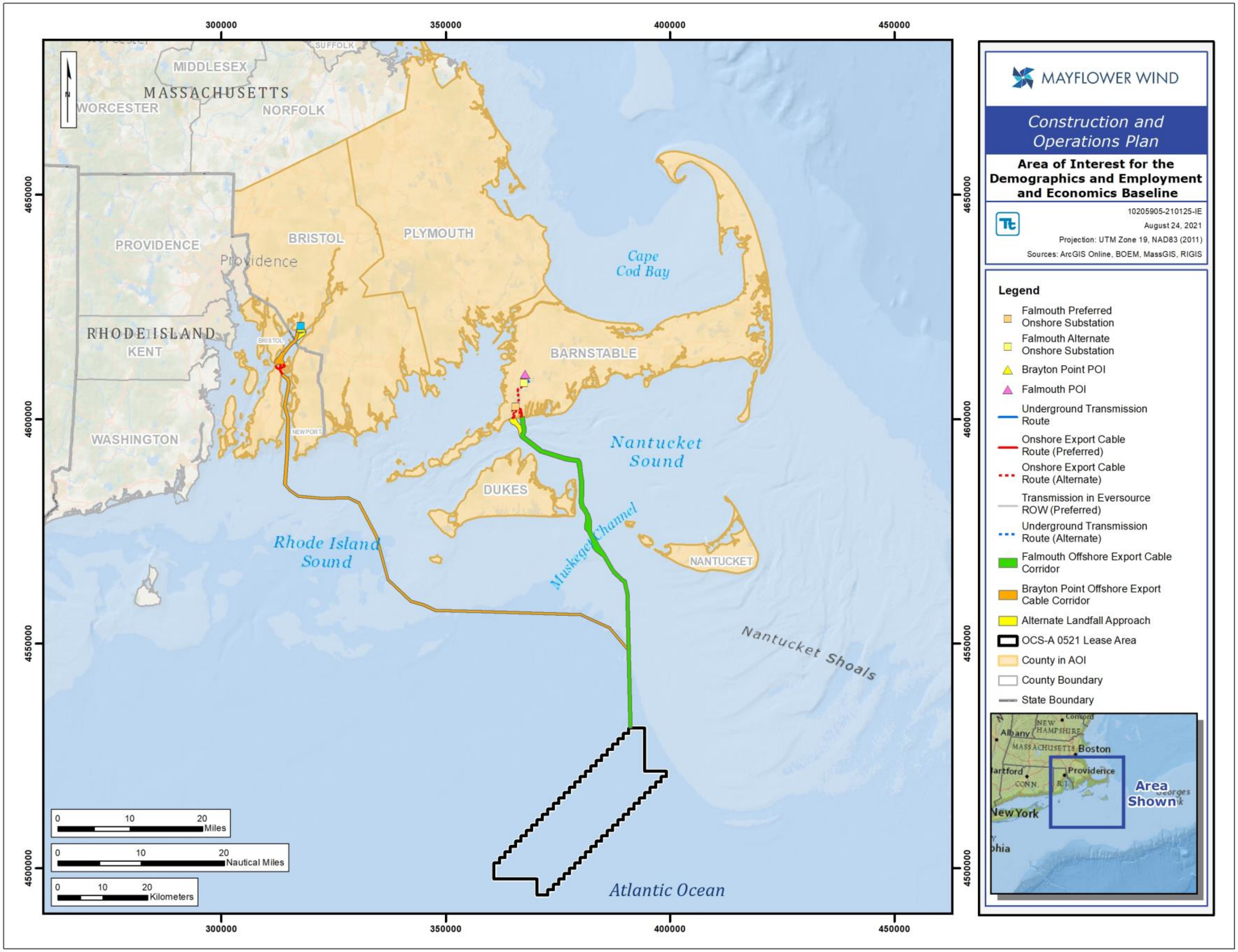


FIGURE 10-1. AREA OF INTEREST FOR THE DEMOGRAPHICS AND EMPLOYMENT, AND ECONOMICS BASELINE

TABLE 10-1. DEMOGRAPHICS OF THE POTENTIALLY AFFECTED ENVIRONMENT

Jurisdiction	Land area (mi^2)	Population (2019)	Population density (persons/mi^2) (2010)	Education (25 years+) (2018)	
				High School +	Bachelor's Degree +
Massachusetts	7,800.06	6,892,503	839.4	90.4%	42.9%
Rhode Island	1,033.81	1,059,361	1,018.1	88.8%	34.2%
Barnstable County, MA	393.72	212,990	548.3	95.5%	42.8%
Bristol County, MA	553	565,217	991.3	84.9%	28.0%
Bristol County, RI	24.16	48,479	2,064	90.9%	49.0%
Dukes County, MA	103	17,332	160.2	95.5%	44.2%
Nantucket County, MA	45	11,399	226.2	95.3%	51.7%
Newport County, RI	103.39	82,082	809.6	94.0%	48.1%
Plymouth County, MA	659.08	521,202	750.9	92.9%	36.7%

Sources: USCB, 2019a, 2019b. Population Estimates Program, 2015-2019 data.

10.1.1.1.1 Commonwealth of Massachusetts

The Commonwealth of Massachusetts covers an area of 7,800 square miles (mi^2) (20,202 square kilometers [km^2]) (USCB, 2019a) and includes 14 counties. The estimated population in 2019 was 6,892,503. The population of Massachusetts is expected to grow by 11.8 percent by 2035, with most of the growth occurring in the greater Boston area, while the population of the Cape Cod peninsula is expected to decrease (Strate, 2015). The population density of Massachusetts was approximately 839 people per mi^2 in 2010. Education levels in the Commonwealth of Massachusetts were high, with 90.4 percent of the 25 years and over population having at least a high school diploma and 42.9 percent having a bachelor's degree or higher in 2018.

10.1.1.1.2 Rhode Island

The State of Rhode Island covers an area of 1,033.81 mi^2 (8,756.75 km^2) (USCB, 2019a) and includes five counties. The estimated population in 2019 was 1,059,361. The population of Rhode Island is expected to grow by approximately 2.3 percent by 2035 (Rhode Island Statewide Planning Program, 2013). The population density was approximately 1,018 individuals per square mile in 2010 (USCB, 2019a). Education levels in Rhode Island were high, with 88.8 percent of persons aged 25 and older graduating from high school and 34.2 percent with a bachelor's degree.

10.1.1.1.3 Barnstable County

Barnstable County is made up of 15 municipalities which form the Cape Cod peninsula. Its estimated population in 2019 represented 3.1 percent of the Commonwealth's population and is expected to decrease by 10 percent by 2035 (Strate, 2015). The County's 2010 year-round population density was noticeably lower than that of the Commonwealth. However, when seasonal residents are considered, the population density of Barnstable County rises by 30 percent to 719 people per mi^2 (Epsilon Associates, Inc., 2020). The 2018 rate of high school graduates was slightly higher than at the Commonwealth level, but higher education rates were similar.

10.1.1.1.4 Bristol County, Massachusetts

Bristol County (Massachusetts) is made up of 20 municipalities across the southeast portion of Massachusetts. Its estimated population in 2019 was 565,217 (USCB, 2019a), roughly 8.2 percent of the Commonwealth's population. The region of Bristol County (inclusive of Plymouth County) is expected to increase by almost 7 percent by 2035 (Strate, 2015). The County's population density was higher than the Commonwealth's as a whole, and the high school and bachelor's degree education levels are less than that of the Commonwealth's as well.

10.1.1.1.5 Newport County

Newport County is made up of 9 municipalities across Aquidneck Island, in the southeastern region of Rhode Island, and various islands within Narragansett Bay. Newport County has a relatively small land area with a comparable size to Bristol County (Massachusetts). Newport County had the second highest population density in 2010 and a relatively high education rate (94 percent of the population 25 years and older graduated high school and 48.1 percent with a higher education degree).

10.1.1.1.6 Adjacent Counties

Plymouth County is significantly larger than Barnstable County in the area of interest in terms of area and has a higher population and population density. The Counties of Dukes and Nantucket have smaller areas, smaller populations and smaller population densities. This is due to the relative remoteness of these islands.

Both Dukes and Nantucket have education rates on par with Barnstable County and slightly higher than the Commonwealth as a whole. Conversely, the high school and higher education levels in Bristol County (Massachusetts) are noticeably lower than the Commonwealth rates. In Plymouth County, the high school education rate is slightly lower than in other Massachusetts Counties and slightly higher than the Commonwealth rate. However, higher education rates are relatively low. Bristol County (Rhode Island) has higher education rates for both high school and higher education compared to the State of Rhode Island averages, but lower than several of the other counties within the affected environment of the Project.

10.1.1.2 Housing

Housing data from the potentially affected environment is summarized in **Table 10-2**. In 2019, 62.4 percent of housing units in Massachusetts were occupied by the owner, and 60.8 percent of housing units in Rhode Island were occupied by the owner. The numbers of housing units in Barnstable, Bristol, and Plymouth Counties in Massachusetts and Newport County in Rhode Island were relatively high compared with Bristol (Rhode Island), Dukes, and Nantucket Counties (Massachusetts). The rates of units occupied by the owners in the counties in the Affected Environment ranged from 60.8 percent to 79.8 percent.

TABLE 10-2. HOUSING IN THE POTENTIALLY AFFECTED ENVIRONMENT

Housing	Massachusetts	Rhode Island	Barnstable County	Bristol County (MA)	Bristol County (RI)	Dukes County	Nantucket County	Newport County	Plymouth County
Total units	2,928,732	470,168	164,674	236,915	21,228	18,146	12,875	42,779	209,542
Owner-occupied occupation rate	62.4%	60.8%	79.8%	62.6%	70.7%	72.3%	60.8%	63.2%	76.5%
Median value of owner-occupied housing units	$381,600	$261,900	$393,500	$299,800	$358,100	$699,500	$1,084,700	$387,900	$370,300
Median gross rent	$1,282	$1,004	$1,311	$901	$1,037	$1,459	$1,765	$1,285	$1,279

Sources: USCB, 2019a, 2019b. Population Estimates Program, 2015-2019 data.

The median home values in Barnstable, Bristol (Massachusetts), and Plymouth Counties were similar to the Commonwealth median house value. However, median home values in Dukes and especially Nantucket Counties were noticeably higher. The median rent in all Counties was similar to the Commonwealth's median rent, except for Bristol County (Massachusetts), where the median rent is noticeably lower. Median home values and median rents were highest in Dukes and Nantucket Counties, where the number of housing units is low. The median house values in Bristol (Rhode Island) and Newport Counties were higher than the State of Rhode Island median home value. The Newport County median rents were higher than the State of Rhode Island's median rent, and the median rents in Bristol County (Rhode Island) were slightly higher than the median rents for the State of Rhode Island.

10.1.1.3 Employment

Publicly available USCB data from 2018 provided employment and labor force and per capita income numbers respectively. The most recent data for each parameter is summarized in **Table 10-3.**

TABLE 10-3. EMPLOYMENT INFORMATION OF THE POTENTIALLY AFFECTED ENVIRONMENT

Jurisdiction	Population aged 16 years+	Employed population (16 years+)	Employment Rate (%)	Unemployment Rate (%)	Per Capita Income
Massachusetts	5,619,991	3,570,257	63.5%	3.6%	$41,794
Rhode Island	873,369	527,972	60.5%	3.9%	$36,079
Barnstable County, MA	185,069	105,075	56.8%	2.8%	$42,578
Bristol County, MA	456,450	283,422	62.1%	3.8%	$34,226
Bristol County, RI	40,792	26,160	64.1%	2.2%	$43,617
Dukes County, MA	14,441	8,684	60.1%	2.0%	$43,822
Nantucket County, MA	9,028	6,471	71.7%	2.0%	$51,270
Newport County, RI	70,272	41,378	58.9%	2.8%	$45,442
Plymouth County, MA	414,111	264,483	63.9%	3.7%	$41,343

Source: USCB, 2018. DP03: Selected Economic Characteristics, 2018: ACS 5-Year Estimates Data Profiles.

10.1.1.3.1 Massachusetts

In 2018, 3,570,257 people were employed, accounting for approximately 64 percent of the total population, while the unemployment rate was 3.6 percent. Approximately 67 percent of the population was of working age (16 years+) and the Commonwealth-wide per capita income in 2018 was $41,794.

10.1.1.3.2 Rhode Island

In 2018, 873,369 people were employed, accounting for approximately 61 percent of the total population, while the unemployment rate was 3.9 percent. Approximately 70 percent of the population was of working age (16 years+) and the state-wide per capita income in 2018 was $36,079.

10.1.1.3.3 Barnstable County

In 2018, both the employment and unemployment rates in Barnstable County were lower than the Commonwealth rates. The per capita income was similar to the Commonwealth per capita income.

10.1.1.3.4 Bristol County, Massachusetts

In 2018, the employment rate was slightly lower than the Commonwealth rates and the unemployment rate was slightly higher than the Commonwealth rate. The per capita income was roughly $5,000 lower than the average per capita income of the Commonwealth.

10.1.1.3.5 Newport County

In 2018, the employment rate and unemployment rate in Newport County was slightly lower than the State of Rhode Island's rates. The per capita income was roughly $9,300 higher in the County than in the average per capita income of the State of Rhode Island.

10.1.1.3.6 Adjacent Counties

In 2018, Dukes and Nantucket Counties had lower unemployment rates than Barnstable County, and significantly lower than the Commonwealth rate, while the rates for Plymouth were similar to the Commonwealth rate. The proportion of employed people in Dukes and Plymouth Counties were higher than Barnstable County and closer to the Commonwealth level. The employment rate in Nantucket County was noticeably higher than the other counties and the Commonwealth.

The per capita income in Nantucket County had the highest per capita income of all the surrounding counties to the Project. The per capita income for Dukes County and Plymouth County were similar to Barnstable County and the Commonwealth per capita incomes. Bristol County (Rhode Island) had a higher median income than the State of Rhode Island as a whole, with a lower unemployment rate.

10.1.1.4 Economy

Information on gross domestic product (GDP) was obtained from the Bureau of Economic Analysis (USBEA, 2018) and information on the main economic sectors was gathered from the USCB (2018). Both were available for 2018. **Table 10-4** presents the GDP of each jurisdiction in the area of interest, while **Table 10-5** provides the importance of the different economic sectors for each County in the affected areas of interest in Massachusetts and Rhode Island.

TABLE 10-4. GDP OF EACH JURISDICTION IN THE AREA OF INTEREST

Jurisdiction	GDP ($ Thousands)
Massachusetts	507,124,536
Rhode Island	53,135,500
Barnstable County, MA	12,591,850
Bristol County, MA	24,895,260
Bristol County, RI	1,584,600
Dukes County, MA	1,786,373
Nantucket County, MA	1,829,071
Newport County, RI	5,215,933
Plymouth County, MA	24,359,846

Source: USBEA, 2018. Regional Data.

TABLE 10-5. MAIN EMPLOYMENT SECTORS IN THE POTENTIALLY AFFECTED ENVIRONMENT

Economic Sector	Massachusetts	Rhode Island	Barnstable County, MA	Bristol County, MA	Bristol County, RI	Dukes County, MA	Nantucket County, MA	Newport County, RI	Plymouth County, MA
Agriculture, forestry, fishing and hunting, and mining	0.4%	0.5%	1.0%	0.7%	0.3%	2.7%	1.9%	1.1%	0.5%
Construction	5.6%	5.5%	9.7%	7.2%	4.3%	16.1%	13.0%	6.7%	7.8%
Manufacturing	8.9%	10.8%	3.9%	11.1%	8.4%	3.8%	1.9%	6.9%	6.7%
Wholesale trade	2.2%	2.4%	1.9%	3.4%	2.2%	1.1%	1.7%	2.4%	2.7%
Retail trade	10.3%	12.1%	13.4%	12.8%	9.8%	9.6%	12.1%	9.4%	11.7%
Transportation and warehousing, and utilities	3.8%	3.8%	3.6%	4.3%	3.0%	3.7%	3.8%	2.8%	4.6%
Information	2.3%	1.7%	1.7%	1.6%	2.5%	1.2%	1.4%	1.5%	2.0%
Finance and insurance, and real estate and rental and leasing	7.4%	6.8%	5.9%	5.7%	7.7%	6.6%	8.2%	6.8%	8.6%
Professional, scientific, management, and administrative and waste management services	13.8%	10.1%	12.3%	9.2%	10.7%	12.9%	16.7%	11.9%	11.2%
Educational services, and health care and social assistance	28.2%	27.3%	24.9%	26.7%	32.8%	24.1%	18.5%	26.6%	25.7%
Arts, entertainment, and recreation, and accommodation and food services	8.7%	10.5%	11.8%	8.9%	10.2%	7.3%	11.7%	12.9%	9.6%
Other services, except public administration	4.5%	4.5%	5.1%	4.3%	4.0%	6.3%	5.1%	5.6%	4.6%
Public administration	3.9%	4.0%	4.8%	4.2%	3.9%	4.7%	4.1%	5.3%	4.3%

Source: USCB, 2018. Selected Economic Characteristics, 2018: ACS 5-Year Estimates Data Profiles.

10.1.1.4.1 Massachusetts

The GDP of the Commonwealth of Massachusetts was $507.1 billion in 2018. According to USCB, the main sectors of employment in Massachusetts were education, health care and social assistance, followed by professional, scientific, management, administrative, waste management services, and retail sales.

10.1.1.4.2 Rhode Island

The GDP of the State of Rhode Island was $53 billion in 2018. According to USCB, the main sectors of employment in Rhode Island were education, health care, social assistance, retail trade and manufacturing, followed by arts and professional services.

10.1.1.4.3 Barnstable County

The GDP of Barnstable County accounted for approximately 2.5 percent of the Commonwealth's total. The main sectors of employment in Barnstable County are the same as for the Commonwealth, i.e., education, healthcare and social assistance, followed by retail sales. Professional, scientific, management, administrative and waste management services were a close third.

10.1.1.4.4 Bristol County, Massachusetts

The GDP of Bristol County (Massachusetts) accounted for approximately 4.9 percent of the Commonwealth's total. The main sectors of employment in Bristol County (Massachusetts) are educational services, health care and social assistance, retail trade, and manufacturing.

10.1.1.4.5 Newport County

The GDP of Newport County accounted for approximately 9.8 percent of the State of Rhode Island's total. The main sectors of employment in Newport County are education, health care and social assistance, arts, and professional services. These sectors are consistent with those of the State of Rhode Island as a whole.

10.1.1.4.6 Adjacent Counties

In 2018, the GDP of both Dukes and Nantucket accounted for less than 0.4 percent of the Commonwealth's GDP (USBEA, 2018). The main sectors of employment in Dukes, Nantucket, and Plymouth Counties follow a pattern that is similar to the Commonwealth's, with some county-specific exceptions. For example, the construction sector was of more importance in Dukes and Nantucket Counties. Bristol County (Rhode Island) accounted for 3.0 percent of the State of Rhode Island's GDP and follows a similar pattern of main employment sectors.

10.1.2 Potential Effects

Impact-Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020a). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

Project effects on the demographics, employment, and the economy may occur in proximity to Project activities as well as within the general region as the proposed Project may affect multiple sectors of the supply chain. The majority of IPFs will occur in the local communities, specifically in Falmouth in Barnstable County, Somerset in Bristol County (Massachusetts), and Portsmouth in Newport County in Rhode Island. The effects will largely be associated with the installation and construction of the onshore and offshore components, as described in Section 3, Description of Proposed Activities.

Similarly, the periodic maintenance and repairs of onshore and offshore components, as well as the presence of the offshore components, could affect communities and the economy. Project WTGs in the Lease Area could be visible from the elevated areas on Martha's Vineyard and Nantucket and their respective coastlines, depending on vegetation, topography, and atmospheric conditions. Disturbance of the seascape could theoretically affect shore-side property values and the area's tourism-based economy. However, the closest Project WTGs would be approximately 20 nm (37 km) from the coast, and would not dominate the view even in the best atmospheric conditions. Visual effects are discussed in Section 8, Visual Resources, and Appendix T, Visual Impact Assessment.

Mayflower Wind will disconnect, dismantle, and remove the WTGs and OSPs at the end of their operational life. The inter-array cables and offshore export cables may be retired in place or removed. Generally, decommissioning activities of offshore components will have similar environmental effects as construction and installation activities. Subject to future discussions, it is envisioned that the onshore components will be left in place for possible future reuse. If necessary, decommissioning of the onshore components would be coordinated closely with the host town and aim to have the fewest environmental effects. Refer to Section 33.19, Conceptual Decommissioning, for detailed information regarding decommissioning.

Table 10-6 provides a summary of the potential effects from the proposed Project on demographics, employment, and the economy. Discussion for these effects are also presented below.

TABLE 10-6. IPFS AND POTENTIAL EFFECTS ON DEMOGRAPHICS, EMPLOYMENT, AND ECONOMICS IN THE AREA OF INTEREST

IPF	Potential Effects				Period of Effect		
	Project Component				Project Phase		
	Lease Area Infrastructure	ECCs	Landfall Locations, Onshore Export Cables, and Transmission Line	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Workforce Hiring	Increase in employment opportunities Contribution to the economy	Increase in employment opportunities Contribution to the economy	Increase in employment opportunities Contribution to the economy	Increase in employment opportunities Contribution to the economy	X	X	X
Procurement of materials, equipment, and services, including port use and vessel charters	Increase in employment opportunities Contribution to the economy	Increase in employment opportunities Contribution to the economy	Increase in employment opportunities Contribution to the economy	Increase in employment opportunities Contribution to the economy	X	X	X
Presence of Infrastructure	Disturbance of economic activities	Disturbance of economic activities	-	-	X	X	X
Influx of non-local employees that could affect housing	Increase in demand for lodging	Increase in demand for lodging	Increase in demand for lodging	Increase in demand for lodging	X	-	X

10.1.2.1 Workforce Hiring

The proposed Project may affect employment and the economy in the proximate communities, namely Falmouth and Somerset in Massachusetts and Portsmouth on Aquidneck Island in Rhode Island, as well as within the general region, including around the Greater Fall River area, the New Bedford MCT, as well as on Martha's Vineyard and Nantucket.

Mayflower Wind commissioned BVG Associates to conduct a detailed analysis of the proposed Project's economic development and job creation potential, assuming a 2.4-GW buildout to reflect the full capacity of the Lease Area (Appendix BB). The following information is derived from this study and can be referenced in Appendix BB. **Table 10-7** summarizes the direct, indirect, and induced jobs created by the Project. **Table 10-8** summarizes job creation across Project phases. A recent report prepared for the New York State Energy Research and Development Authority (BVG Associates, 2017) supports the expected job creation estimates from development of the offshore wind industry in the Northeast.

TABLE 10-7. DIRECT, INDIRECT AND INDUCED JOBS CREATED BY THE PROJECT

	Direct	Indirect	Induced	Total
FTE years created in Massachusetts	14,860	4,300	7,780	26,940
FTE years created in region	15,260	4,530	8,040	27,830

TABLE 10-8. JOB CREATION ACROSS PROJECT PHASES

	Development	Construction	O&M	Decomm.	Total
Duration (approximate in years) a/	6	2	30	2	40
FTE years created in Massachusetts	530	5,760	20,330	310	26,940
FTE years created in region	530	5,760	21,230	310	27,830

Notes:

a/ Durations are based on those used in the economic development and job creation potential modeling.

10.1.2.1.1 Construction

Skilled and unskilled labor is required for construction of the proposed Project. The proposed Project will directly and indirectly create an estimated 530 jobs (full-time equivalent years) during development and 5,760 jobs during construction in Massachusetts and elsewhere in the region. During construction, the biggest source of Project-related employment in Massachusetts will be from component staging. Construction activities will also provide job opportunities within the marine trades and affiliated industries, including tug and other vessel charters, docking and fueling, vessel servicing, provisioning, and worker transport.

Mayflower Wind is committed to encourage the hiring of personnel from the Project region to fill the positions required for the various preparation and construction activities. Furthermore, Mayflower Wind is committed to working upstream to aid in the development of a trained workforce for future construction of the proposed Project. The training and use of local and regional resources would be prioritized so that the populations concerned by the proposed Project can benefit as much as possible from the direct and indirect economic benefits. Mayflower Wind has further committed to make at least 75 percent of O&M local, contributing $20,000 in additional funding per employee shortfall to support workforce development. Mayflower Wind will continue to maintain a stakeholder engagement plan with outreach and communications mechanisms to share information and gather input from external stakeholders, including regional workforce training providers.

10.1.2.1.2 Operations and Maintenance

Skilled and unskilled labor is required for the operation and maintenance of the proposed Project. The proposed Project will directly and indirectly create an estimated 20,330 jobs over its 30 years of operation in Massachusetts, and an additional 900 jobs in operations will be created elsewhere in the region, including Rhode Island.

As for the jobs created during the construction phase, Mayflower Wind will encourage the hiring of personnel from the proposed Project region to fill the required positions.

10.1.2.1.3 Decommissioning

Skilled and unskilled labor is required for the decommissioning of the proposed Project. The proposed Project will create an estimated additional 310 jobs during decommissioning.

Decommissioning activities will be similar to the construction phase but less intensive. The decommissioning of WTGs and other Project structures, as well as the rehabilitation of sites, will require the hiring of workers, but fewer than during the construction phase. Transporting the dismantled equipment and material would also require the services of local providers in the region. The decommissioning work will generate short-term economic benefits in the region. Following the decommissioning of the proposed Project, the region would lose the permanent jobs necessary during operations.

Overall, the jobs created by the proposed Project will increase the number of new job opportunities in the area as well as the regional job market. The increase in jobs will be noticed mostly during construction and decommissioning activities. While Project-related jobs will cease after decommissioning, the proposed Project will have contributed to the development of technical and professional expertise within the local and regional workforce throughout the estimated 30-year lifetime of the proposed Project. This workforce can then contribute to the rapidly growing offshore wind industry in the Massachusetts and Rhode Island area.

10.1.2.2 Procurement of Materials, Equipment, and Services, Including Port Use and Vessel Charters

The proposed Project may affect the economy throughout the supply chain of Project-related activities in the communities hosting the proposed Project as well as within the general region. These areas include the New Bedford MCT, and on Martha's Vineyard and Nantucket.

10.1.2.2.1 Construction

The proposed Project will benefit local coastal economies and industries supporting the activities of the proposed Project throughout its anticipated 30-year lifetime. Installation and construction activities of the proposed Project infrastructure will require amenities and services to support numerous workers, including lodging, restaurants, banks, shops, medical services, entertainment, parks, tourism, sports, gas stations, etc.

The proposed Project is expected to have a strengthening effect on the Massachusetts and regional supply chain of Project-related activities, such as offshore wildlife surveys, marine vessel operators, blade and cable inspection and repair services (Appendix BB). The proposed Project will source equipment, materials and supplies, and other services such as vessel provisioning and servicing, and certain fabrication work from within the Project region, to the extent feasible (Appendix BB). Mayflower Wind will continue to maintain a stakeholder engagement plan with outreach and communications mechanisms to share information and gather input from external stakeholders, including potential supply chain partners, throughout construction, operations and decommissioning activities. Effects associated with sourcing of equipment, materials, and services are anticipated to have a stimulating effect on the regional economy.

Construction activities will require the use of the port facilities located near staging areas. As described previously, Mayflower Wind anticipates using the Port of New Bedford's MCT as the primary port to be used for Project activities. Other area ports are also being considered (see Section 3.3.13, Port Facilities). The New Bedford MCT has been expanded to accommodate offshore wind projects (BOEM, 2020b). Further investments in port upgrades and general infrastructure improvements at the New Bedford MCT site and/or other ports in the region are expected to yield high long-term economic benefits to Southeastern Massachusetts (Appendix BB). Construction activities will provide job opportunities within the marine trades and affiliated industries, including tug and other vessel charters, docking and fueling, vessel servicing, provisioning, and worker transport.

As determined in an economic development and jobs analysis (Appendix BB), Mayflower Wind expects to invest approximately $3.9 billion in the Commonwealth and approximately $4.0 billion in the region over the life of the proposed Project. Mayflower Wind will execute financial commitments pursuant to the proposed Project's Section 83C proposal, under the terms of an agreement with Massachusetts Clean Energy Center, including: $35 million ports and infrastructure; $10 million local innovation and entrepreneurship; $5 million applied research; $5 million workforce development; $10 million marine science; $7.5 million O&M port upgrades; and $5 million low income strategic electrification.

10.1.2.2.2 Operations and Maintenance

Periodic maintenance and repairs may require equipment, materials and supplies, and services such as vessel provisioning and servicing, which will be sourced within the Project region to the extent feasible.

While the proposed Project is expected to benefit local economies and industries during the O&M phase, the extent of these effects will be much lower than during the construction or decommissioning phases.

10.1.2.2.3 Decommissioning

As during the construction phase, decommissioning of the Project infrastructure will require amenities and services for numerous workers; including lodging, restaurants, banks, shops, medical services, entertainment, parks, tourism, sports, gas stations, etc.

Also, equipment, materials and supplies, and services such as vessel provisioning and servicing for decommissioning work will be sourced from within the Project region to the extent feasible (Appendix BB). Effects associated with sourcing of equipment, materials, and services are anticipated to have a stimulating effect on the regional economy.

Decommissioning activities will require the use of the port facilities, likely the New Bedford MCT. Any investments in port upgrades and general infrastructure improvements at the New Bedford MCT site and/or other ports in the region, at the time of decommissioning, are expected to yield economic benefits throughout Southeastern Massachusetts (Appendix BB).

Following the dismantling and decommissioning of the proposed Project, the region would lose the direct economic benefits linked to the operation of the proposed Project.

10.1.2.3 Presence of the Infrastructure

The proposed Project may disturb the local and regional economy through potential conflicts in the use of the Lease Area, as well as through visual effects on the tourism-based economy on Martha's Vineyard and Nantucket.

10.1.2.3.1 Construction

Installation and construction activities may temporarily disrupt employment and the economy by hindering established commercial activities, such as sailboat races (including, but not limited to, the Transatlantic Race and the Marion to Bermuda Race), tour boat routes, for-hire recreational boating and fishing, commercial fishing, and recreation and tourism. Effects on commercial and recreational fishing are discussed in Section 11, Commercial and Recreational Fisheries and Fishing Activity, effects on recreational resources are discussed in Section 12, Zoning and Land Use, effects on navigation are discussed in Section 13, Navigation and Vessel Traffic, and effects on recreation and tourism are discussed in Section 10.3.

10.1.2.3.2 Operations and Maintenance

The presence of the Project WTGs and OSPs in the Lease Area may increase the risk of vessel allision. See Appendix X, Navigation Safety Risk Assessment, for detailed information. Vessel operators may take longer routes to navigate around or through offshore wind facilities to avoid allision, which would affect their fuel costs, operating time, and revenue. Project effects on navigation are discussed in Section 13, Navigation and Vessel Traffic.

The presence of Project offshore structures may also affect commercial and recreational fishing operations due to entanglement of fishing gear. Mayflower Wind will work with fishermen through a lost gear claims form process to determine if reimbursement is warranted on a case-by-case basis. Effects on commercial and recreational fishing are discussed in Section 11, Commercial and Recreational Fisheries and Fishing Activity, and Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report. Effects on recreation and tourism are discussed in Section 10.3.

10.1.2.3.3 Decommissioning

As during the construction phase, decommissioning of offshore structures may temporarily disrupt employment and the economy by hindering established commercial activities. Effects on commercial and recreational fishing, recreational resources, and navigation will be addressed as described in Section

11, Commercial and Recreational Fisheries and Fishing Activity, Section 10.3, and Section 13, Navigation and Vessel Traffic.

10.1.2.4 Influx of Non-Local Employees that Could Affect Housing

The proposed Project may affect the demand for lodging in the proximate communities as well as within the general region, including around the New Bedford MCT, and on Martha's Vineyard or on Nantucket.

10.1.2.4.1 Construction

Even during peak construction activities, the influx of workers that may relocate to the area will only marginally add to the resident populations of local communities. It is likely that most temporary workers will reside on the mainland near the Onshore Project Areas (Barnstable, Bristol, and Plymouth Counties, Massachusetts, or Newport County, Rhode Island) and ports used to transport workers to the installation sites in the Offshore Project Area. It is anticipated that most temporary workers will avoid residing in Dukes and Nantucket Counties as rent is more expensive and daily commutes to and from these islands would complicate access to the Project construction location(s).

Housing and accommodations in the region are plentiful and unlikely to be affected by the presence of temporary workers. Among the Counties in the area of interest, Barnstable County was estimated to have the strongest seasonal tourism (Epsilon Associates, Inc., 2020) and hotel room occupancy statistics from the Cape Cod Chamber of Commerce indicated that the peak hotel room occupancy rate observed between 2010 and 2017 was 85 percent in August 2013. Occupancy rates drop during winter months and lodging demand declines by 50,000 to 100,000 rooms per month. The proposed Project may contribute to offsetting some of this reduction in occupancy, especially during the temporary construction and decommissioning phases.

10.1.2.4.2 Decommissioning

Decommissioning activities will be similar to the construction phase, but less intensive. Therefore, fewer workers would be required than during the construction phase. The influx of workers that may relocate to the area will only marginally add to the resident populations of local communities, mainly near the Onshore Project Area (Barnstable, Bristol, and Plymouth Counties, Massachusetts, or Newport County, Rhode Island) and the New Bedford MCT. Housing and accommodation in the region are plentiful and unlikely to be affected by the presence of temporary workers during decommissioning.

Transporting the dismantled equipment and material would require the services of specialists in the region similar to the construction phase. This would generate some short-term economic benefits in the region.

10.1.2.5 Conclusion

The construction and operation of the proposed Project will have an overall positive effect on employment and the economy of the region, while few effects on population and housing are expected.

Overall, the jobs created by the proposed Project will benefit the local job market as well as the regional job market to a lesser degree. The proposed Project will directly and indirectly create an estimated 27,830 jobs (full-time equivalent years) in Massachusetts and the region as a whole.

Decommissioning activities will have a temporary, positive effect. However, the proposed Project's employment and economic benefits will cease once the proposed Project is fully decommissioned. It is important to note that these losses would be due to the nature of the proposed Project and therefore are entirely predictable. Also, the Project will have contributed to the development of technical and professional expertise within the local and regional workforce for several decades. This workforce can then contribute to the rapidly growing offshore wind industry in the Massachusetts and Rhode Island area. Over its entire life, the proposed Project will have contributed to the overall economy of the region. Mayflower Wind will implement certain measures to further reduce the likelihood of any negative effects and promote potential positive effects to regional demographics, employment, and economics.

10.2 Environmental Justice and Minority and Lower Income Groups

This section describes the potential presence of environmental justice (EJ) populations in the jurisdictions affected by the proposed Project and includes an evaluation of potential Project-related effects, as well as proposed avoidance, minimization, and mitigation measures.

In 1994, President Clinton signed Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, which requires each federal agency to account for EJ as part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The EO further stipulates that federal agencies conduct their programs and activities in a manner that does not have the effect of excluding persons from participation in them, denying persons the benefits of them, or subjecting persons to discrimination because of their race, color, or national origin. The EPA's *EJ 2020 Action Agenda* (EPA, 2016) furthers the intent of EO 12898 by setting eight priority areas and four significant national challenges, which includes federal, state, and local collaboration and coordination on EJ issues. In addition, EO 13175 (2000), *Consultation and Coordination with Indian Tribal Governments*, charges all executive departments and agencies with engaging in regular, meaningful, and robust consultation with Tribal officials in the development of Federal policies that have Tribal implications. This policy was reaffirmed in a White House Memorandum issued in January 2021.

The following assessment considers the areas in which the proposed Project may result in environmental effects, the presence and characteristics of potentially affected EJ populations residing in the area of interest, and the extent to which these communities may be disproportionately affected in comparison to the wider population.

10.2.1 Affected Environment

The proposed Project has the potential to affect populations, the economy, and the environment directly and indirectly at the local and regional levels (see Section 10.1). The broader area of interest for this section, therefore, includes Barnstable and Bristol Counties in Massachusetts, and Newport County in Rhode Island, as well as the following adjacent counties: Bristol County in Rhode Island, and Dukes, Nantucket, and Plymouth counties in Massachusetts (**Figure 10-1**). In addition, as explained below, the following analysis also includes a more detailed review of the census block groups that either include or are located within 1 mile (1.6-km) of onshore Project components.

10.2.1.1 Potential Environmental Justice Populations

Guidelines provided by the Council for Environmental Quality (CEQ, 1997) and EPA (1998) indicate that a minority population may be defined as either: 1) where the minority population comprises more than 50 percent of the total population; and/or 2) where the minority population is meaningfully greater than the minority population in the general population of an appropriate benchmark region used for comparison.[11] Minority populations may consist of a group of individuals living in geographic proximity to one another, or a geographically dispersed set of individuals who would be similarly affected by the proposed action or program. Further, a minority population exists if there is "more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds (CEQ 1997)."[12]

The CEQ and EPA guidelines indicate that low-income populations should be identified based on the annual statistical poverty thresholds established by the USCB. Like minority populations, low-income populations may consist of individuals living in geographic proximity to one another, or a geographically dispersed set of individuals who would be similarly affected by the proposed action or program.

10.2.1.1.1 Massachusetts Environmental Justice Policy

In 2021, the Commonwealth of Massachusetts enacted the *Act Creating A Next-Generation Roadmap For Massachusetts Climate Policy*, St. 2021, c. 8 (2021 Climate Act) which changed the definition of EJ populations under the Massachusetts EJ Policy (the "Massachusetts Policy"; EEA, 2017). The 2021 Climate Act (which took effect on June 23, 2021) defines EJ populations as a neighborhood that meets one or more of the following criteria:

- The annual median household income is not more than 65 percent of the statewide annual median household income,
- Minorities comprise 40 percent or more of the population,
- 25 percent or more of households lack English language proficiency, or
- Minorities comprise 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

In addition, for a neighborhood that does not meet these criteria, but a geographic portion of that neighborhood meets at least one criterion, the Executive Office of Energy and Environmental Affairs (EEA) Secretary may designate that geographic portion as an EJ population upon the petition of at least 10 residents of the geographic portion of that neighborhood meeting any of the criteria.

Further, the EEA Secretary may determine that a neighborhood, including any geographic portion of it, shall not be designated an EJ population upon finding that:

---

[11] The benchmark region used for comparison is also referred to as the "reference community" (Federal Interagency Working Group on Environmental Justice & NEPA Committee, 2016). Two reference communities – the states of Massachusetts and Rhode Island – are used for this analysis, with the potentially affected counties and census block groups compared to the state in which they are located, as appropriate.

[12] Minority populations identified by the USCB include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, and Other Race, which are considered races, and persons of Hispanic or Latino origin, which is considered an ethnicity.

- The annual median household income of that neighborhood is greater than 125 percent of the statewide median household income;
- A majority of persons age 25 and older in that neighborhood have a college education;
- The neighborhood does not bear an unfair burden of environmental pollution; and
- The neighborhood has more than limited access to natural resources, including open spaces and water resources, playgrounds, and other constructed outdoor recreational facilities and venues.

The Massachusetts Policy (EEA, 2017) emphasized the need to support EJ populations in high-minority and low-income neighborhoods as they are most at risk of being unaware of or unable to participate in environmental, energy, or climate change decision-making. The policy also prescribed specific efforts that must be made to address environmental and health risks associated with existing and potential new sources of pollution, among other things. Under these requirements, effort must be made to enhance opportunities for EJ populations to participate in environmental, energy, and climate change decision making.

10.2.1.1.2 Rhode Island Department of Environmental Management Environmental Justice Focus Areas

RIDEM, as part of its *Policy for Considering Environmental Justice in the Review of Investigation and Remediation of Contaminated Properties* has identified Environmental Justice Focus Areas. These areas are identified using data at the census block group level. Areas are identified as EJ focus areas where the percent of the census block group that is minority or low-income rank in the top 15 percent of block groups statewide. Low-income populations are defined as those with income less than 200 percent of the federal poverty level (RIDEM, 2009).

10.2.1.2 Potential Minority and Low-Income Populations

According to the most recent Census estimates (**Table 10-9**), approximately 71.6 percent of the population of Massachusetts is White. The Hispanic or Latino population was identified as the largest minority group, accounting for about 11.8 percent of the total population, followed by the Black or African American and Asian populations, which accounted for an estimated 6.9 percent and 6.6 percent of the total, respectively. The estimated White shares of the population in the five counties in the area of interest in Massachusetts all exceeded the commonwealth average, ranging from 80.6 percent (Plymouth County) to 89.3 percent (Barnstable County). The total minority percentage of the populations in the five counties is less than 50 percent and less than the Commonwealth average and, therefore, the populations in these counties do not meet the definition of a minority population based on applicable CEQ and EPA guidelines. The estimated minority totals in all five Massachusetts counties are also less than 40 percent and, therefore, do not meet the criteria to be considered a minority population under the Massachusetts 2021 Climate Act.

TABLE 10-9. RACE AND ETHNICITY BY STATE AND COUNTY

Geographic Area a/	Total Population	Percent of Total						
		White b/	Black or African American b/	Hispanic or Latino	Native American and Alaska Native b/	Asian b/	Other Race b/ c/	Total Minority d/
Massachusetts	**6,850,553**	**71.6**	**6.9**	**11.8**	**0.1**	**6.6**	**3.0**	**28.4**
Barnstable County	213,496	89.3	2.9	3.1	0.6	1.5	2.7	10.7
Bristol County	561,037	81.3	3.9	8.0	0.1	2.3	4.5	18.7
Dukes County	17,312	85.6	4.2	3.6	0.7	0.3	5.6	14.4
Nantucket County	11,168	85.2	6.6	4.2	0.3	0.6	3.1	14.8
Plymouth County	515,303	80.6	9.6	3.9	0.1	1.4	4.4	19.4
Rhode Island	**1,057,231**	**72.0**	**5.7**	**15.4**	**0.3**	**3.3**	**3.2**	**28.0**
Bristol County	48,764	91.4	1.3	3.0	0.1	2.1	2.1	8.6
Newport County	82,801	85.8	3.5	5.7	0.4	1.9	2.7	14.2

Source: USCB, 2021a

Notes:

a/ All estimates are annual totals developed as part of the 2015-2019 American Community Survey 5-Year Estimates.

b/ Non-Hispanic only. The Federal Government considers race and Hispanic/Latino origin (ethnicity) to be two separate and distinct concepts. People identifying as Hispanic or Latino origin may be of any race. The data summarized in this table present Hispanic/Latino as a separate category.

c/ The "Other Race" category presented here includes census respondents identified as Native Hawaiian and Other Pacific Islander, Two or More Races, or Some Other Race.

d/ The total minority population is the sum of the Black or African American, Hispanic or Latino, Asian, Native American and Alaska Native, and Other Race categories shown here.

A majority of the population in Rhode Island was also identified as White (72 percent), with persons of Hispanic or Latino origin accounting for 15.4 percent of the population, followed by the Black or African American and Asian populations, which accounted for an estimated 5.7 percent and 3.3 percent of the total, respectively (**Table 10-9**). The White shares of the population in the two Rhode Island counties in the area of interest exceeded the state average, with 91 percent (Bristol County) and 86 percent (Newport County) identified as White. The total minority percentage of the populations in both counties is less than 50 percent and less than the state average and, therefore, the populations in these counties do not meet the definition of a minority population based on applicable CEQ and EPA guidelines.

Native American and Alaska Natives comprise an estimated 0.1 percent and 0.3 percent of the total populations in Massachusetts and Rhode Island, respectively. Viewed by county, Native American and Alaska Natives as a share of total population ranged from 0.3 percent (Dukes County, Massachusetts) to 2.3 percent (Bristol County, Massachusetts) (**Table 10-9**).

Table 10-10 presents median household income and the share of the population with income less than 200 percent of the federal poverty level for Massachusetts and Rhode Island and the seven counties in the area of interest. In Massachusetts, median household income in the five counties in the area of interest ranged from 85 percent (Bristol County) to 133 percent (Nantucket County) of the Commonwealth median and, therefore, these areas do not meet the criteria to be considered a low-income population under the Massachusetts 2021 Climate Act. The share of the population with income below 200 percent of the federal poverty level ranged from 17 percent (Plymouth County) to 26 percent (Bristol County) compared to a Commonwealth average of 22 percent (**Table 10-10**).

TABLE 10-10. MEDIAN HOUSEHOLD INCOME AND POVERTY BY STATE AND COUNTY

Geographic Area a/	Total Population	Median Household Income		Income Below Poverty Level (%) c/
		Dollars b/	Percent of State Median	
Massachusetts	**6,850,553**	**81,215**	**100%**	**22%**
Barnstable County	213,496	74,336	92%	19%
Bristol County	561,037	69,095	85%	26%
Dukes County	17,312	71,811	88%	23%
Nantucket County	11,168	107,717	133%	19%
Plymouth County	515,303	89,489	110%	17%
Rhode Island	**1,057,231**	**67,167**	**100%**	**27%**
Bristol County	48,764	83,092	124%	18%
Newport County	82,801	79,454	118%	20%

Sources: USCB 2021b, 2021c
Notes:
a/ All estimates are annual totals developed as part of the 2015-2019 American Community Survey 5-Year Estimates.
b/ Median household income is for the past 12 months expressed in 2019 inflation-adjusted dollars.
c/ These estimates represent the share of the population with income less than 200 percent of the federal poverty level.

In the Rhode Island part of the area of interest, median household income was higher than the state median in both Bristol and Newport counties. In addition, the share of the population with income below 200 percent of the federal poverty level was lower than the statewide average (28 percent) in both counties (**Table 10-10**).

Larger and more populated geographic areas may have the effect of "masking" or "diluting" the presence of concentrations of minority and/or low-income populations (CEQ, 1997; EPA, 1998). Therefore, data were also reviewed separately at the census block group level. A census block group is a statistical subdivision of a census tract, generally defined to contain between 600 and 3,000 people and 240 and 1,200 housing units.

Data for the census block groups in the five counties in the area of interest in Massachusetts were obtained from the Massachusetts Bureau of Geographic Information, which has mapped potential environmental justice populations based upon the 2021 Climate Act demographic criteria using data compiled from the USCB's 2015-2019 American Community Survey 5-Year Estimates (MassGIS, 2021). Census block group data for the two Rhode Island counties in the area of interest were obtained from RIDEM, which has mapped Environmental Justice Focus Areas using census data on race and ethnicity and poverty (RIDEM, 2021). These data are shown for the census block groups in the broader area of interest in **Figure 10-2**.

A total of 35 census block groups either contain and/or are located within 1 mile (1.6 km) of onshore Project components. Fourteen of these census block groups contain or are crossed by onshore Project components; the remaining 21 census block groups considered do not contain onshore Project components but are located within 1 mile (1.6 km). Review of this subset of block groups identified four block groups with potential EJ populations in the Falmouth Onshore Project Area. All four of these block groups are crossed by onshore Project facilities (**Figure 10-3**).[13] According to MassGIS (2021), three of the four block groups meet the EEA criteria to be considered potential low-income populations and the other meets the EEA criteria to be considered a potential minority population.

It should, however, be noted that review of the source data (USCB, 2021a) for the identified potential minority population indicates that the total minority population in the block group comprises 25.7 percent of the total population and, therefore, does not meet the criteria to be considered a potential minority population under the Massachusetts 2021 Climate Act because the minority share does not comprise 40 percent or more of the population. Median household income in the block group is equivalent to 115 percent of the state median and, therefore, the block group also does not meet the 2021 Climate Act criteria to be considered a potential low-income population (USCB, 2021b). However, taken together these two percentages meet the fourth criteria established by the 2021 Climate Act, as follows:

- Minorities comprise 25 percent or more of the population and the annual median household income of the municipality in which the neighborhood is located does not exceed 150 percent of the statewide annual median household income.

[13] Note two other block groups with potential EJ populations are also shown in Figure 10-3. Both are further than 1 mile (1.6 km) from onshore Project components.

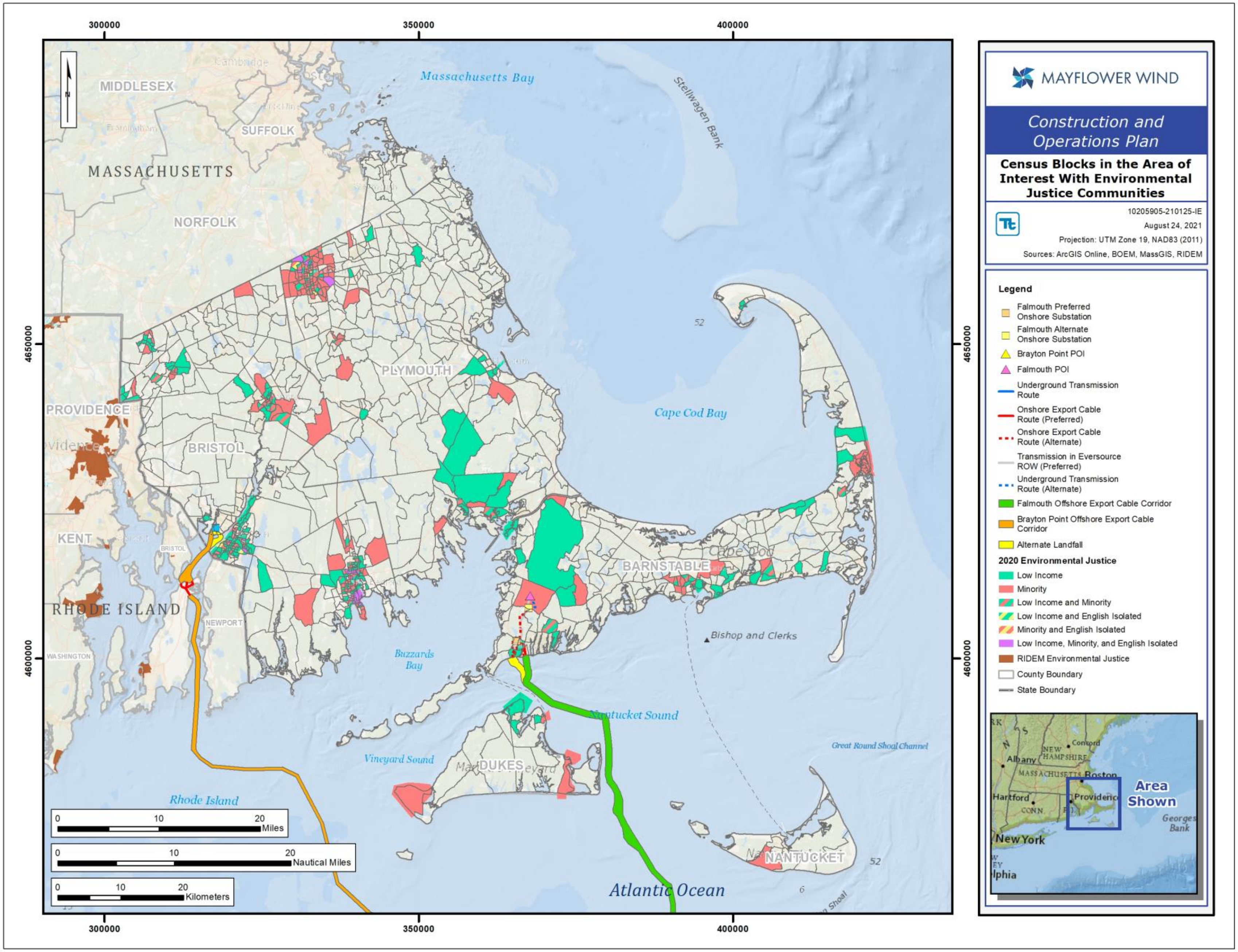


FIGURE 10-2. CENSUS BLOCK GROUPS IN THE AREA OF INTEREST WITH POTENTIAL EJ POPULATIONS

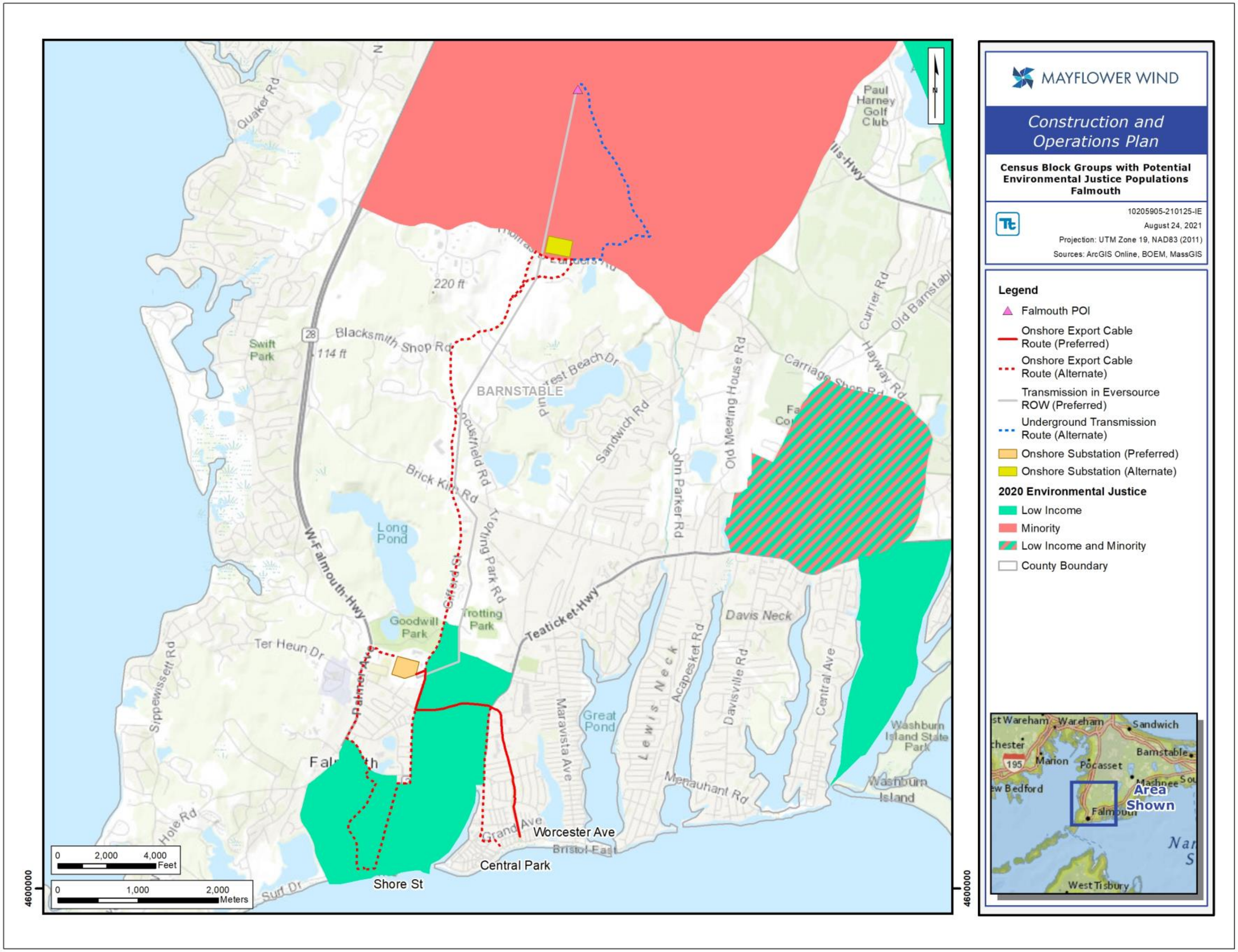


FIGURE 10-3. CENSUS BLOCK GROUPS WITH POTENTIAL EJ POPULATIONS IN PROXIMITY TO THE FALMOUTH ONSHORE PROJECT AREA

Review of the source data for the three block groups shown as potential low-income populations indicates that these block groups meet the criteria to be considered a potential low-income population under the 2021 Climate Act because median household income in each of these block groups is less than 65 percent of the state median (USCB, 2021b).

Census block groups with potential EJ populations in the vicinity of the Brayton Point Onshore Project Area are shown in **Figure 10-4**. None of the identified block groups are crossed by onshore Project facilities. No EJ Focus Areas were identified by RIDEM within 1 mile (1.6 km) of the Brayton Point onshore export cable route on Aquidneck Island, in Portsmouth, Rhode Island (RIDEM, 2021, **Figure 10-2**).

Native Americans and Alaska Natives account for an estimated 0.1 percent and 0.3 percent of total populations in Massachusetts and Rhode Island, respectively (**Table 10-9**). Review of the census block groups that either contain and/or are located within 1 mile (1.6 km) of onshore Project components, identified four block groups in Massachusetts with Native American and Alaska Native populations that exceed 1 percent of the total population. Shares of Native American and Alaska Native populations in these block groups range from 1.6 percent to 8.9 percent of the total population (USCB, 2021a). Two of these block groups contain onshore Project components.

10.2.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed activities, is considered for the analysis of potential effects.

The proposed Project has the potential to affect EJ populations directly and indirectly at the regional level with potential impacts related to workforce hiring; procurement of materials, equipment, and services; the presence of infrastructure; and potential impacts due to temporary Project-related demand for short-term housing. More localized effects could occur from temporary reductions in access and disturbance due to Project-related vehicle traffic and air emissions. **Table 10-11** provides a summary of the potential effects to EJ populations.

10.2.2.1 Workforce Hiring

As discussed in Section 10.1, skilled and unskilled labor is required for all phases of the proposed Project.

10.2.2.1.1 Construction

Project construction and installation activities will likely increase employment opportunities and economic activity in the broader area of interest. Mayflower Wind's commitment to encourage the hiring of the skilled and unskilled labor from the Project region may provide new opportunities for EJ populations (Appendix BB).

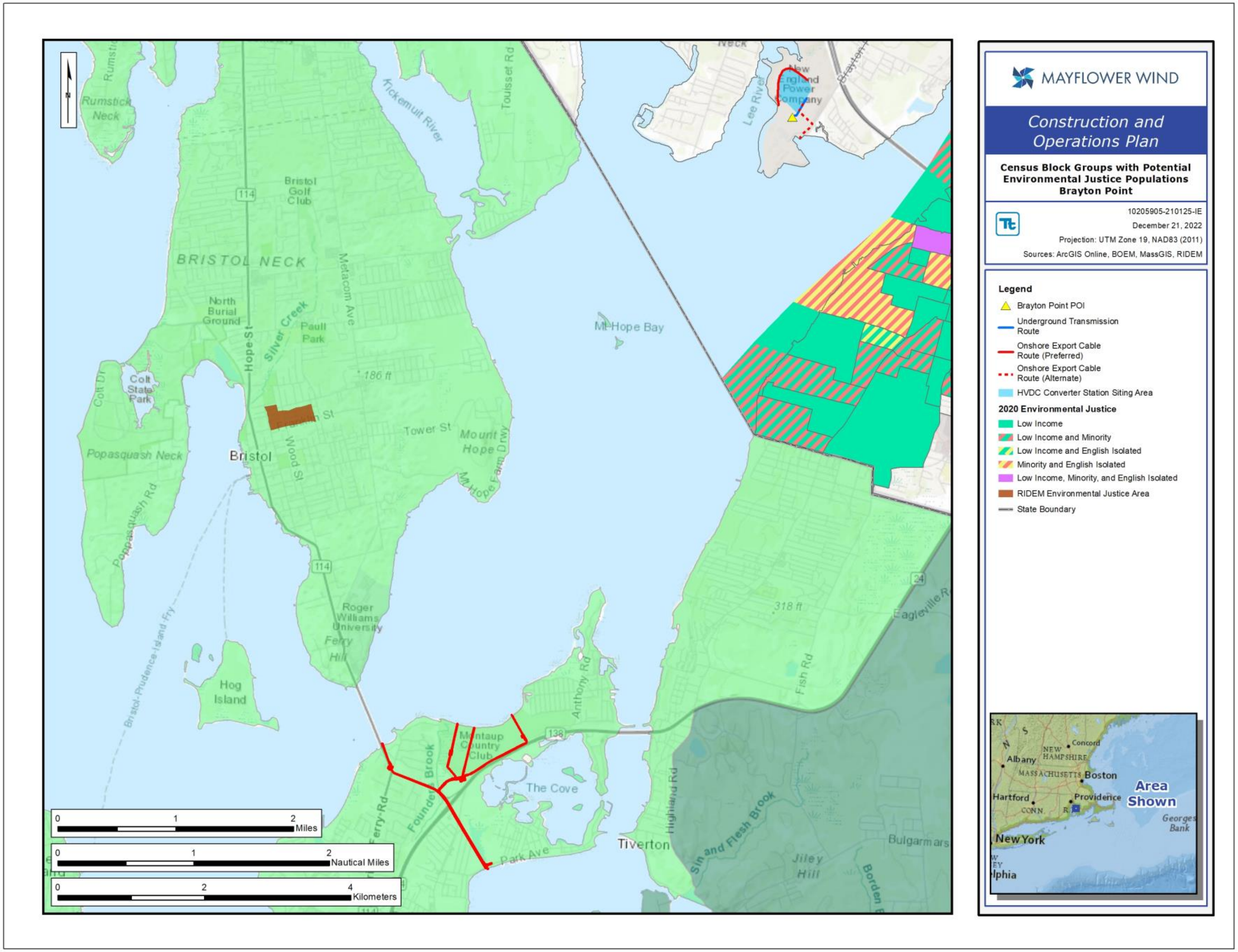


FIGURE 10-4. CENSUS BLOCK GROUPS WITH POTENTIAL EJ POPULATIONS IN PROXIMITY TO THE BRAYTON POINT ONSHORE PROJECT AREA

TABLE 10-11. IPFS AND POTENTIAL EFFECTS ON EJ POPULATIONS IN THE AREA OF INTEREST

IPF	Potential Effects				Period of Effect		
	Project Component				Project Phase		
	Lease Area Infrastructure	ECCs	Landfall Locations, Onshore Export Cables and Transmission Lines	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Workforce Hiring	Increase in employment and economic opportunities	Increase in employment and economic opportunities	Increase in employment and economic opportunities	Increase in employment and economic opportunities	X	X	X
Procurement of materials, equipment, and services, including port use and vessel charters	Increase in employment and economic opportunities	Increase in employment and economic opportunities	Increase in employment and economic opportunities	Increase in employment and economic opportunities	X	X	X
Presence of Infrastructure	Disturbance of offshore economic activities	Disturbance of offshore economic activities	-	-	X	X	X
Vehicle Traffic	-	-	Reduced access; Disturbance	Reduced access; Disturbance	X	X	X
Influx of non-local employees that could affect housing	Increase in demand for lodging	Increase in demand for lodging	Increase in demand for lodging	Increase in demand for lodging	X	-	X
Planned Discharges – Air Emissions	-	-	Disturbance from fugitive dust	Disturbance from fugitive dust	X	-	X

Mayflower Wind's community engagement commitments include engaging local communities and local stakeholders, as well as specific EJ populations such as Indigenous communities. These commitments are consistent with the Massachusetts Policy as they facilitate opportunities for all interested parties to participate. See Section 10.1 for additional information regarding Project workforce hiring commitments.

10.2.2.1.2 Operations and Maintenance

During the operations phase, the proposed Project will provide employment opportunities within the area of interest, and Mayflower Wind's community commitments will carry on throughout the life of the proposed Project, including sourcing goods and services from the surrounding community to the extent feasible. Mayflower Wind has committed to make at least 75 percent of O&M local, contributing $20,000 in additional funding per employee shortfall to support workforce development. These opportunities are expected to benefit the general population and may also provide opportunities for EJ populations.

10.2.2.1.3 Decommissioning

Offshore decommissioning activities are expected to be comparable to the construction phase but less intensive, and effects on employment and the local and regional economy would be similar but less significant than during construction. While Project-related jobs will cease after decommissioning, the proposed Project's contribution to the development of technical and professional expertise within the local and regional workforce will be felt by EJ populations and the wider population.

10.2.2.2 Procurement of Materials, Equipment and Services Including Port Use and Vessel Charters

As discussed in Section 10.1, the proposed Project may affect the economy through the supply chain of Project-related activities, potentially affecting the communities hosting the proposed Project, as well as within the general region, including around the New Bedford MCT, and on Martha's Vineyard and Nantucket.

10.2.2.2.1 Construction, Operations and Maintenance, and Decommissioning

The proposed Project will benefit local coastal economies and industries supporting the activities of the proposed Project throughout its life. The construction phase will require the use of the port facilities near staging areas and require amenities and services for numerous workers, including lodging, restaurants, banks, shops, medical services, entertainment, parks, tourism, sports, and gas stations. Project expenditures will support existing employment in these economic sectors, which may include increased hours and overtime opportunities for existing workers, as well as potentially creating new employment opportunities as affected businesses hire more workers. These activities may provide continued or new employment opportunities for EJ populations.

Periodic maintenance and repairs may require equipment, materials, supplies, and services such as vessel provisioning and servicing, which will be sourced from within the Project region to the extent feasible. While the proposed Project is expected to benefit local economies and industries during O&M phase, the extent of the effect will be much lower than during the construction or decommissioning phases.

Offshore decommissioning activities are expected to be comparable to the construction phase but less intensive, and effects on the procurement of materials and equipment would be similar but less significant than during construction.

10.2.2.3 Presence of Infrastructure

10.2.2.3.1 Construction, Operations and Maintenance, and Decommissioning

The presence of offshore infrastructure may disturb the local and regional economy through potential conflicts in the use of the Lease Area during Project construction, O&M, and decommissioning as discussed in Section 10.1.2.3. Information related to potential impacts to cultural resources, including marine archaeology, terrestrial archaeology, and above-ground historic properties is provided in Section 7, Cultural Resources. Related ongoing tribal consultation and potential impacts to cultural resources are assessed in that section. Potential impacts related to the presence of infrastructure also include effects to commercial and recreational fishing, including commercial or recreational fishing by EJ populations. Effects on commercial and recreational fishing are discussed in Section 11, Commercial and Recreational Fisheries and Fishing Activity, and Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

Periodic planned and unplanned maintenance of Project components may affect communities in the immediate vicinity of these activities. Such activities may include the clearing of vegetation along rights-of-way, planned replacement of equipment and materials, and the operation of maintenance equipment. These maintenance activities are not expected to affect the general population or potential EJ populations.

10.2.2.4 Influx of Non-Local Employees that Could Affect Housing

As discussed in Section 10.1, the proposed Project may affect the demand for lodging in the communities hosting the proposed Project as well as within the general region, including around the New Bedford MCT, on Martha’s Vineyard, or on Nantucket.

10.2.2.4.1 Construction and Decommissioning

Even during peak construction activities, the influx of workers that may relocate to the area will only marginally add to the resident populations of local communities. Housing and accommodation in the region are plentiful and unlikely to be affected by the presence of temporary workers. Overall, it is anticipated that potential effects of the construction, O&M, and decommissioning activities on housing and temporary accommodations will not be different on any EJ populations compared with the overall population.

10.2.2.5 Vehicle Traffic

10.2.2.5.1 Construction, Operations and Maintenance, and Decommissioning

Project construction is anticipated to result in a temporary increase in construction, support, and workforce vehicle traffic along and to and from the onshore Project components, as well as to and from the ports. Nearby communities, including potential EJ populations, will experience an increase in construction-related activities, including a short-term increase in construction-related noise and equipment emissions. The Project would use existing roads, ROWs, and infrastructure where possible;

therefore, new impacts resulting from construction activities would be minimized to the extent practicable and are anticipated to be similar in nature to other utility or road improvement works carried out in these locations. Impacts are expected to be similar during Project decommissioning.

O&M activities will result in a small increase in Project-related vehicle traffic around the onshore Project components, but the numbers are anticipated to be low and are not expected to result in a noticeable increase to existing traffic volumes in the area.

10.2.2.6 Planned Discharges – Air Emissions

10.2.2.6.1 Construction, Operations and Maintenance, and Decommissioning

Construction-related air emissions may affect the communities in the immediate vicinity of the construction activities. Air emissions will mostly be created by vehicles and construction equipment, and will include carbon monoxide, sulfur dioxide, nitrogen oxides, sulfuric acid mist, particulate matter, etc. Earth moving activities will also create particulate matters (construction dust). Air quality effects are discussed in more detail in Section 5.1, Air Quality.

Installation of the underground cables in Falmouth and the preferred onshore substation location could temporarily affect neighboring communities, including beaches and residential and commercial areas along the onshore export cable route. Viewed by census block group, onshore Project components in the Falmouth Onshore Project Area are located in block groups that have potential EJ populations, as well as other block groups with populations that do not meet the Massachusetts 2021 Climate Act EJ definitions (**Figure 10-3**). Air emissions from the construction of the alternate onshore substation location would have little effect on communities as the neighboring areas are mostly unoccupied. The construction of the Brayton Point onshore export cable route, including the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island and the installation of the Brayton Point onshore Project components may also temporarily affect neighboring communities, including residents of Portsmouth and residents within the vicinity of Brayton Point.

Project activities would generate air emissions at the New Bedford MCT and, to a lesser extent, any of the other ports. But these effects are typical for industrial ports; the proposed Project would not increase these effects above the levels typically experienced or expected in the vicinity of these facilities.

Overall, Project-related air emissions are not expected to have disproportionately high and adverse impacts on potential EJ populations. The proposed Project will implement BMPs to minimize potential effects. Also, an onshore construction schedule will be developed to minimize effects to neighboring communities to the extent feasible. Onshore construction activities will comply with local regulatory authority requirements. Further avoidance, minimization, and mitigation measures related to air emissions are described in Section 5.1, Air Quality.

10.3 Recreation and Tourism

This section describes the recreation and tourism activities in areas that may be affected by the proposed Project and includes an evaluation of potential Project-related effects, as well as proposed avoidance, minimization, and mitigation measures.

Recreation and tourism activities are categorized into land and nearshore activities (e.g., cultural events, sightseeing, restaurants, beaches, snorkeling, paddle sports, windsurfing, personal watercraft, water skiing, ecotourism, camping, etc.) and water-based activities (e.g., fishing, boating, diving, whale watching, deep-sea fishing, etc.). Although water-based activities must be staged from land or nearshore locations and, therefore, may be affected by onshore Project activities, the potential effects and mitigation measures are largely distinct for the two categories.

10.3.1 Affected Environment

The proposed Project can potentially affect recreation and tourism activities during the construction and decommissioning of the onshore infrastructure in Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island, where the Project landfall locations, onshore export cables, onshore substation, converter station, and underground transmission routes will occur. Therefore, the area of interest for the evaluation of onshore effects on recreation and tourism includes the local communities around the construction activities (i.e., Falmouth in Barnstable County [Massachusetts], Somerset in Bristol County [Massachusetts], and Portsmouth in Newport County [Rhode Island]). **Figure 10-5** and **Figure 10-6** illustrate the onshore area of interest.

Construction and decommissioning of the offshore infrastructure can potentially affect recreation and tourism activities in the Lease Area located south of Nantucket island, along the export cable corridors, as well as near the staging areas at the New Bedford MCT in Bristol County (Massachusetts) and other ports under consideration (see Section 3.3.13, Port Facilities). Recreation and tourism may also be affected during the O&M phase due to the potential visibility of the offshore infrastructure from Martha’s Vineyard and Nantucket islands. The area of interest for the evaluation of Project effects on recreation and tourism includes Barnstable, Bristol, Dukes and Nantucket Counties in Massachusetts, and Bristol and Newport Counties, in Rhode Island. **Figure 10-7** illustrates the offshore area of interest.

10.3.1.1 Land-based and Nearshore-based Recreation and Tourism Resources

10.3.1.1.1 Falmouth Onshore Project Area

The Falmouth Onshore Project Area consists of the landfall in Falmouth, Massachusetts, as well as the onshore substation and onshore export cable route. Most of Barnstable County is comprised of the Cape Cod peninsula consisting of 15 towns with unique historic character (CCC, 2019). The area includes approximately 550 miles (884 km) of coastline, almost 1,000 freshwater ponds, and more than 100,000 acres of habitat, wetlands, and protected open space, over 150 beaches and many private beaches, approximately 30 harbors, 40 marinas and boatyards, and approximately two dozen private boating and yacht clubs in the County (CCC, 2019; Epsilon Associates, Inc., 2020). The area is ideal for beach going, walking, snorkeling, windsurfing, boating, and fishing. The Cape Cod National Seashore, located at the northern tip of the peninsula, was visited 4,096,104 times in 2019 (NPS, 2020).

Many of the communities in the area of interest are popular tourist destinations and depend on the tourism and recreation industries for significant revenues. The Cape Cod Chamber of Commerce estimated that the area’s tourism industry generated $1.1 billion in direct spending and $122 million in state and local taxes in 2017 (CCC, 2019).

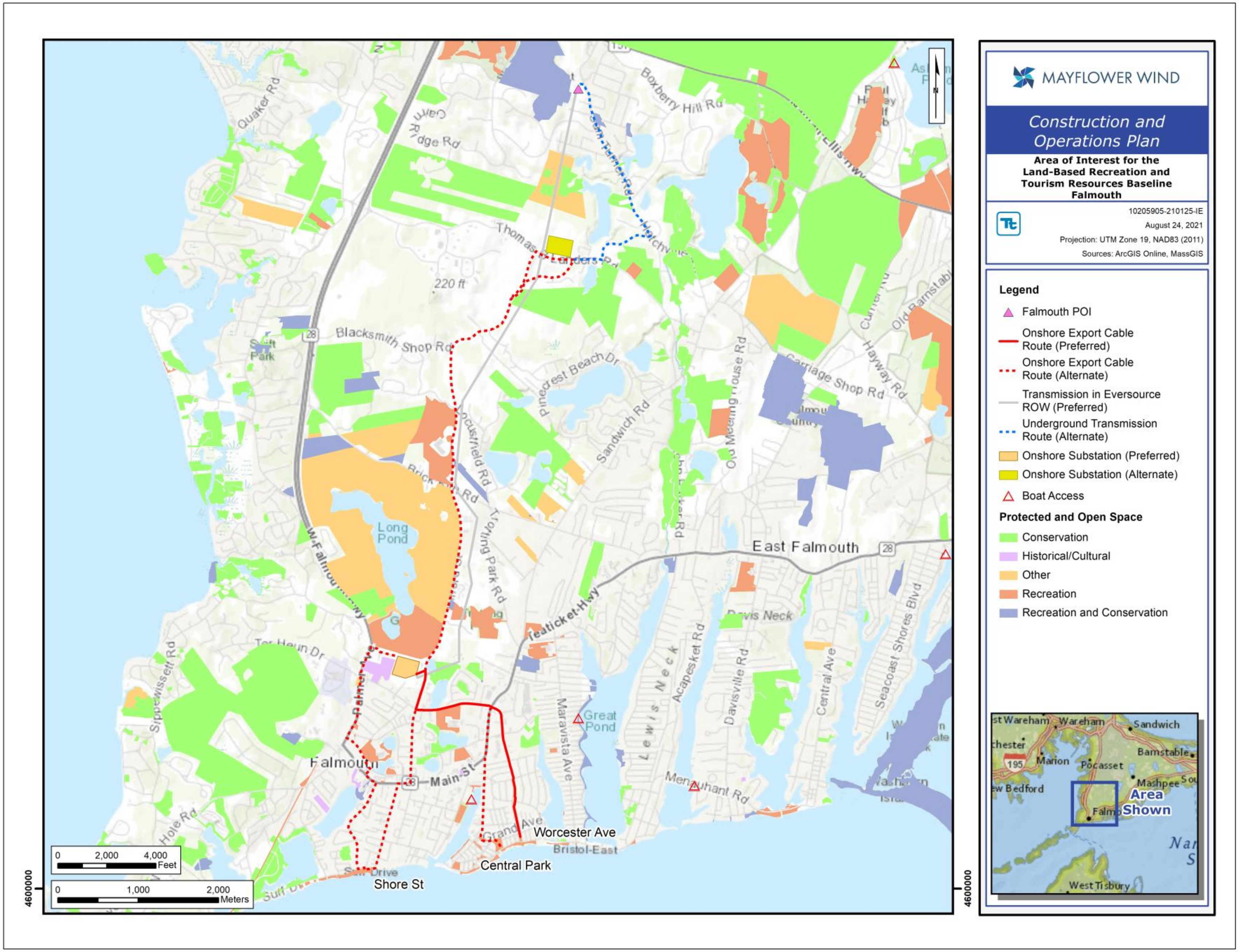


FIGURE 10-5. FALMOUTH AREA OF INTEREST FOR THE LAND-BASED RECREATION AND TOURISM RESOURCES BASELINE

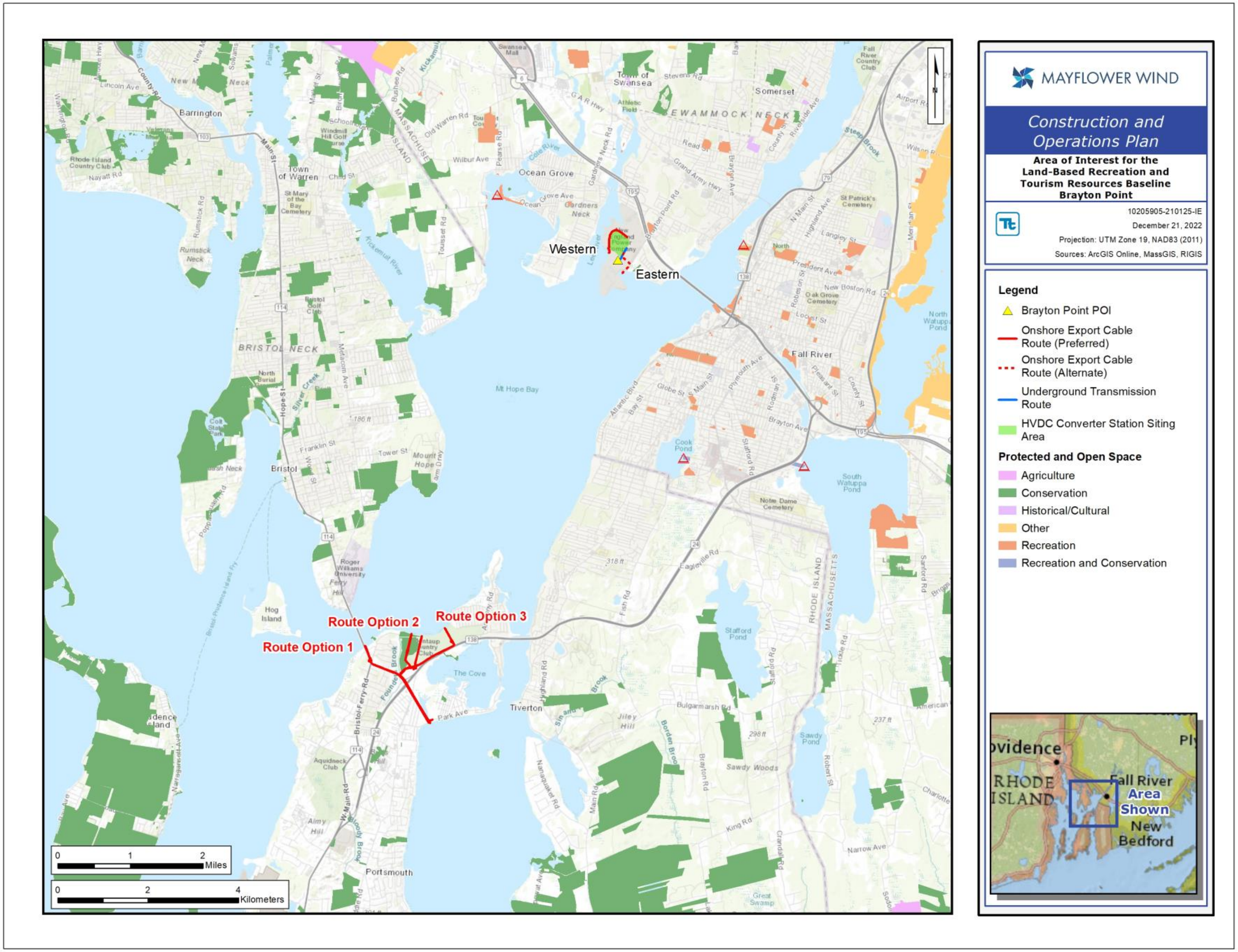


FIGURE 10-6. BRAYTON POINT AREA OF INTEREST FOR THE LAND-BASED RECREATION AND TOURISM RESOURCES BASELINE

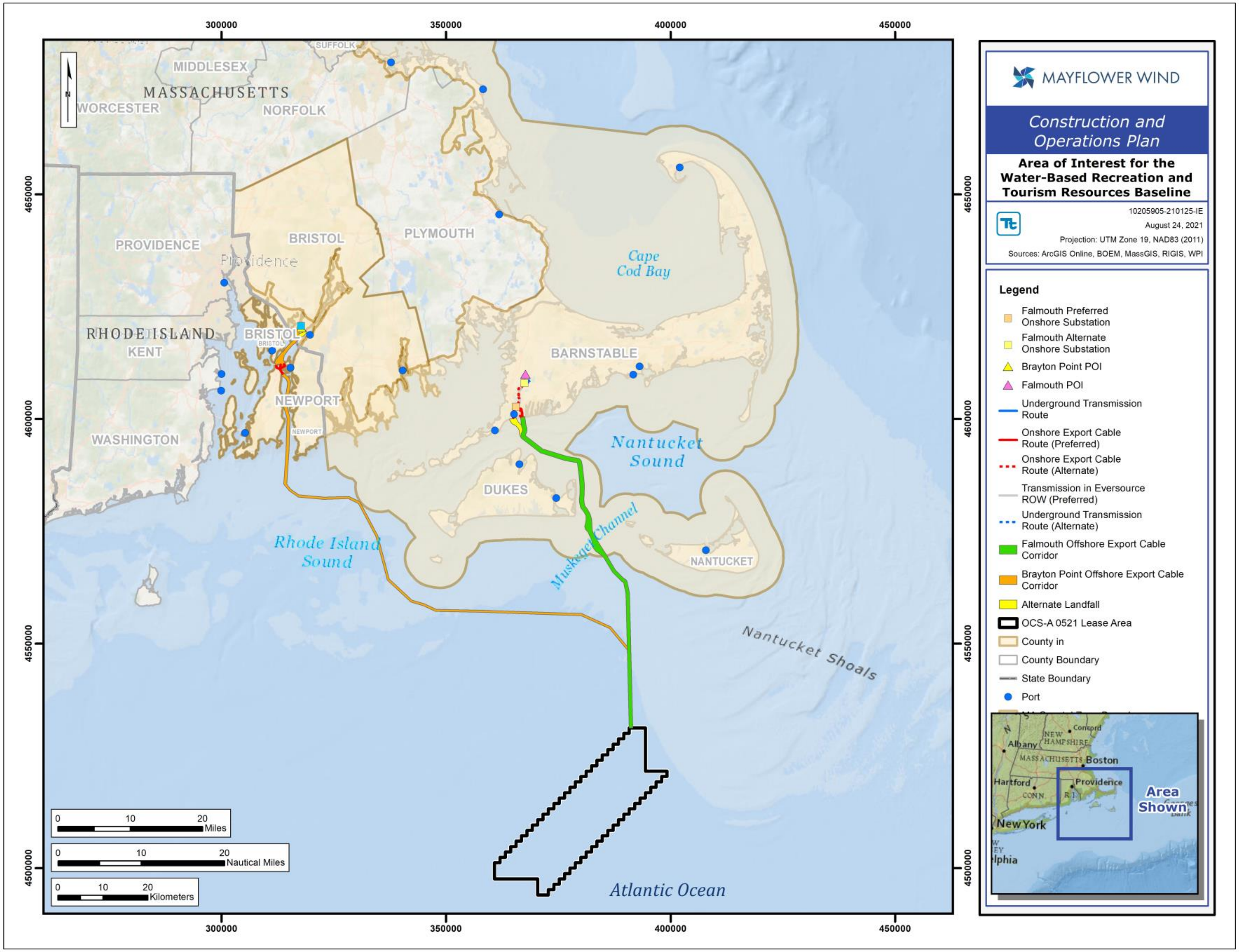


FIGURE 10-7. AREA OF INTEREST FOR THE WATER-BASED RECREATION AND TOURISM RESOURCES BASELINE

Barnstable County's recreation and tourism sectors are supported by close to 300 lodging services and approximately 869 food and drink establishments, which generated nearly $300 million and $700 million, respectively, in annual revenue in 2012. Approximately 32 percent of the 62,705 residential units located in Barnstable County are used for seasonal, occupational, or occasional use (USCB, 2021).

Recreation and tourism are a large component to the economies of adjacent counties. Summer tourists and seasonal residents increase the population of Martha's Vineyard by a factor of ten, and Nantucket by five (Appendix T, Visual Impact Assessment). Consequently, these counties, as well as the other adjacent counties, include many lodging facilities offering short term accommodations, food and drink establishments, and complete amenities.

Onshore construction and installation activities are not expected to directly affect communities outside the immediate area, but tourists based in other communities in the region may be indirectly affected. Recreation and tourism activities in Dukes and Nantucket Counties reflect those of Barnstable County. The Massachusetts Office of Travel & Tourism (2020) indicates that the adjacent counties contain hundreds of kilometers of coastline, many public beaches, harbors, marinas/boatyards, yacht clubs, and public boat launch facilities providing access to coastal waters. Dukes County has one federally protected area, Nomans Land Island NWR (USFWS, 2017) and nearly 40 percent (19,968 acres [8,100 hectares]) of Martha's Vineyard is conserved open space (Martha's Vineyard Commission, 2020). Nantucket also has one federally protected area, the Nantucket NWR, which accounts for 24 ac (9.7 ha) of federally protected land. Nearly 50 percent of Nantucket is conserved open space.

As for Barnstable County in general, most recreation and tourism in Falmouth, Massachusetts revolves around the coastlines and beaches. Nearshore recreational boating, including paddle sports, sport fishing, and diving are seasonally important recreational activities. Nearshore recreational activities, including canoeing, kayaking, and paddle boarding take place close to shore, in sheltered waters, and predominantly within 1 mile (1.6 km) of the coastline.

Falmouth offers many inland tourism activities such as restaurants, galleries, theaters, a diverse local music scene, golf, parks, hiking, camping, sightseeing, bird watching, agritourism, as well as scientific facilities such as the Woods Hole Oceanographic Institution and the Marine Biological Laboratory in Woods Hole on the southwestern tip of Falmouth, Massachusetts (Massachusetts Office of Travel & Tourism, 2020).

10.3.1.1.2 Brayton Point Onshore Project Area

The Brayton Point Onshore Project Area consists of the landfall and onshore Project infrastructure at Brayton Point in Somerset, Massachusetts as well as the intermediate landfall on Aquidneck Island, in Portsmouth, Rhode Island.

10.3.1.1.2.1 Bristol County (Massachusetts)

For the most part, recreation and tourism activities in Bristol County reflect those of Barnstable County. Bristol County covers twenty municipalities in the southeastern portion of the Commonwealth of Massachusetts bordering Rhode Island. Bristol County is home to a variety of recreational activities and locations, including Buttonwood Park, Freetown-Fall River National Forest, Horseneck Beach State Reservation, and New Bedford Whaling National Historic Park (Southeastern Massachusetts Visitors Bureau, 2021).

Bristol County can cater to a variety of different recreational users, including bikers, hikers, swimmers, fishermen, and campers (Southeastern Massachusetts Visitors Bureau, 2021). Inland marine recreational activity is popular within Bristol County as well. The main watercourses are the Taunton, Achushnet, Ten Mile, Westport, and Warren rivers, while North and South Watuppa ponds are the largest lakes (Brittanica, 2013). However, there are no recreational resources in the Bristol County portion of the Brayton Point Onshore Project Area, as it is entirely zoned for industrial purposes (see Section 12, Zoning and Land Use, for more information) and was the location of a coal-fired power plant which was decommissioned in 2017.

10.3.1.1.2.2 Newport County

The County of Newport, Rhode Island is home to six municipalities including the City of Newport, Jamestown, Little Compton, Middletown, Portsmouth, and Tiverton. Newport County is home to many popular tourism activities and was once termed "America's First Resort" (Rhode Island Commerce Corporation, 2021). Much of the tourism in Newport County is dominated by activity within the City of Newport.

Recreational activities in Newport are a combination of outdoor recreational activities (sailing, swimming, surfing, etc.), as well as indoor recreational activities (museum and mansion tours) (Rhode Island Commerce Corporation, 2021). A popular tourist destination within the City of Newport is the Cliff Walk, a 3.5-mile public access walk that traverses the eastern shore of the city. The City of Newport is situated in the southwest corner of the County of Newport, and Portsmouth, Rhode Island is situated in the northeast corner of the County.

10.3.1.1.2.3 Bristol County (Rhode Island)

Bristol County (Rhode Island) is an adjacent county to the Brayton Point Onshore Project Area. It is connected to Newport County and Aquidneck Island by the Mount Hope Bay Bridge. Bristol County (Rhode Island) is home to the towns of Barrington, Bristol, and Warren.

Onshore construction and installation activities are not expected to directly affect communities outside the immediate area with the exception of the Montaup Country Club, a semi-private golf course that is crossed by one of the Brayton Point onshore export cable routes of the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island (Montaup Country Club, n.d.). Tourists based in other communities in the region may be indirectly affected during construction.

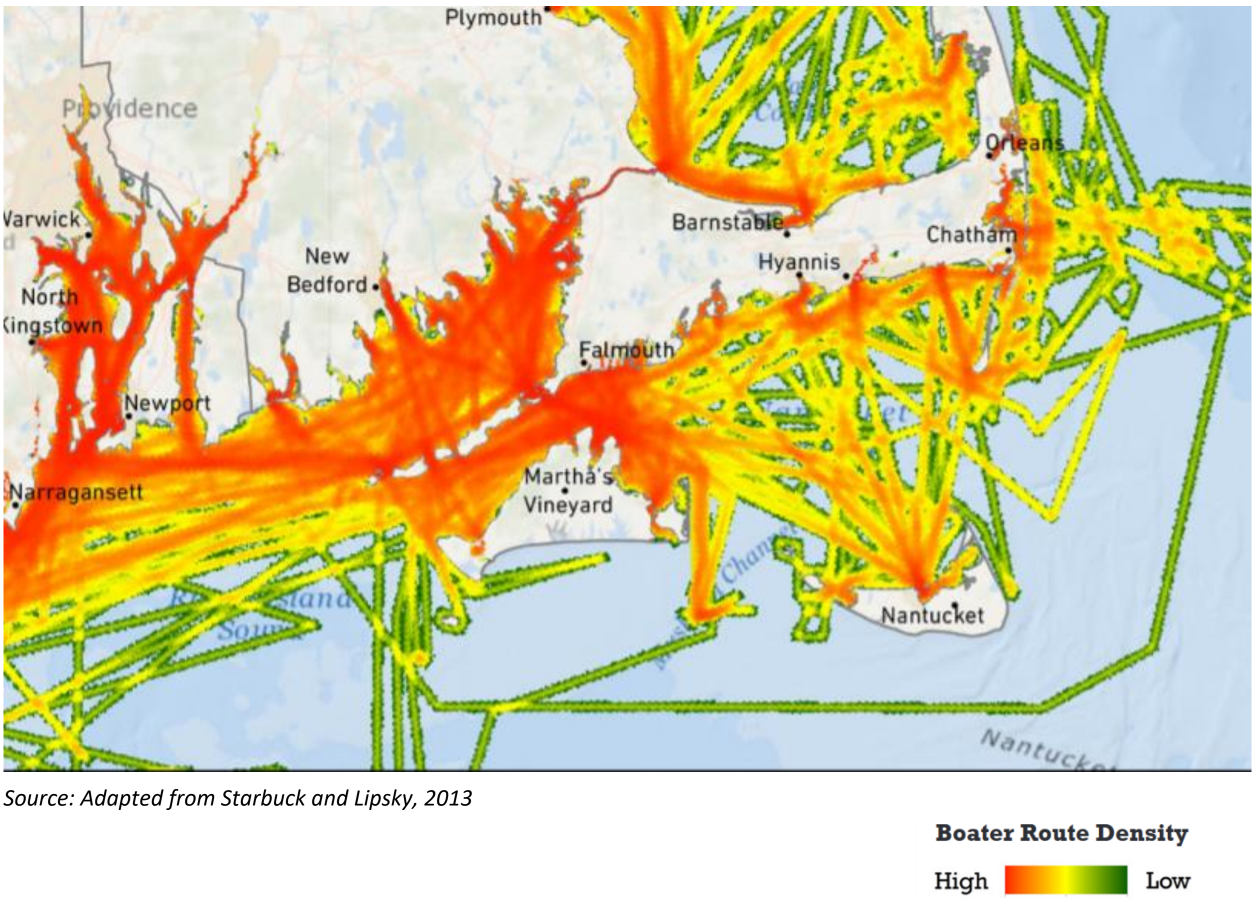
10.3.1.2 Water-based Recreation and Tourism Resources

Water-based recreation and tourism resources include those activities that occur within the Lease Area and along the export cable corridors. Water based recreational activities include fishing, boating races, parasailing, sailing, wildlife viewing, and deep-sea diving.

10.3.1.2.1 Boating

A 2012 survey of boating patterns and economic activity of 373,766 qualified registered boaters from Massachusetts, Maine, New Hampshire, Rhode Island, Connecticut, and New York found that the majority of recreational boating occurs within 3 nm (5.5 km) of shore and within state waters (Starbuck and Lipsky, 2013). Also, there were no known concentrated navigational routes of any significance near the Lease Area, although recreational boaters may transit within it. The survey identified 5,114 boating routes and 4,635 activity points (Starbuck and Lipsky, 2013). In Nantucket Sound, the boating routes with the highest density were located in the channel between Falmouth and Martha's Vineyard and north of the Nantucket Boat Basin (**Figure 10-8**), in and around the northern portion of the Falmouth export cable corridor. In Mount Hope Bay and the Sakonnet River, boating density was relatively even across the bay with less density towards the northern terminus (**Figure 10-8**).

Of the estimated 907,400 boating trips in ocean and coastal areas during 2012, 39 percent (262,649 trips) were attributed to vessels registered in Massachusetts and 7 percent (65,042 trips) were attributed to vessels registered in Rhode Island. Most boating trips occur between May and October, with a peak in July and August. The survey estimated that boaters with vessels registered in the study region (Massachusetts, Maine, New Hampshire, Rhode Island, Connecticut, and New York) spent almost $2 billion on recreational boating and related activities in 2012, of which $489 million occurred in Massachusetts and $134 million occurred in Rhode Island.



Source: Adapted from Starbuck and Lipsky, 2013

FIGURE 10-8. BOATER ROUTE DENSITY IN THE AREA OF INTEREST

10.3.1.2.2 Fishing

Fishing was the most frequently recorded activity for recreational boaters. Additional information and analysis on fishing activity in the vicinity of the Offshore Project Area is provided in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report. Recreational fishing vessels can launch from most harbors in the area of interest. The entire near-coastal region along with numerous offshore locations within the area of interest may host species targeted during recreational fishing (**Figure 10-9**). Several areas in the area of interest were considered popular locations for recreational fishing, including "The Dump," an approximately 64,000 ac (25,900 ha) Dumping Area identified on National Oceanic and Atmospheric Administration charts near the southerly end of the Massachusetts Wind Energy Area (MA WEA; Epsilon Associates, Inc., 2020). The Dump and other areas along the 20 and 30 fathom line ("The Owl," "The Star," and "Gordon's Gully") are popular locations for vessels targeting highly migratory and other recreational species.

A report to BOEM, *Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic* (Kirkpatrick et al., 2017), reported that most fishing activity was located along the coast near Falmouth, as well as Tisbury and Oak Bluffs on Martha's Vineyard. Although recreational fishing occurs year-round in the area of interest, it is more prominent during the warmer weather, and tends to follow the timing of migratory fish species' "run" through the area of interest, although the timing of offshore fishing is much less variable than nearshore fishing.

Estimations by BOEM indicated that approximately 4.4 percent of the nearly two million angler trips occurring in Massachusetts and 0.4 percent occurring in Rhode Island between 2007 and 2012 occurred within 1 mile (1.6 km) of the MA WEA (Kirkpatrick et al., 2017).

During that time period, recreational angler trips occurring within 1 mile (1.6 km) of the MA WEA most frequently originated from Tisbury, Nantucket, and Falmouth Harbors; while fewer than 600 angler trips originated from Rhode Island (Kirkpatrick et al., 2017). Furthermore, up to 60 saltwater fishing tournaments are held each year during the summer months in waters throughout the area of interest. The species most targeted during recreational fishing and the tournaments include Atlantic cod (*Gadus morhua*), black sea bass (*Centropristis striata*), bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), haddock (*Melanogrammus aeglefinus*), and bluefin and yellowfin tuna (*Thunnus thynnus* and *Thunnus albacares*).

Relaxing, swimming, and wildlife viewing were reported as less common activities. Wildlife viewing was mainly related to bird watching, accounting for 51 percent of all wildlife viewing. Most wildlife viewing in the area of interest occurred along the coast of Naushon, Gosnold, and Nashawena Islands, as well as along the eastern coast of Nantucket. The New Bedford Whaling National Historical Park provides whale watching activities within the Lease Area.

10.3.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

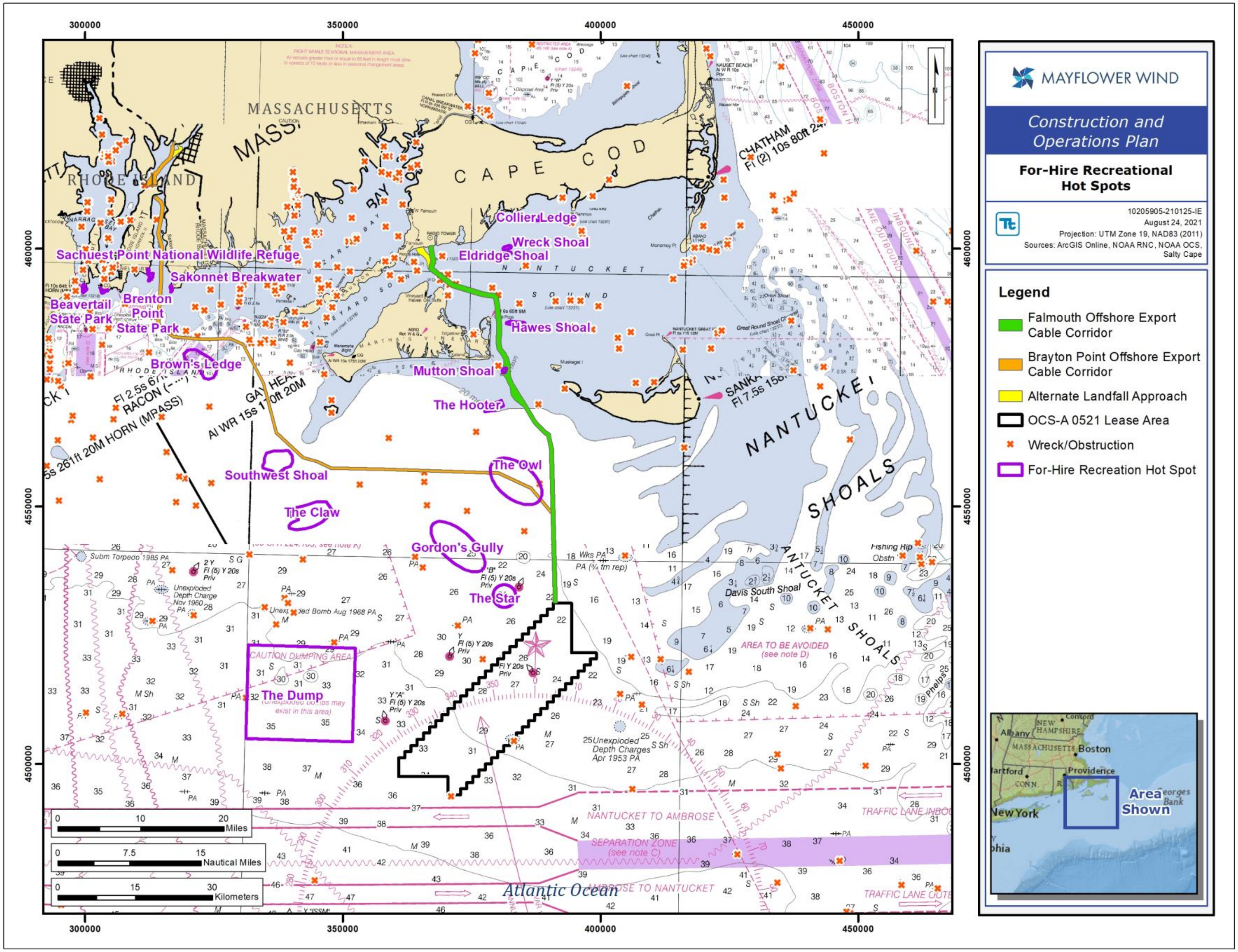


FIGURE 10-9. RECREATIONAL FISHING LOCATIONS

Effects to visual aesthetics is a concern for offshore wind projects, as ocean views are an important attractive factor for tourists to coastal areas. Project WTGs in the Lease Area could be visible from the elevated areas on Martha's Vineyard and Nantucket and their respective coastlines, depending on vegetation, topography, and atmospheric conditions. A change of the seascape could theoretically affect tourism-based activities as the scenery and setting may contribute to why tourists are drawn to the area. However, given the Lease Area's distance from the coast, Project WTGs will be difficult to see from the shoreline, especially during summer months (BOEM, 2012). These effects are described in Section 8, Visual Resources, and Appendix T, Visual Impact Assessment.

The development of the Brayton Point Onshore Project Area in Somerset, Massachusetts would redevelop a former existing industrial site. This will lead to an influx of positive socioeconomic impacts to the surrounding communities, including the creation of jobs, continued maintenance on the existing facility, and converting an existing industrial site to new uses as a renewable energy hub.

The majority of IPFs will occur in the local communities, specifically in Falmouth in Barnstable County, Somerset in Bristol County (Massachusetts), and Portsmouth in Newport County, and to a lesser degree in surrounding areas. Project effects to recreation and tourism resources will largely be associated with the installation and construction of the onshore and offshore components, as described in Section 3.3, Project Components and Project Stages. **Table 10-12** provides a summary of the potential effects from the proposed Project on recreation and tourism resources, and discussions for these effects are presented below.

10.3.2.1 Construction Areas and Traffic

The proposed Project may disrupt accessibility around the installation activities of onshore and offshore infrastructure. No direct installation activities will occur around the New Bedford MCT, on Martha's Vineyard or on Nantucket. Offshore disruptions may occur mostly along the export cable corridors in Nantucket Sound, and in the Lease Area.

10.3.2.1.1 Construction

The main potential effects to onshore recreation and tourism will arise from the disruption of accessibility due to traffic around onshore construction activities.

Temporary blockage of some roads during installation activities may restrict access to some local areas, although it is unlikely that access to specific establishments or tourist venues will be completely inhibited. As detailed in the Project construction schedule (Section 3, Description of Proposed Activities), the disruptions in access will occur for a short period at any given location as installation of equipment progresses along the underground onshore export cables and transmission line route. At the Falmouth landfall location and the Falmouth onshore substation area, installation activities may cause temporary restrictions of pedestrian access to limited areas. The converter station at Brayton Point is located on a site that has no pedestrian access.

TABLE 10-12. IPFS AND POTENTIAL EFFECTS ON RECREATION AND TOURISM IN THE AREA OF INTEREST

IPF	Potential Effects				Period of Effect		
	Project Component				Project Phase		
	Lease Area Infrastructure	ECCs	Landfall locations, Onshore Export Cables and Transmission Lines	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Construction Areas, Vehicle Traffic	-	-	Accessibility disruption; Reduced enjoyment	Accessibility disruption; Reduced enjoyment	X	X	X
Saturation of Tourism-related services (boat rentals, accommodations, outfitters, etc.)	Accessibility disruption	Accessibility disruption	Accessibility disruption	Accessibility disruption	X	X	X
Influx of non-local employees that could impact housing	Increase in demand for lodging	Increase in demand for lodging	Increase in demand for lodging	Increase in demand for lodging	X	-	X
Planned Discharges – Air Emissions	-	-	Reduced enjoyment	Reduced enjoyment	X	X	X

Mayflower Wind will develop an onshore construction schedule to minimize effects to recreational uses and tourism-related activities to the extent feasible, such as scheduling nearshore construction activities to avoid the height of the summer tourist season. Mayflower Wind will work with and coordinate with stakeholders/visitors' bureaus to schedule construction activities outside of major events taking place onshore. For example, Mayflower Wind does not anticipate HDD installation activities at the Falmouth landfall location between Memorial and Labor Day.

Mayflower Wind will work with the Towns of Falmouth, Somerset, and Portsmouth to develop a Traffic Management Plan to minimize disruptions to residences and commercial establishments in the vicinity of construction and installation activities. Construction monitoring would be implemented to ensure compliance with the Traffic Management Plan. Furthermore, an onshore construction schedule will be developed to minimize effects to neighboring recreation and seasonal tourism activities to the extent feasible, and the proposed Project will coordinate with stakeholders to schedule work activities outside of major events taking place onshore.

The main potential effects to offshore recreation and tourism during construction could arise from the disruption of vessel accessibility due to the installation of the offshore export cables, as well as the presence of Project-related vessel traffic involved in transportation of workers, equipment, and materials along the export cable corridors, and to a lesser degree in and transiting to the Lease Area.

While Project vessel traffic is not expected to markedly increase the levels of vessel traffic within the area of interest, the installation activities may potentially create navigation complications and restricted access to the immediate work locations. Further information regarding vessel traffic is provided in Appendix X, Navigation Safety Risk Assessment. This effect would mostly be felt through inshore traffic zones in Nantucket Sound where vessel traffic intensity is the highest. Effects may also be felt through any vessel traffic separation scheme in Nantucket Sound, and along the export cable corridors to the Lease Area. However, effects are generally not anticipated, as the current level of traffic is relatively light.

Therefore, the Project construction and installation phase may result in temporary but unlikely effects to recreational boating activities, mostly in the northern portions of the export cable corridors. Temporary effects may arise from the presence of Project-related vessels stationed at the work locations along the export cable corridors and in the Lease Area. Mayflower Wind will implement construction safety zones in consultation with the USCG and communicate to local mariners regarding upcoming and ongoing construction activities within the export cable corridors and the Lease Area.

10.3.2.1.2 Operations and Maintenance

During the O&M phase, activities will consist of equipment and infrastructure maintenance. Periodic maintenance and repairs could have temporary effects on recreation and tourism similar to work on any other utility infrastructure, including short-term effects due to traffic. These effects will be addressed as described above in Section 10.3.2.1.1.

10.3.2.1.3 Decommissioning

Subject to future discussions, it is envisioned that the onshore components will be left in place for possible future reuse. WTGs and OSPs will be disconnected, dismantled, and removed the at the end of their operational life. The inter-array cables and offshore export cables may be retired in place or removed. Decommissioning activities and their effects will be similar to the construction phase but less intensive. Potential effects will be addressed as described above. Mayflower Wind will implement decommissioning safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing decommissioning activities within the export cable corridors and the Lease Area.

10.3.2.2 Saturation of Tourism-related Services (Boat Rentals, Outfitters, etc.)

10.3.2.2.1 Construction

It is possible that the Project activities at the New Bedford MCT and other local ports will limit access to some activities requiring port services and boat rentals. However, due to the volume of ports serving the region, recreational and tourism activities involving vessel charters are not expected to be meaningfully affected. The increased demand in vessel charters to ferry Project workers, materials, and equipment to and from the Offshore Project Area will provide a source of business during the offseason.

Nearshore recreational activities, such as beaches, snorkeling, paddle sports, windsurfing, personal watercraft, water skiing, etc. are not likely to occur within the export cable corridors or Lease Area and therefore will not be affected by Project construction.

10.3.2.2.2 Operations and Maintenance

No negative effects are expected from Project operation and maintenance on offshore recreational resources. Navigation through the Lease Area, particularly for smaller vessels, should not be affected due to the 1 nm x 1 nm (1.9 km x 1.9 km) grid layout (See Section 11, Commercial and Recreational Fisheries and Fishing Activity). The intensity and locations of recreational fishing within the Lease Area are not expected to be affected. In fact, the proposed Project may provide some positive effects to recreational fisheries by creating new fish-friendly habitats for certain species (Kirkpatrick et al., 2017). It has been recognized that the Project infrastructure (WTGs and OSPs) may function as fish aggregating devices (BOEM, 2012) and provide additional habitat for certain species. This may result in an increased interest in recreational fishing within the Lease Area.

The Project components, including the offshore export cables, the WTGs, and OSPs will be monitored and controlled remotely from the proposed Project's O&M Facilities. While unlikely, any unplanned maintenance or repair of the offshore infrastructure would be of short duration and very localized. Furthermore, the Project will implement a comprehensive communication plan and a Fisheries Communication Plan (see Appendix W) to keep relevant marine stakeholders informed of the Project activities, especially during the construction and decommissioning phases. This will include the distribution of notices to inform mariners of Project-related activities within the offshore export cable corridors and Lease Area.

Furthermore, the Project WTGs may provide recreational opportunities. One study of Delaware beachgoers found that 45 percent of respondents would be interested in boat tours to an offshore wind facility (Lilley et al., 2010). Another study published by University of Rhode Island found that nightly reservations, occupancy rates (19 percent), and monthly revenues for AirBnB properties on Block Island in July and August increased significantly following construction of the Block Island Wind Farm. The study concluded that offshore wind farms could act as an attractive feature of a location, rather than a deterrent (Carr-Harris and Lang, 2019). As noted in above, many vessel and sightseeing operators located in the area of interest may provide excursions to the Lease Area. As there is no intention to limit access to the Lease Area, recreational and tourism activities in the Lease Area should not be affected.

10.3.2.2.3 Decommissioning

As described in Section 3.3.19, Conceptual Decommissioning, subject to future discussions, it is envisioned that the onshore components will be left in place for possible future reuse. Therefore, it is expected that no land-based recreation and tourism resources will be affected during Project decommissioning.

The WTGs and OSPs will be disconnected, dismantled, and removed at the end of their operational life. The inter-array cables and offshore export cables may be retired in place or removed. Decommissioning activities will be similar to the construction phase but less intensive. Access to some activities requiring port services and boat rentals will only be marginally affected. Therefore, the Project decommissioning phase may result in temporary but unlikely effects to recreational activities. Potential effects will be addressed as described above.

10.3.2.3 Influx of Non-local Employees that Could Impact Housing

10.3.2.3.1 Construction and Decommissioning

The influx of workers to the area, especially during the construction and decommissioning phases, has the potential to create business activity during offseason while only marginally reducing the availability of rental housing and accommodations for tourists. Mayflower Wind recognizes that infrastructure projects affect local activities during construction and is committed to working cooperatively with state and local officials to minimize impacts on housing availability. As discussed in Section 10.1, the presence of Project workers is expected to affect short-term lodging occupancy only marginally in the area. It is unlikely that the proposed Project will affect the availability of lodging for recreationists and tourists.

10.3.2.4 Planned Discharges – Air Emissions

10.3.2.4.1 Construction and Decommissioning

Construction related air pollutants may affect the enjoyment of recreation and tourism resources in the immediate vicinity of the construction activities. Onshore construction and installation activities will require the use of construction equipment and vehicles which emit air pollutants, such as flatbed trucks, backhoe tractors, concrete trucks, trenching vehicles, etc. Effects to air quality are discussed in more detail in Section 5.1, Air Quality, and Appendix G, Air Emissions Report. This increase in air pollutants may cause annoyance and decrease enjoyment of recreation and tourism resources while construction is happening. It is anticipated that these effects will occur only during (and in the immediate vicinity of) the construction and installation activities.

The proposed Project will implement best management practices to minimize potential effects. Also, an onshore construction schedule will be developed to minimize effects to neighboring communities to the extent feasible. Onshore construction activities will comply with regulatory authority requirements. Further avoidance, minimization, and mitigation measures related to air emissions are described in Section 5.1, Air Quality.

10.3.2.4.2 Operations and Maintenance

Periodic maintenance and repairs could have temporary effects on recreation and tourism, similar to work on any other utility infrastructure, including effects to air quality. These effects will also be addressed as described above.

11 Commercial and Recreational Fisheries and Fishing Activity

Fishing was one of the Commonwealth of Massachusetts' first industries. Commercial and recreational (for-hire charters, private anglers) fisheries are important economic and cultural activities that occur in state and federal waters off the coast of Massachusetts, Rhode Island, and other nearby states. This section describes and analyzes commercial and recreational fisheries and fishing activity that has the potential to occur in the Offshore Project Area, followed by an evaluation of potential Project-related effects and corresponding potential avoidance, minimization, and mitigation measures.

Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report, describes in detail the data from various databases, studies, and assessments used to identify the types, values of fisheries, as well as commercial and recreational fishing activity near and in the Offshore Project Area. Appendix V provides a full overview of the commercial and recreational fish species and fishing effort and landing data for important species in the Offshore Project Area. This section summarizes the information from Appendix V and incorporates relevant elements and information from the proposed Project's construction, O&M, and decommissioning phases to evaluate the potential for effects of the proposed Project on commercial and recreational fisheries and fishing activity. In accordance with BOEM guidance (BOEM 2020a), these elements include the best available literature and science used to document past and current trends in fishing activity and are described in full in Appendix V. Supporting information from elsewhere in the COP, not explicitly presented in this section or Appendix V but relevant to this section, used to support the evaluation is also included in:

- Section 5.2, Water Quality
- Section 6.6, Benthic and Shellfish and Appendix M, Benthic and Shellfish Resources Characterization Report
- Section 6.7, Finfish and Invertebrates
- Section 10.1, Demographics, Employment, and Economics
- Section 13, Navigation and Vessel Traffic, and Appendix X, Navigation Safety Risk Assessment
- Appendix N, Essential Fish Habitat Assessment and Finfish Study Report
- Appendix W, Mayflower Wind Fisheries Communication Plan
- Appendix U2, Underwater Acoustic Assessment

11.1 Affected Environment

The Offshore Project Area includes the Lease Area, two offshore export cable corridors, three landfall locations in Falmouth, Massachusetts, and two landfall locations at Brayton Point in Somerset, Massachusetts, and four landfalls under consideration for the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island.

The proposed Project is located within the MA/RI WEA (**Figure 11-1**) as well as the MA WEA, hereinafter referred to as the "Kirkpatrick Study Area," following the analysis contained within (Kirkpatrick et al., 2017). Collectively, the MA/RI WEA consists of: Lease OCS-A 0486 (Revolution Wind), OCS-A 486/530 (Sunrise Wind), OCS-A 517 (South Fork Wind), Lease OCS-A 0500 (Bay State Wind), Lease OCS-A 0501 (Vineyard Wind 1), Lease OCS-A 0534 (Vineyard Wind South), Lease OCS-A 0520 (Beacon Wind), Lease OCS-A 0521 (Mayflower Wind), and Lease OCS-A 0522 (Vineyard Wind 2).

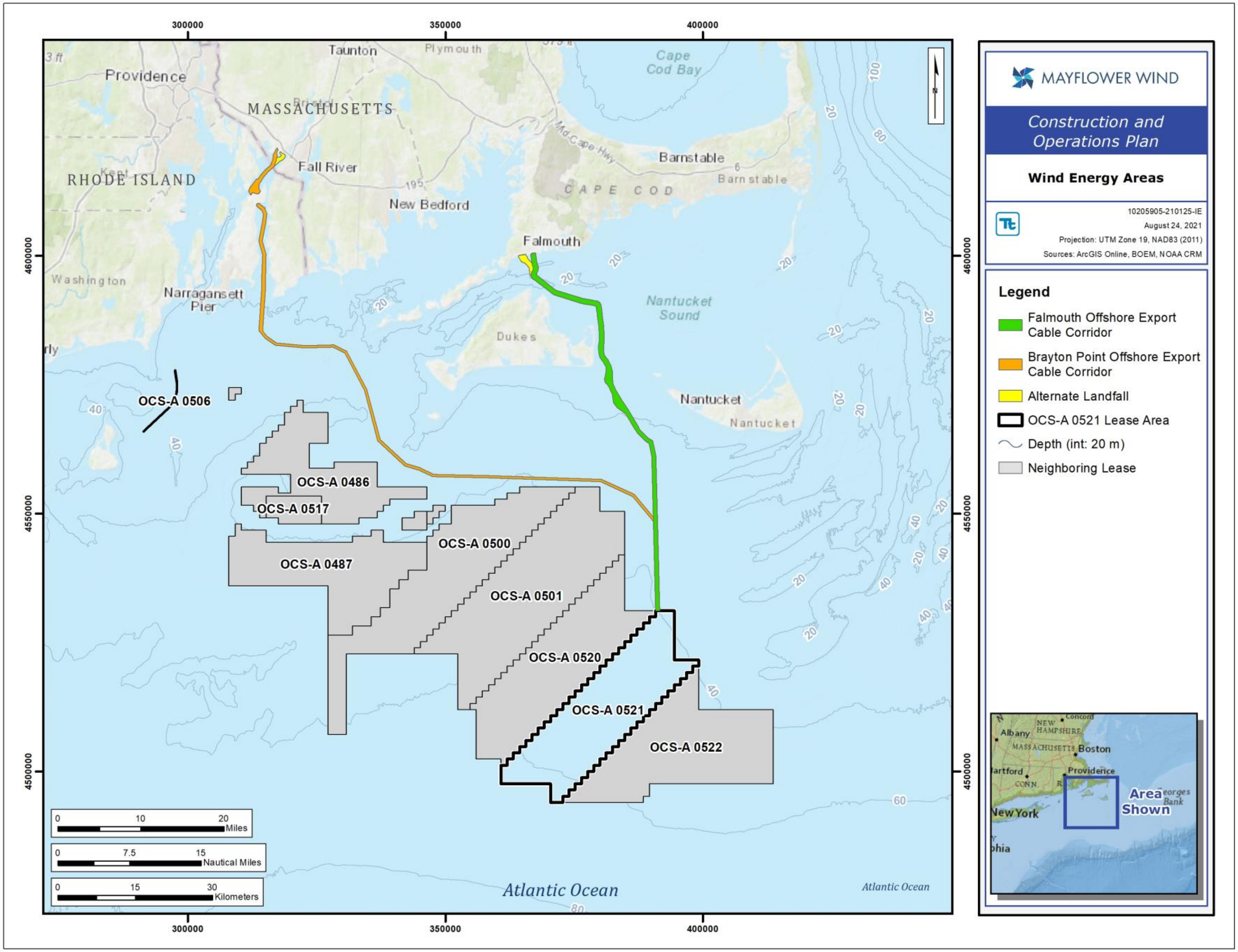


FIGURE 11-1. MASSACHUSETTS/RHODE ISLAND WIND ENERGY AREAS

11.1.1 Data Sources

This section was written using BOEM's BMPs to address potential conflicts between commercial wind energy lessees and commercial fishermen (BOEM, 2014, 2020a). These practices include:

- The development of a Fisheries Communication Plan (Appendix W) with the aid of a Fisheries Liaison Officer (FLO) and a Fisheries Representative (FR),
- Input from the commercial fishing industry on Project siting, design, navigation, and access, and
- Process for financial compensation to commercial fishermen for damages or loss to fishing gear from Project activities.

Fisheries data and information are collected in various ways (e.g., commercial permit holders that self-report their catches, independent observers on the vessels, landings data at the ports, etc.). Data collection also includes supplemental fishing data and information provided by fishermen, federal and state government agencies, and academic and non-governmental institutions. This section is based on a review of published scientific literature and publicly available technical data/reports, including vessel-based monitoring databases and synthesis reports conducted for other offshore wind facilities in the northern U.S. Atlantic. Data collected during various geophysical and geotechnical field surveys conducted for the proposed Project were also used to inform this assessment.

Table 11-1 and **Table 11-2** list the data sources used to provide information regarding the landed weight and dollar value of specific species, the type of fishing gear deployed, and the geographic location of fishing activity for commercial and recreational fisheries.

TABLE 11-1. COMMERCIAL FISHERIES DATA SOURCES

Federal Data Sources			
Source	**Data**	**Study Area**	**Citations and Links**
NMFS	VTRs	Mayflower Wind Offshore Project Area (OCS-A-0521)	B. Galuardi, personal communications, 6 October 2020 and 2 July 2021.
	Commercial fishing revenue maps based on VTRs	State and federal waters	GARFO, 2020
			B. Galuardi, personal communication, 6 October 2020.
	Annual Commercial Landing Statistics	State and federal waters	NMFS, 2021a
	Socioeconomic impacts of Atlantic offshore wind development	All Atlantic OCS offshore wind energy lease areas	NMFS, 2020a
	Commercial fisheries landings and values	Mayflower Wind Lease Area, export cable corridors, nearby offshore wind energy lease areas	NMFS, 2020a; B. Galuardi, personal communications, 6 October 2020 and 2 July 2021.
NMFS Law Enforcement	VTR raw position report data (in the form of polar histograms)	Mayflower Wind Lease Area	NMFS, 2020d

Federal Data Sources			
Source	**Data**	**Study Area**	**Citations and Links**
Atlantic Coastal Cooperative Statistics Program (ACCSP)	Comprehensive, species-specific landings database	State and federal waters	ACCSP, 2021
BOEM	Report: Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic	Massachusetts Wind Energy Area (federal waters)	Kirkpatrick et al., 2017.
Northeast Regional Ocean Council (NROC)	Visualization and mapping of Vessel Monitoring System (VMS) data	State and federal waters	NROC, 2009
MA DMF	Annual Landings Reports	State waters, statistical reporting areas 10 (Nantucket Sound) and 12 (waters south of Muskeget Channel)	MA DMF, 2018a
CZM	Massachusetts Ocean Management Plan	State waters	MA CZM, 2015
CRMC	CRMC Federal Consistency Manual	State and federal waters	CRMC, 2018
CRMC	Rhode Island Ocean Special Area Management Plan (SAMP), Chapter 5 “Commercial and Recreational Fisheries”	State and federal Waters	CRMC, 2010
Mayflower Wind	Stakeholder outreach and engagement	State and federal waters	Appendix A, Agency Correspondence; Appendix X, Navigation Safety Risk Assessment
	Geotechnical and geophysical surveys and scouting reports	Mayflower Wind Lease Area, export cable corridors, nearby offshore wind energy lease areas	Mayflower Wind Energy LLC. 2021. Appendix E, Marine Site Investigation Report

TABLE 11-2. RECREATIONAL FISHERIES DATA SOURCES

Source	Data	Study Area	Citation and Link
Massachusetts Recreational Saltwater Fishing Regulations	Information on commonly caught recreational fish species and regulations information	State waters	Massachusetts Saltwater E-Regulations, 2020
Rhode Island Recreational Saltwater Fishing Regulations	Information on recreational fishing size and possession limits within Rhode Island	State waters	RIDEM, 2021a
NOAA Marine Recreational Information Program	Recreational Fisheries Statistics	Federal waters	B. Galuardi, personal communication, 2 July 2021.

11.1.1.1 Economic Overview of Commercial Fisheries in the Region

A diverse array of commercial fishing activity occurs in the region. Specific fisheries resources are targeted for the purpose of marketing these fish and shellfish for profit (B. Galuardi, personal communication, 6 October 2020). Fisheries resources are targeted in the region and within the Offshore Project Area by vessels of different sizes using different gear types and are dictated by seasons, quotas, environmental factors, market forces, and federal and state-led regulations.

In 2019, ports in Massachusetts landed 234.3 million pounds of fish valued at $680.03 million (NMFS, 2021b). The most commonly landed species in Massachusetts by weight were sea scallops, haddock, and shortfin squid. The most commonly species landed by value were sea scallops, American lobster, and eastern oyster (ACCSP, 2021). The Port of New Bedford is consistently the highest valued port in the United States, landing 115.8 million pounds of fish in 2019, worth approximately $450.8 million, accounting for 66 percent of the entire revenue from all commercial fish landings in Massachusetts.

In 2019, ports in Rhode Island landed 78.8 million pounds of fish valued at $109.25 million (B. Galuardi, personal communication, 2 July 2021). The most commonly landed species in Rhode Island by weight were shortfin squid, longfin squid, and butterfish. The highest landed species by value were sea scallops, longfin squid, and American lobster (B. Galuardi, personal communication, 2 July 2021). Point Judith is the highest valued port in Rhode Island (and the twelfth highest valued in the U.S. in 2019) with a value of $66 million in 2019, roughly 60 percent of the state's total landings (NMFS, 2021b; **Table 11-4**).

While the fishing activity in the Offshore Project Area (and particularly the Lease Area) is relatively lower than in other areas of the region, there are commercial fishing vessels from Massachusetts, Rhode Island, and other states that fish in the Offshore Project Area. Fish caught in the Offshore Project Area may be landed in other states besides Massachusetts and Rhode Island. Based on the discussion of landings and ports in this section and also in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report, landings from commercial fisheries in Massachusetts, Rhode Island, Connecticut, New York, and New Jersey in 2019 are shown in **Table 11-3**. This, along with the exposure analysis (Kirkpatrick et al., 2017), allows for landings from the Offshore Project Area to be better understood in the larger context in which fisheries exist and fishing activity is conducted. As discussed below, exposure is defined in the Kirkpatrick et al., study as "the potential for an impact from WEA development" (Kirkpatrick et al., 2017).

TABLE 11-3. COMMERCIAL LANDINGS IN MASSACHUSETTS, RHODE ISLAND, CONNECTICUT, NEW YORK, AND NEW JERSEY, 2019

Rank	Species	Pounds (lbs.)	Species	Dollars ($)
1	Menhaden	86,113,435	Sea scallop	$525,585,154
2	Shortfin squid	58,196,016	American lobster	$108,458,206
3	Sea scallop	55,837,828	Longfin squid	$42,195,146
4	Atlantic surfclam	34,362,291	Eastern oyster	$37,294,451
5	Longfin squid	26,997,528	Atlantic surfclam	$29,229,303
6	Monkfish	20,926,409	Shortfin squid	$27,316,141
7	American lobster	19,181,793	Haddock	$18,267,804
8	Haddock	18,737,505	Summer flounder	$17,300,186
9	Winter skate	17,399,657	Northern quahog	$16,947,565
10	Jonah crab	15,105,753	Menhaden	$14,938,549
Total Pounds Landed (all species)		**521,182,338**	**Total Value (all species)**	**$1,031,016,212**

Source: NMFS, 2021a

Several ports in the vicinity of the Offshore Project Area are among the thirty ports in the country with the highest landings and highest revenue; including three ports that are in both categories, Gloucester, Massachusetts, New Bedford, Massachusetts, and Point Judith, Rhode Island (**Table 11-4**).

TABLE 11-4. PORTS WITH THE HIGHEST LANDINGS NEAR THE OFFSHORE PROJECT AREA, 2019

Port	Rank	Landings (millions of pounds)	Port	Rank	Value (millions of dollars)
New Bedford, MA	14	115.8	New Bedford, MA	1	$450.8
Cape May-Wildwood, NJ	16	94.5	Point Judith, RI	12	$65.9
Gloucester, MA	18	50.2	Gloucester, MA	15	$56.6
Point Judith, RI	29	48.1			

Source: NMFS, 2021a

11.1.1.1.1 Ports in the Offshore Project Area

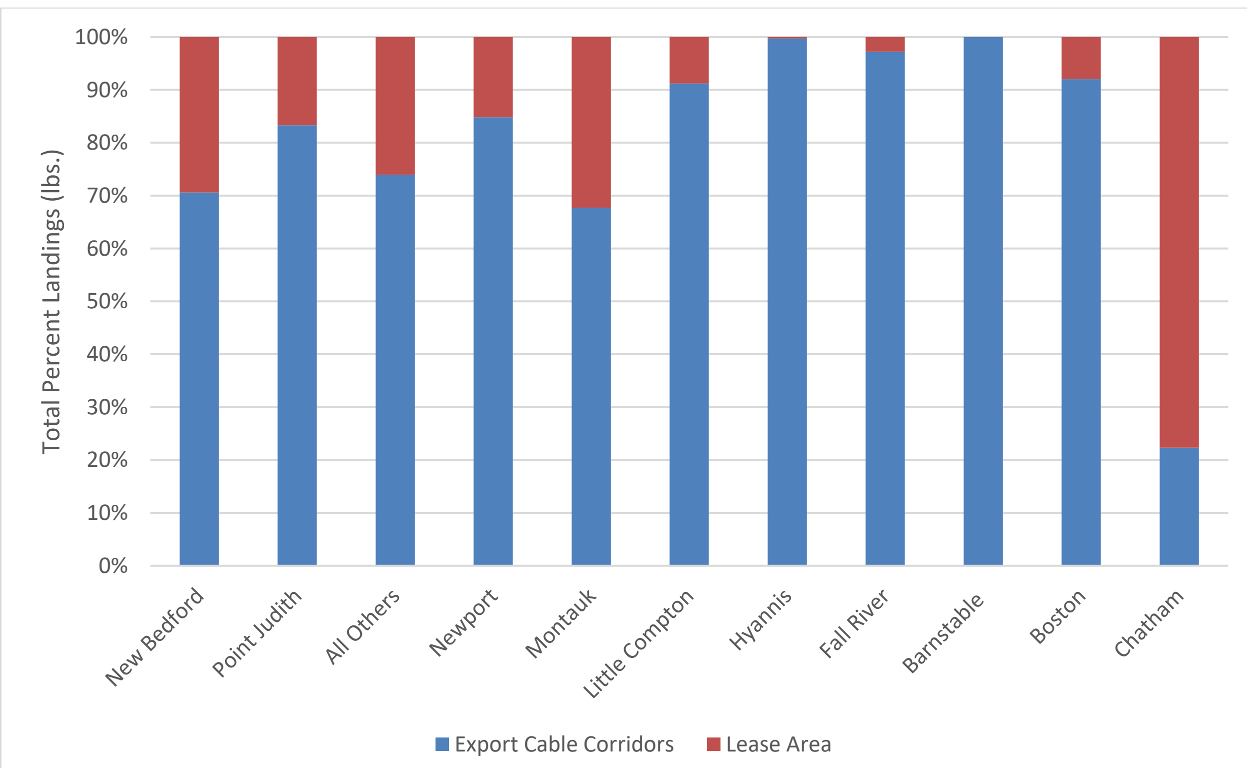
The total landings and values from the Offshore Project Area per port over an 11 year period (2008 to 2018) are shown in **Table 11-5** and **Figure 11-2**. The top three by weight are New Bedford, Massachusetts, Point Judith, Rhode Island and "All Others". Ports listed as "All Others" are, like other landings data tied to other strata reported in this NMFS VTR data that are listed as "All Others", listed this way because of confidentiality constraints. Records that did not meet the 'rule of three' (i.e., data that is not tied to three or more unique dealers and three or more unique permits) were anonymized, aggregated, and reported as "All Others".

TABLE 11-5. TOTAL LANDINGS & VALUE (2008 TO 2018) FOR TOP 10 PORTS IN OFFSHORE PROJECT AREA

Port Landed	Total Landings (lbs.)	Total Value (dollars)
New Bedford	9,591,243	$4,937,433
Point Judith	9,013,605	$9,201,998
All Others	2,164,719	$2,596,186
Newport	1,547,655	$671,080
Montauk	1,392,942	$1,607,004
Little Compton	1,106,747	$1,418,273
Hyannis	673,949	$925,239
Fall River	635,484	$154,985
Barnstable	519,011	$564,801
Boston	327,173	$153,578
Total for All Ports	**29,638,843**	**$25,721,058**

Source: B. Galuardi, personal communication, 6 October 2020; NMFS, 2021a

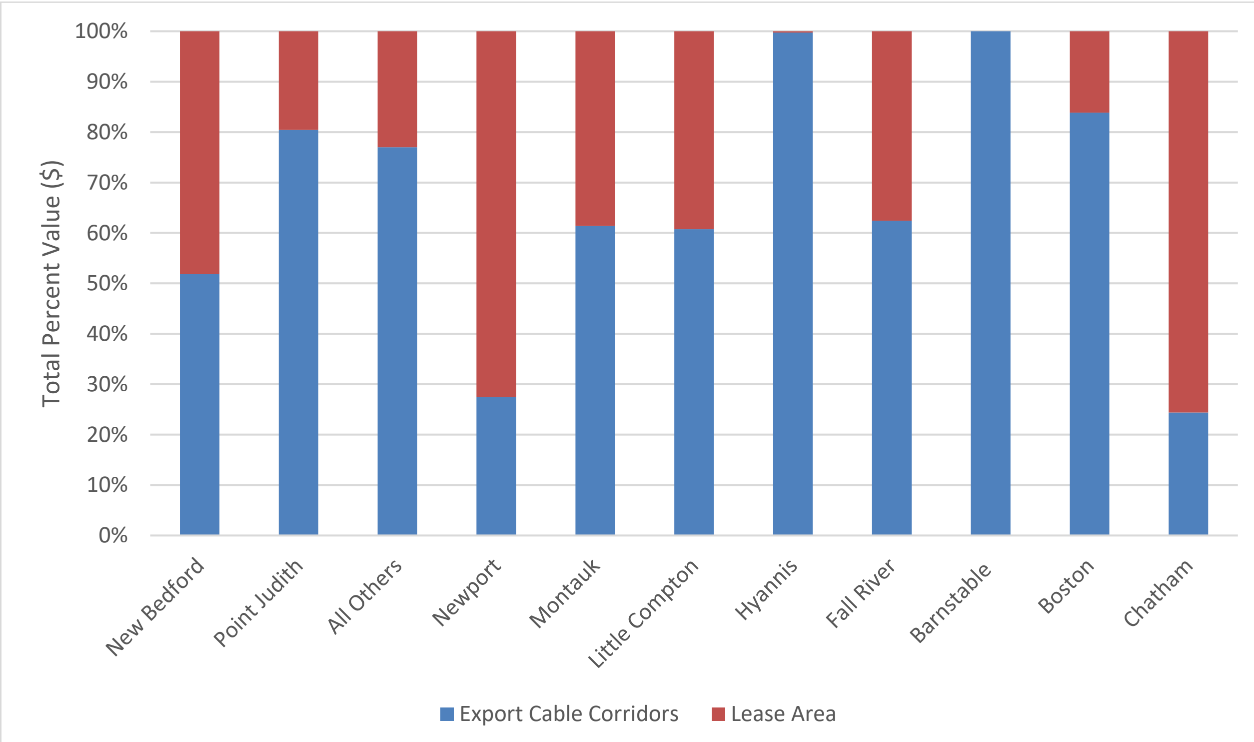
As shown in **Figure 11-2**, the top ports are represented by percentages for landings per the Lease Area and export cable corridors. For all ports aside from Chatham, the majority of landings were caught within the export cable corridors.



Source: B. Galuardi, personal communications, 6 October 2020 and 2 July 2021

FIGURE 11-2. TOTAL PERCENT LANDINGS FOR TOP 10 PORTS IN OFFSHORE PROJECT AREA

As shown in **Figure 11-3**, the top ports are represented by percentages for value per the Lease Area and export cable corridors. For the ports of Chatham Massachusetts and Newport, Rhode Island, the majority of the value is from the Lease Area. For all other ports, the majority of fish value is in the export cable corridors.



Source: B. Galuardi, personal communications, 6 October 2020 and 2 July 2021

FIGURE 11-3. TOTAL PERCENT VALUE FOR TOP 10 PORTS IN OFFSHORE PROJECT AREA

The top 10 ports with the highest annual average landings based on annual totals from 2008 to 2018 in the Offshore Project Area are shown in **Table 11-6**. The category noted as "All Others" is due to the confidentiality restraints discussed above. Therefore, this category may contain the composite landings representing other smaller ports within the region. The annual average landings between 2008 and 2018 for "All Others" was 196,793 pounds and average value was $236,017.

When considering ports with a sufficient number dealers or unique permits to result in landings data that can be reported, the top three are New Bedford, Massachusetts, Point Judith, and Newport, Rhode Island. Descriptions of these ports, including species commonly landed, can be referenced in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

TABLE 11-6. AVERAGE ANNUAL LANDINGS & VALUE FOR TOP 10 PORTS IN OFFSHORE PROJECT AREA

Port Landed	Average Yearly Landings (lbs.)	Average Yearly Value (dollars)
New Bedford	871,931	$ 448,858
Point Judith	819,419	$ 836,545
All Others	196,793	$ 236,017
Newport	140,696	$ 61,007

Port Landed	Average Yearly Landings (lbs.)	Average Yearly Value (dollars)
Montauk	126,631	$ 146,091
Little Compton	100,613	$ 128,934
Hyannis	61,268	$ 84,113
Fall River	57,771	$ 14,090
Barnstable	47,183	$ 51,346
Boston	29,743	$ 13,962
Total for All Ports	**2,694,440**	**$ 2,338,278**

Source: B. Galuardi, personal communications, 6 October 2020 and 2 July 2021

The top 10 ports with the highest annual average landings based on annual totals from 2008 to 2018 in the Lease Area are shown in **Table 11-7**. The annual average landings for "All Others Ports" was 51,339 pounds and its average value was $46,048. When considering ports with more dealers or unique permits, the top three in the Lease Area are New Bedford, Point Judith, and Montauk.

TABLE 11-7. AVERAGE ANNUAL LANDINGS & VALUE FOR TOP 10 PORTS IN THE LEASE AREA

Port Landed	Average Yearly Landings (lbs.)	Average Yearly Value (dollars)
New Bedford, MA	165,235	$ 100,033.45
Point Judith, RI	136,844	$ 119,537.64
All Others	51,339	$ 46,048.09
Montauk, NY	40,886	$ 47,652.45
Chatham, MA	24,702	$ 22,327.27
Gloucester, MA	24,667	$ 3,211.09
Newport, RI	21,369	$ 19,247.82
Little Compton, RI	8,853	$ 7,443.00
Fairhaven, MA	8,106	$ 7,465.27
Westport, CT	5,882	$ 7,233.36
Total for All Ports	**510,128**	**$ 403,983**

Source: B. Galuardi, personal communications, 6 October 2020 and 2 July 2021

The top 10 ports with the highest annual average landings based on annual totals from 2008 to 2018 in the Falmouth export cable corridor are shown in **Table 11-8**. The annual average landings for all other ports was 60,409 pounds and its average value was $150,393.91. When considering ports with more dealers or unique permits, the top three in the Falmouth export cable corridor are Point Judith, New Bedford, and Hyannis.

TABLE 11-8. AVERAGE ANNUAL LANDINGS & VALUE FOR TOP 10 PORTS IN THE FALMOUTH EXPORT CABLE CORRIDOR

Port Landed	Average Yearly Landings (lbs.)	Average Yearly Value (dollars)
Point Judith, RI	418,031	$ 468,558.64
All Others	60,409	$ 150,393.91
New Bedford, MA	131,237	$ 83,419.73

Port Landed	Average Yearly Landings (lbs.)	Average Yearly Value (dollars)
Hyannis, MA	58,783	$ 80,527.55
Montauk, NY	63,752	$ 73,458.09
Barnstable, MA	44,574	$ 48,887.91
Falmouth, MA	15,371	$ 23,797.36
New London, CT	9,191	$ 9,799.82
Boston, MA	7,411	$ 8,062.91
Vineyard Haven, MA	977	$ 7,481.18
Total for All Ports	**846,438**	**$ 1,000,726**

Source: B. Galuardi, personal communications, 6 October 2020 and 2 July 2021

The top 10 ports with the highest annual average landings based on annual totals from 2008 to 2018 in the Brayton Point export cable corridor are shown in **Table 11-9**. The annual average landings for all other ports was 85,044 pounds and its average value was $40,282. When considering ports with more dealers or unique permits, the top three in the Brayton Point export cable corridor were New Bedford, Point Judith, and Newport.

TABLE 11-9. AVERAGE ANNUAL LANDINGS & VALUE FOR TOP 10 PORTS IN THE BRAYTON POINT EXPORT CABLE CORRIDOR

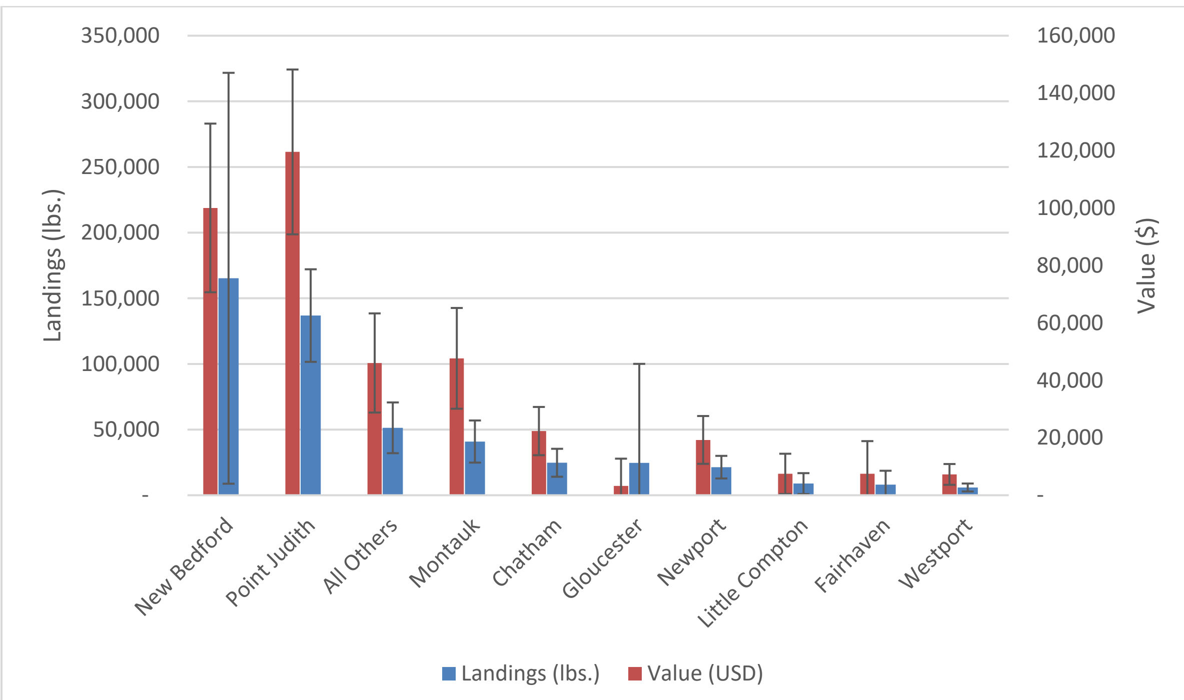
Port Landed	Average Yearly Landings (lbs.)	Average Yearly Value (dollars)
New Bedford, MA	575,459	$ 265,404
Point Judith, RI	264,544	$ 248,449
Newport, RI	114,982	$ 37,928
Little Compton, RI	91,258	$ 120,977
All Others	85,044	$ 40,282
Fall River, MA	56,161	$ 13,358
Gloucester, MA	28,054	$ 4,226
Montauk, NY	21,992	$ 24,981
Boston, MA	19,966	$ 3,646
Barnstable, MA	2,609	$ 2,458
Total for All Ports	**1,331,827**	**$ 910,751**

Source: B. Galuardi, personal communication, 2 July 2021

Figure 11-4, **Figure 11-5,** and **Figure 11-6** compare the average value and landings in the Lease Area and export cable corridors for the Top 10 ports respectively. Included, is a comparison of variability in annual values and landings by ports in each part of the Offshore Project Area. There is variability in annual average landings and values for each port, as shown by the standard deviation bars on these figures, indicating that the value and landings of species fluctuates between years, and that port value and landings are not consistent either from year-to-year or by fishing activity. It should also be noted that the Top 10 ports by Lease Area and export cable corridors fluctuate year-to-year and by port based on target species fished by fishermen in those ports.

Figure 11-4 shows the Top 10 ports in the Lease Area (B. Galuardi, personal communications, 6 October 2020 and 2 July 2021) with averaged fish landed and valued by port. Note that data available for each port is not consistent. This means that each port may not report value and landings for all years between 2008 and 2018. The top ports reported as fishing in the Lease Area include New Bedford, Point Judith, and Montauk. Collectively, all other ports landed an average of 51,339 pounds per year, valued at $46,048. The time series of data analyzed for each port is noted in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

Variability is demonstrated, for instance, in evaluation of the top port fishing in the Lease Area—New Bedford—which has reported value and landings from 2008 and 2018; those values range between approximately $30,000 and $78,000 and landings range between 33,000 and 177,000 pounds per year. Annual landings and values can be referenced in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

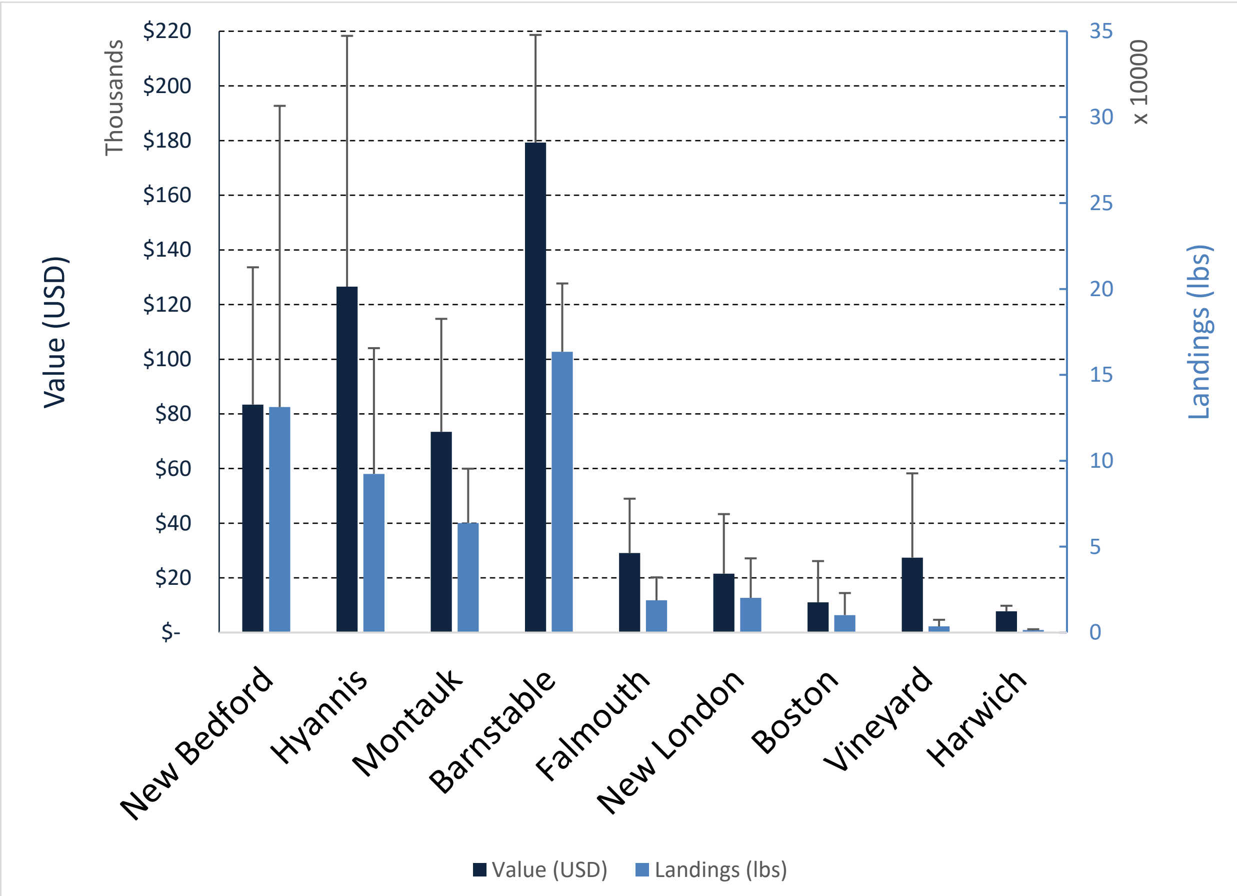


Source: B. Galuardi, personal communication, 6 October 2020

FIGURE 11-4. AVERAGE VALUE AND LANDINGS (±SD) FOR TOP PORTS IN THE LEASE AREA

Figure 11-5 shows the top 10 ports in the Falmouth export cable corridor (B. Galuardi, personal communication, 6 October 2020) with averaged fish landed and valued by port. Note that data available for each port is not consistent, meaning not each port reports value and landings for all years between 2008 and 2018. The top ports fishing in the export cable corridors are fishermen based in Point Judith (not shown on **Figure 11-5**), Hyannis, Barnstable, and New Bedford. The time series of data analyzed for each port is noted in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

Variability is again demonstrated, in evaluation of the value and landings reported from 2008 to 2018 by the top fishing port in the Falmouth export cable corridor—Point Judith— exhibit a standard deviation of approximately $300,000 and 250,000 pounds, respectively, between years. For the top nine ports, not including Point Judith, the value and landings range between approximately less than $10,000 and $126,000 and 2,000 and 91,000 pounds annually. Yearly statistics for each port can be referenced in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.



Source: B. Galuardi, personal communication, 6 October 2020

FIGURE 11-5. AVERAGE VALUE AND LANDINGS (±SD) FOR TOP PORTS IN THE FALMOUTH EXPORT CABLE CORRIDOR

Point Judith is the top port for fishing activity in the Falmouth export cable corridor, which is reflective of productive squid fishing locations at the entrance of Muskeget Channel and in Nantucket Sound. The full analysis can be referenced in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

Figure 11-6 shows the average value and landings from 2008 to 2018 for the top ten ports in the Brayton Point export cable corridor (B. Galuardi, personal communication, 2 July 2021). Note that the availability of data for each port is not consistent (e.g., each port may not report value and landings for every year between 2008 and 2018). The ports that exhibited the highest value and landings in the Brayton Point export cable corridor were from fishermen based in New Bedford, Point Judith, Newport, and Little Compton. The collective landings in all other ports were on average 85,044 pounds per year and a value of $40,282.

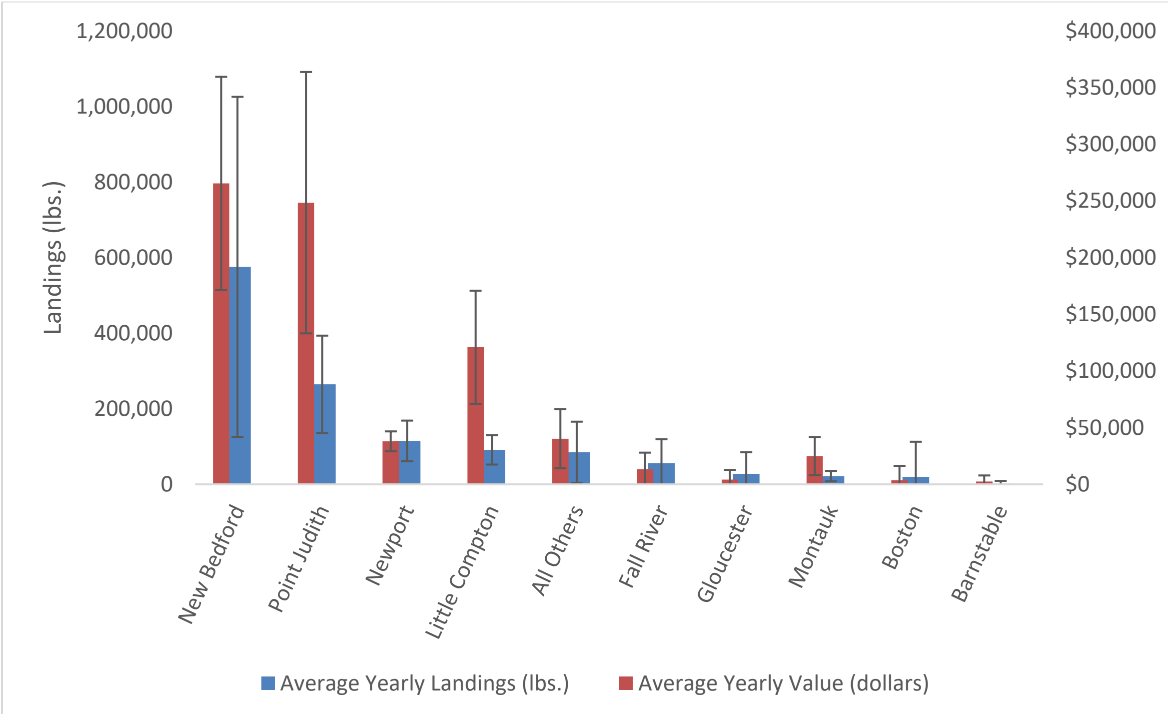


FIGURE 11-6. AVERAGE VALUE AND LANDINGS FOR TOP PORTS IN THE BRAYTON POINT EXPORT CABLE CORRIDOR

Source: B. Galuardi, personal communication, 2 July 2021

11.1.1.2 Commercial Fishing Activity in the Offshore Project Area

Mayflower Wind analyzed fishing activity and landing datasets, including VTRs, vessel monitoring systems (VMS), and automatic identification system (AIS) to analyze the amount, type, nature, timing, and other general patterns of fishing activity occurring in and around the Offshore Project Area. These analyses are divided below into sections based on the respective data type considered. Within each section, Mayflower Wind summarizes how the data are collected and how the data inform fishing transit, activity, and fisheries landings and value in the Offshore Project Area.

11.1.1.3 Landings Data

NMFS's Fisheries Statistics Division houses a variety of publicly accessible data on commercial and recreational fisheries. From 1990 onward, landings can be searched by state, species, date, and pound or dollar value of landings. Trip-level reporting to MA DMF is required of all Massachusetts commercial fishing vessels. Exemptions are made for vessels permitted with federal reporting requirements. Landings data are presented within MA DMF and NMFS designated Statistical Reporting Areas, which include the Falmouth export cable corridor and portions of the Brayton Point export cable corridor.

The Atlantic Coastal Cooperative Statistics Program (ACCSP) supplies non-confidential fishery dependent data from 23 state and federal agencies for public use. For recreational fisheries, the ACCSP works with partners to collect angler data and hires services to conduct telephone surveys to coordinate recreational fisheries data collection. Yearly commercial landing statistics can be sorted by state, year, and species through the Standard Atlantic Fisheries Information System, managed by ACCSP. NMFS maintains the Marine Recreational Information Program, which is a database of recreational fishing statistics including participation, effort, and catch information (NMFS, 2019a). Data incorporated from the ACCSP is provided in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

11.1.1.4 Summary of Data Limitations

The data described in Section 11.1.1 provide very valuable information about commercial and recreational fisheries. However, this cannot provide a complete picture, as it is not possible to monitor the landings of every permit holder in a fishery or to count and measure every fish in a stock using nonlethal means. Thus, fishery-independent surveys are conducted by the NEFSC, research organizations, and state natural resources agencies. Data from these surveys, and inferences that can be drawn from them, are critical to informing fisheries management decisions and in describing the potential effects on commercial and recreational fisheries from the development of offshore wind projects. This information is provided in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

Due to the nature of the type and methods of data collected, some commercial and recreational fisheries data reviewed in this report include some data gaps and limitations. These can be attributed to differences in VMS reporting requirements for certain fisheries, the confidentiality of various data sources, and the lack of landings data for less lucrative or more commonly caught species. These data gaps and limitations are well known, understandable, and present challenges to all data users, including fisheries managers. Where data gaps and limitations exist, many parties have historically put effort into drawing inferential conclusions with varying levels of accuracy and precision, depending on the available data while acknowledging the available data's inherent limitations. As such, Mayflower Wind reviewed commercial and recreational data sources from various sources and stakeholders in the commercial and recreational fisheries industry to form a comprehensive depiction of fishing activity in the Offshore Project Area.

A primary limitation of utilizing VMS data is that it is not required for some species, including American lobster, which represents a substantial commercial fishery in the region. Gaps in VMS data are supplemented with other vessel-related data such as self-reported VTR data, AIS data, and landings data collected in the Offshore Project Area (B. Galuardi, personal communications, 6 October 2020 and 2 July 2021; NMFS, 2020b, 2020c, 2021c; Benjamin et al., 2018; DePiper, 2014). In contrast, gaps in VTR data are supplemented with VMS data along with information included in Fishery Management Plans (FMPs) detailing trends and ports with the highest landings for commercial and recreational species. The NMFS VTR data have reasonable limitations that preclude statements with absolute certainty, like most fisheries data, but it currently represents the best Offshore Project Area-specific data sets available. Limitations of landings data utilized in this analysis include data gaps due to confidentiality measures or because of a low threshold of data available. In these instances, historical landings data, stock assessment, VMS data, and species-specific occurrence data were assessed to draw conclusions on fishing activity in the Offshore Project Area.

Further details on data types, data limitations, and fisheries can be referenced in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

11.1.1.4.1 Vessel Trip Report Data Analysis

VTRs are required for any federally permitted vessel when fish are caught, or when operations include activities that support fishing. This includes preparing to catch or harvest fish, or when attempting to catch or harvest fish, even if no landings are made. VTR is a self-monitoring mechanism of reporting that does not use GPS to record location. In some regards, VTR is not as precise of a reporting mechanism as other monitoring systems due to potential manual recording errors in location and catch.

However, VTR can provide detailed information on when and where a catch occurs, the trip date, crew on board, species and quantities caught, trip location, principal port, and vessel data. Location details of where fish were caught as reported using VTRs are not as specific as VMS data because VTRs report only one set of coordinates for each trip, which may include fishing effort spread over a wide area. VMS data are described in greater detail below. However, this information can also be aggregated into broad statistical chart areas to provide a sense of where, when, and how certain species are being caught.

VTR data can be analyzed by gear type to view fishing activity in a given area. For the purposes of this document, VTR activity of bottom trawls, dredges, gillnets, longlines, and pots and traps were analyzed to understand fishing activity within the Offshore Project Area (**Figure 11-7** and **Figure 11-8**).

There are three variations of VTR data considered in this analysis. Combining the Project-requested data from NMFS (B. Galuardi, personal communications, 6 October 2020 and 2 July 2021), publicly available NMFS socioeconomic data (2020a), and the data present in the Kirkpatrick et al., study (2017), VTR data provides a broad overview of where fishing effort is occurring (at a large geographic scale) and the landings and valuations of these fisheries. While the Kirkpatrick et al. study presents the 10 most commonly landed species in the Kirkpatrick Study Area as ranked by exposure, the NMFS socioeconomic data presents the 10 most commonly landed species by landings and then revenue in the Lease Area, and the Project-requested NMFS data presents all landings and revenues that originate in either the Lease Area or the export cable corridors. For the purposes of this section, the Lease Area represented the combined VTR data for two separate parcels which have been combined to represent the entire Lease Area. This is explained in greater detail in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

While there is broad agreement between these databases in regard to which fisheries may be most impacted by the proposed Project, the use of exposure in the Kirkpatrick et al., data (as opposed to landings and revenue in the NMFS data) results in different species included in the Kirkpatrick et al., and NMFS lists of 10 most commonly landed species. Differences in the geographic bounds of the studies also result in differences in output. The Mayflower Wind-specific NMFS data is the only data of these three datasets that provide data coverage for the export cable corridors. Differences in NMFS data between the socioeconomic data and the Mayflower Wind-specific data for the same temporal and spatial extents appear to be minor and likely due to rounding. For full records of VTR data from each of these different datasets, refer to Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report. For this section, the citations and text descriptions denote which specific VTR dataset is referenced.

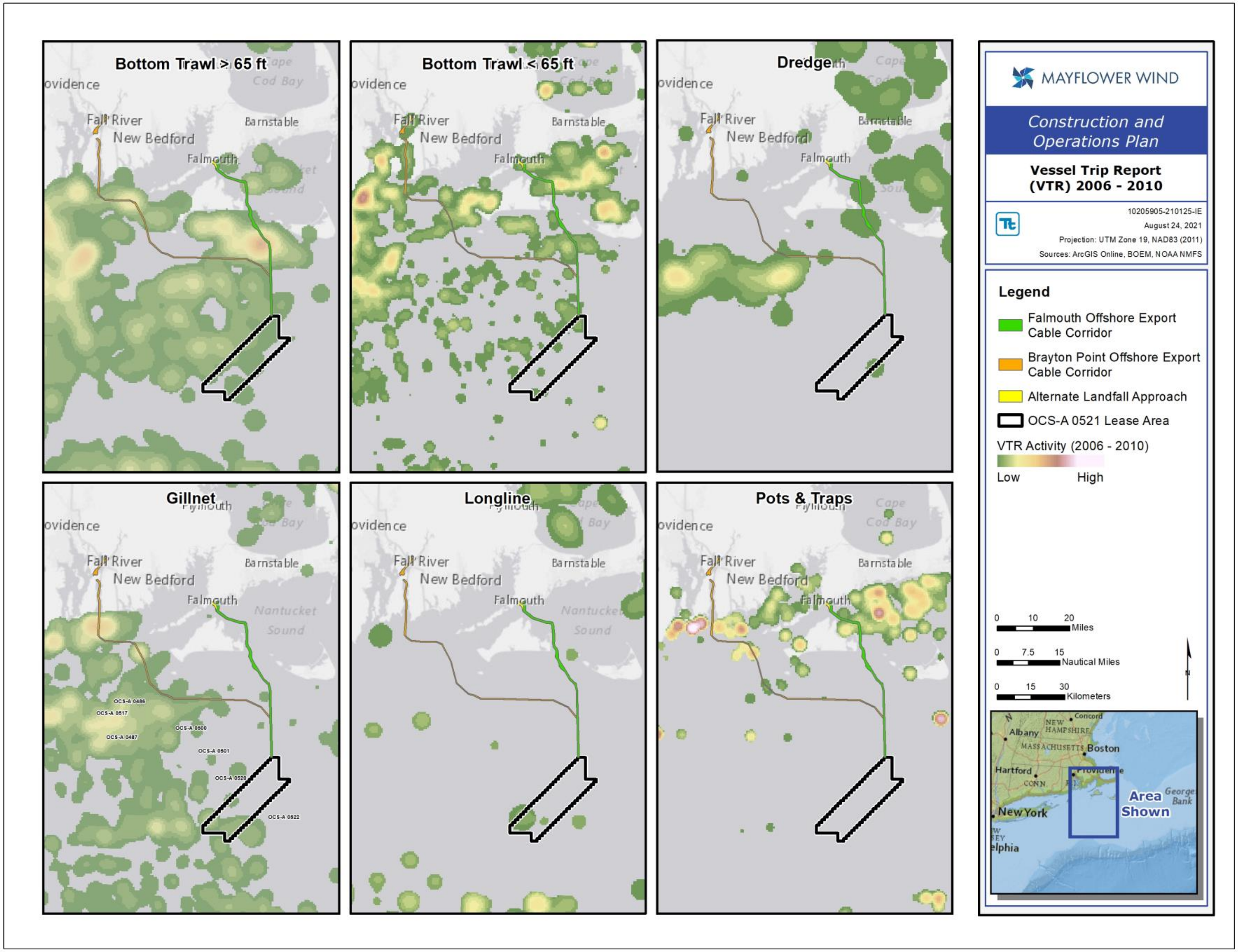


FIGURE 11-7. VESSEL TRIP REPORT (VTR) FISHING EFFORT (2006-2010)

FIGURE 11-8. VESSEL TRIP REPORT (VTR) FISHING EFFORT (2011-2015)

In addition to publicly available VTR data for the Atlantic OCS Wind Energy Areas compiled in the series of NMFS reports collectively titled *Socioeconomic Impacts of Atlantic Offshore Wind Development*, NMFS provided Mayflower Wind with customized, modeled fisheries landings and valuation data based on the Offshore Project Area; inclusive of the Lease Area and the export cable corridor boundaries (B. Galuardi, personal communications, 6 October 2020 and 2 July 2021; NMFS, 2020a). This data includes an 11-year period from 2008-2018 and provides modeled landings data representing the catch within the Lease Area (calculated as the sum of the two parcels into which the Lease Area is split only for this dataset) and the export cable corridors, as presented in **Figure 11-1.**

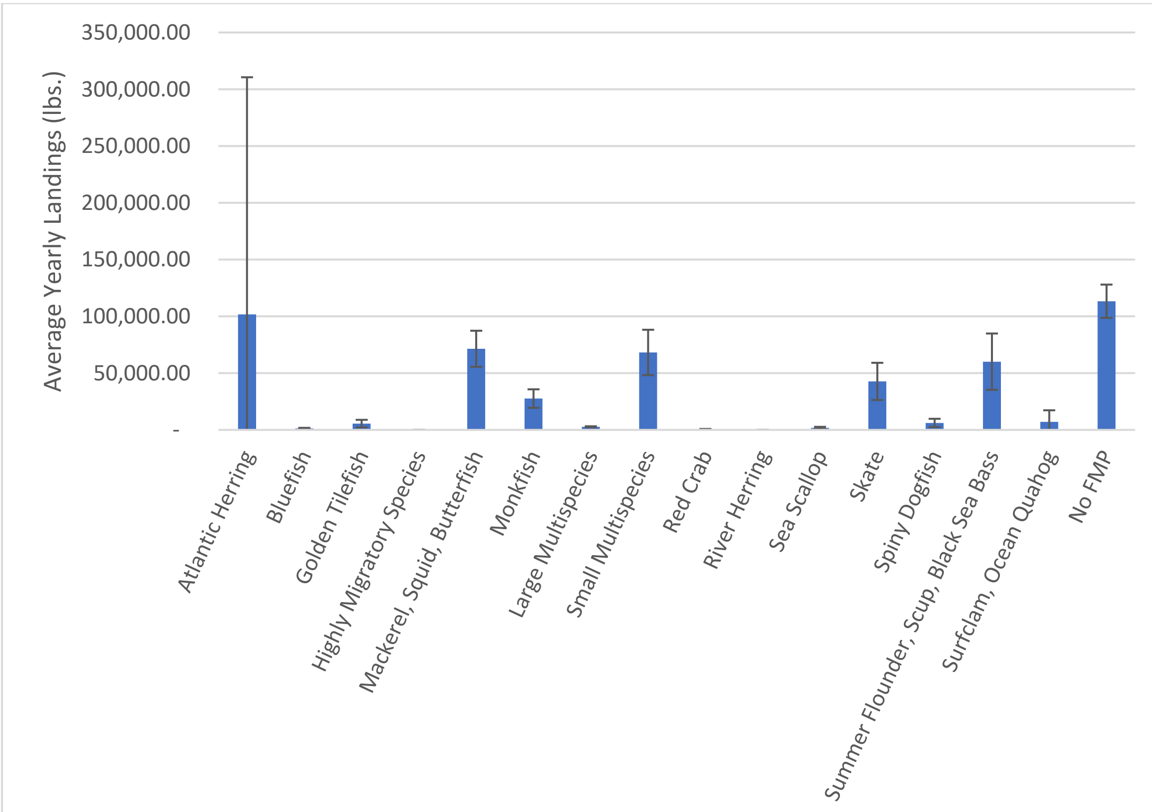
For the species listed in **Table 11-10**, fishermen caught an annual average of 510,128 pounds of fish worth an annual average $403,983 between 2008 and 2018 within the Lease Area (B. Galuardi, personal communication, 6 October 2020). The highest landed species by weight were Atlantic herring, Jonah crab, and silver hake. The highest landed species by revenue were Jonah crab, longfin squid, and monkfish (**Table 11-10**). Records with fewer than three unique dealers or three unique permits are represented as “All Others” due to confidentiality restraints (e.g., the ‘rule of three’). Jonah crab and red hake represented the highest percent exposure (1.0 percent and 0.9 percent) of total landings of weight caught within the Lease Area. As defined earlier, exposure is defined as the potential for an impact from Project development, based on the overlap of landings that have originated within the Lease Area or export cable corridors (Kirkpatrick et al., 2017).

TABLE 11-10. AVERAGE VTR LANDINGS IN THE LEASE AREA FROM 2008-2018

Species	Average Landings (lbs.)/Year	Average Value ($)/Year	Species Landings (lbs.) Exposure (percent)	
			Min.	Max.
Atlantic herring	101,214	$ 8,255	0.0	0.7
Jonah crab	96,463	$ 76,028	0.0	1.0
Silver hake	59,609	$ 35,961	0.0	0.6
Longfin squid	59,055	$ 68,221	0.0	0.3
Scup	50,986	$ 36,610	0.0	1.2
Skates	42,668	$ 20,612	0.0	0.3
Monkfish	27,564	$ 40,784	0.0	0.3
All others	10,244	$ 7,625	N/A	N/A
Summer flounder	8,584	$ 23,672	0.0	0.1
Red hake	7,635	$ 2,174	0.1	0.9
Butterfish	7,156	$ 3,835	0.0	0.8
American lobster	6,522	$ 27,873	0.0	0.1
Rock crab	6,518	$ 3,103	0.1	0.8
Spiny dogfish	6,115	$ 1,332	0.0	0.1
Golden tilefish	5,523	$ 19,713	0.0	0.7
Total for All Species	**510,128**	**$ 403,983**	**0.0**	**0.9**

Source: B. Galuardi, personal communication, 6 October 2020.

Landings from the Lease Area are highly variable from year to year within each FMP, with Atlantic herring being a particularly notable outlier. Atlantic herring exhibit the highest annual average but the highest variability, as shown by the error bars in **Figure 11-9** which represent standard deviation. In 2010, landings of Atlantic herring in the Lease Area totaled $76,938 and 1,020,340 pounds, yet in no other year between 2008 and 2018 did landings exceed $5,716 or 45,046 pounds. (NMFS, 2020a).



Source: B. Galuardi, personal communication, 6 October 2020.

FIGURE 11-9. AVERAGE LANDINGS (POUNDS, ±S.D.) BY FISHERY MANAGEMENT PLAN IN THE LEASE AREA (2008-2018)

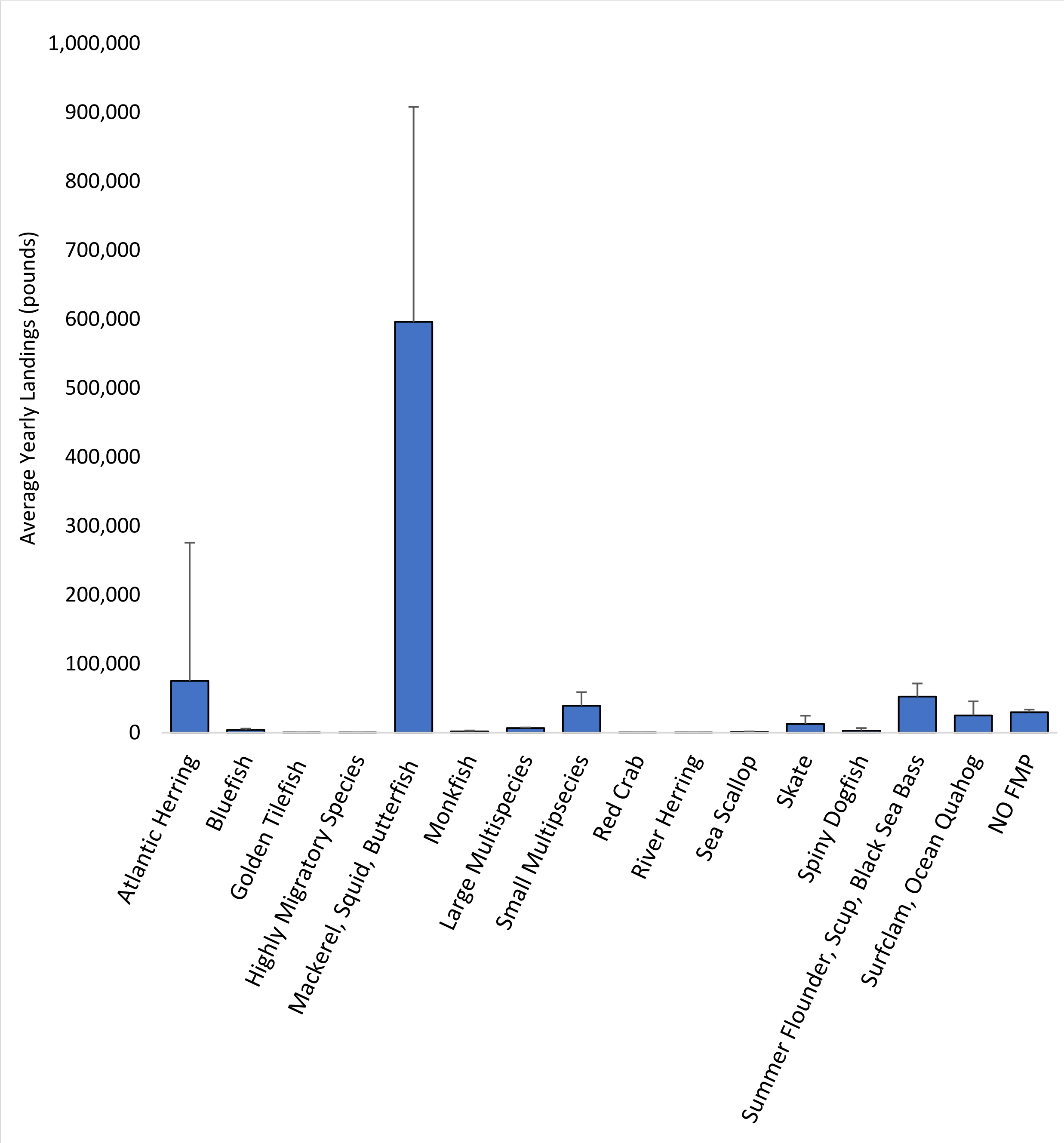
Within the Falmouth export cable corridor, the average annual fish landings were 825,584 pounds valued at $952,553. The most commonly landed species by weight were longfin squid, Atlantic herring, and scup. The most commonly landed species by revenue were longfin squid, channeled whelk, and summer flounder/fluke (**Table 11-11**). Longfin squid also represented the highest percent exposure (3.9 percent) of total landings by weight caught within the Falmouth export cable corridor.

TABLE 11-11. AVERAGE VTR LANDINGS IN THE FALMOUTH EXPORT CABLE CORRIDOR FROM 2008-2018

Species	Average Annual Landings (lbs.)/Year	Average Annual Value ($)/Year	Species Landings (lbs.) Exposure (percent)	
			Minimum	Maximum
Longfin squid	579,526	$ 696,035	0.6	3.9
Atlantic herring	75,016	$ 6,086	0.0	0.5
Scup	35,572	$ 21,867	0.1	0.5
Silver hake	34,114	$ 19,098	0.0	0.1
All others	23,583	$ 17,585	N/A	N/A
Channeled whelk (bushel)	15,602	$ 115,374	0.6	2.4
Skates	12,663	$ 3,691	0.0	0.1
Summer flounder	12,072	$ 40,605	0.1	0.2
Butterfish	7,522	$ 4,243	0.1	0.8
Atlantic mackerel	5,890	$ 2,661	0.0	0.1
Jonah crab	5,375	$ 4,187	0.0	0.1
Black sea bass	4,626	$ 15,416	0.1	0.4
Red hake	4,213	$ 1,190	0.1	0.7
Bluefish	3,969	$ 2,798	0.1	0.3
Shortfin squid	2,938	$ 1,139	0.0	0.0
Spiny dogfish	2,903	$ 578	0.0	0.1
Total for All Species	**825,584**	**$ 952,553**	**0.0**	**3.9**

Source: B. Galuardi, personal communication, 6 October 2020.

Landings from the Falmouth export cable corridor are also highly variable from year to year within each FMP, with mackerel, squid, and butterfish exhibiting the highest annual average, as well as the highest variability as shown by the error bars in **Figure 11-10,** which represent standard deviation. Similar to the Atlantic herring catch in the Lease Area, the catch in the Falmouth export cable corridor saw a peak in 2010 that was far higher than any other year in the data set analyzed. Landings of Atlantic herring in the Falmouth export cable corridor in 2010 were $43,425 and 677,411 pounds, but did not exceed $5,140 and 27,988 pounds in any other year between 2008 and 2018 (B. Galuardi, personal communication, 6 October 2020).



Source: B. Galuardi, personal communication, 6 October 2020

FIGURE 11-10. AVERAGE LANDINGS (POUNDS, ±S.D.) BY FISHERY MANAGEMENT PLAN IN THE FALMOUTH EXPORT CABLE CORRIDOR (2008-2018)

Within the Brayton Point export cable corridor, the average annual fish landings were 1,331,827 pounds valued at $910,751. The most commonly landed species by weight were Atlantic herring, skate wings, and Loligo squid. The most commonly landed species by revenue were American lobster, Loligo squid, and summer flounder/fluke (**Table 11-12).** Bluefish also represented the highest percent exposure (0.05 percent) of total landings by weight caught within the Brayton Point export cable corridor. Similar to the

Lease Area and the Falmouth export cable corridor, Atlantic herring represented the highest average landings, but also the highest variability. In 2013, landings of Atlantic herring in the Brayton Point export cable corridor totaled $238,472 and 2,000,563 pounds, but did not exceed $90,492 and 1,081,204 pounds in any other year between 2008 and 2018 (B. Galuardi, personal communication, 6 October 2020).

TABLE 11-12. AVERAGE VTR LANDINGS IN THE BRAYTON POINT EXPORT CABLE CORRIDOR FROM 2008-2018

Species	Average Annual Landings (lbs.)/Year	Average Annual Value ($)/Year	Species Landings (lbs.) Exposure (percent)	
			Minimum	Maximum
Atlantic herring	441,022	$ 50,638	0.0	0.01
Skate Wings	299,731	$ 44,196	0.0	0.02
Loligo Squid	167,324	$191,311	0.0	0.01
All others	113,148	$72,783	N/A	N/A
Scup/ Porgy	59,187	$39,147	0.0	0.01
American lobster	43,638	$211,205	0.0	0
Spiny dogfish	31,903	$7,026	0.0	0.01
Silver Whiting/hake	27,256	$15,480	0.0	0
Summer flounder/fluke	25.457	$85,426	0.0	0
Bluefish	21,344	$10,859	0.0	0.05
Jonah crab	18,843	$12,924	0.0	0.0
Atlantic mackerel	18,229	$3,921	0.0	0.0
Monk	11,397	$18,629	0.0	0.0
Butterfish	8,961	$5,917	0.0	0.0
Black sea bass	8,021	$30,510	0.0	0.0
Channeled whelk (bushel)	6,189	$48,848	0.0	0.0
Total for All Species	**1,331,827**	**$910,751**	**0.0**	**0.05**

Source: B. Galuardi, personal communication, 2 July 2021

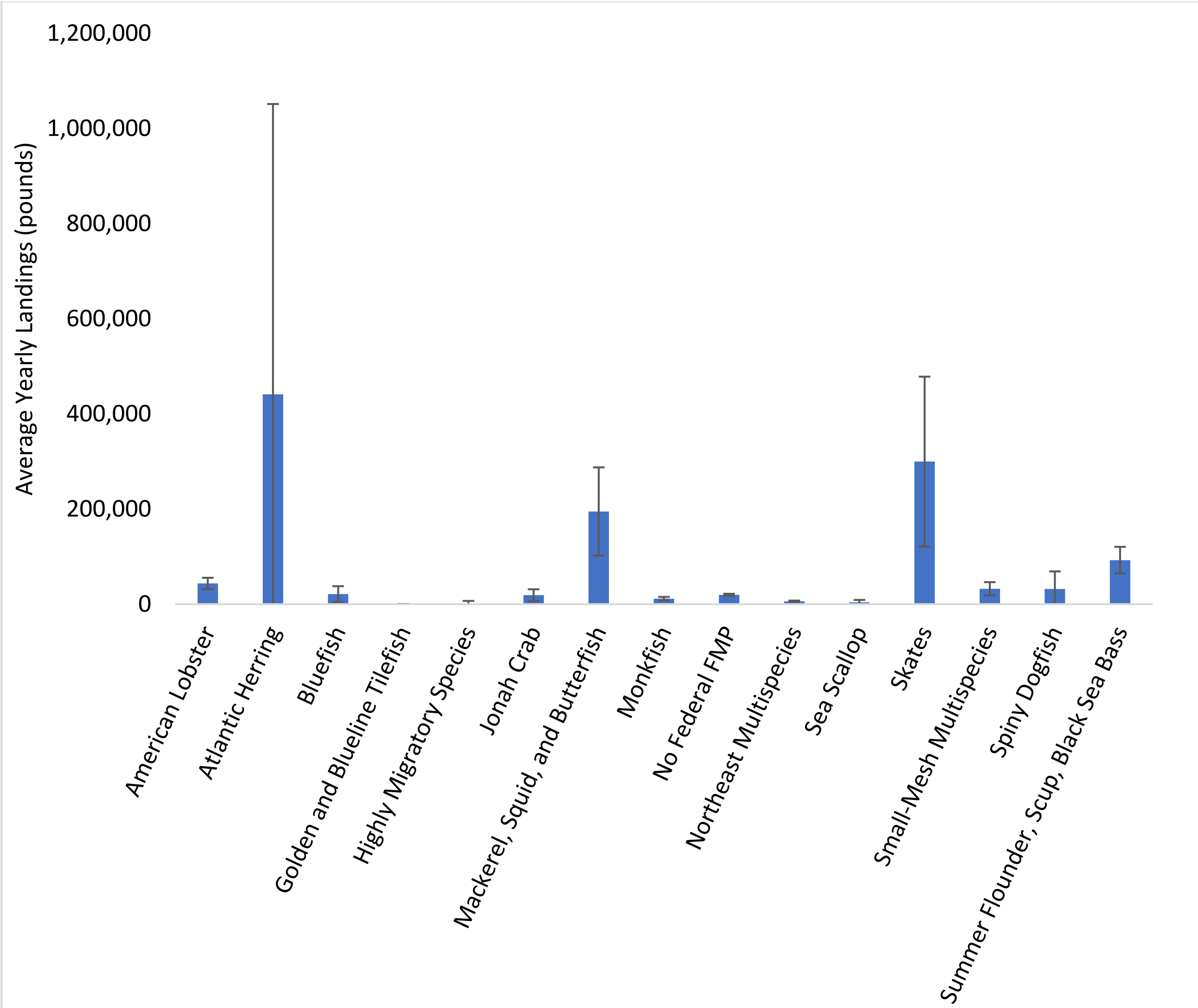


FIGURE 11-11. AVERAGE LANDINGS (POUNDS, ±S.D.) BY FISHERY MANAGEMENT PLAN IN THE BRAYTON POINT EXPORT CABLE CORRIDOR (2008-2018)

Source: B. Galuardi, personal communication, 2 July 2021

11.1.1.4.2 Vessel Monitoring System Data Analysis

Commercial vessels are required by law to carry mechanisms of monitoring on board to aid in management and regulatory enforcement. VMS utilize NMFS-approved mobile transceiver units to record and transmit vessel locations at least once per hour (50 CFR § 660.14).

A fishing vessel is required to carry a VMS and transmit a signal indicating its position when fishing for species in a method that triggers VMS requirements. In the Northeast U.S., VMS is required for the following permitted vessels (NMFS, n.d.):

- Full-time or part-time limited access scallop, or limited access general category scallop permit
- Occasional limited access scallop permit when fishing under the scallop area access program

- Limited access monkfish, occasional scallop, or combination permit electing to provide VMS notifications
- Limited access multispecies permit when fishing on a Category A or B day-at-sea, or a catches regulated species or ocean pout while on a sector trip; or a limited access multispecies small vessel category or a Handgear A-permitted vessel that fishes in multiple stock areas
- Atlantic surfclam or ocean quahog open access permit
- Maine mahogany quahog limited access permit
- Limited access monkfish vessel electing to fish in the Monkfish Offshore Fishery Program
- Limited access herring permit, or an Areas 2/3 open access herring permit, or a vessel declaring a herring carrier trip via VMS
- Limited access mackerel permit
- Longfin squid/butterfish moratorium permit
- Shortfin squid moratorium permit

Within the Offshore Project Area, VMS is required when fishing for Atlantic sea scallops, monkfish, Atlantic herring, Atlantic surfclam, ocean quahog, shortfin squid, longfin squid, butterfish and species managed under the Northeast Multispecies Management and Consolidated Atlantic Highly Migratory Species Management Plans. There are nuances to these requirements, but this broadly describes VMS fisheries. VMS data can provide information regarding the date, speed over ground, and the vessels' declaration code. This may help with identifying a fishery plan, associated identifiers, and/or gear-type.

VMS data showing vessels traveling below a certain speed (often assumed as either four or five knots, depending on the fishery) may indicate the presence of vessels actively fishing rather than in transit, as suggested by fishing industry members and managers. The proportion of vessel traffic below this speed may most accurately be interpreted as the relative level of vessel presence at speeds likely consistent with fishing activity. Where speed is not indicated, there is no distinction between fishing activity, vessel transit, or other vessel activities. The most accurate interpretation of this case is that it indicates relative levels of vessel presence. This type of data does not illustrate more recent or future changes in fishing activity resulting from changing environmental and economic conditions, fisheries management, and other factors.

The Mid-Atlantic Regional Council on the Ocean (MARCO, n.d.) and the Northeast Regional Ocean Council (NROC) maintain publicly available databases and maps related to commercial fishing, among other ocean activities. VMS data for the northeast and mid-Atlantic regions from 2006 and 2016 can be utilized to monitor commercial fishing activities within seven fisheries, including herring, monkfish, multispecies, pelagic, scallop, squid, and surfclams. **Figure 11-12** shows speed-filtered VMS fishing activity between 2011 and 2014 and **Figure 11-13** shows speed-filtered VMS fishing activity between 2015 and 2016. Between 2011 and 2016, there was no active fishing activity occurring in the Lease Area for vessels with herring and Atlantic surfclam/ocean quahog permits.

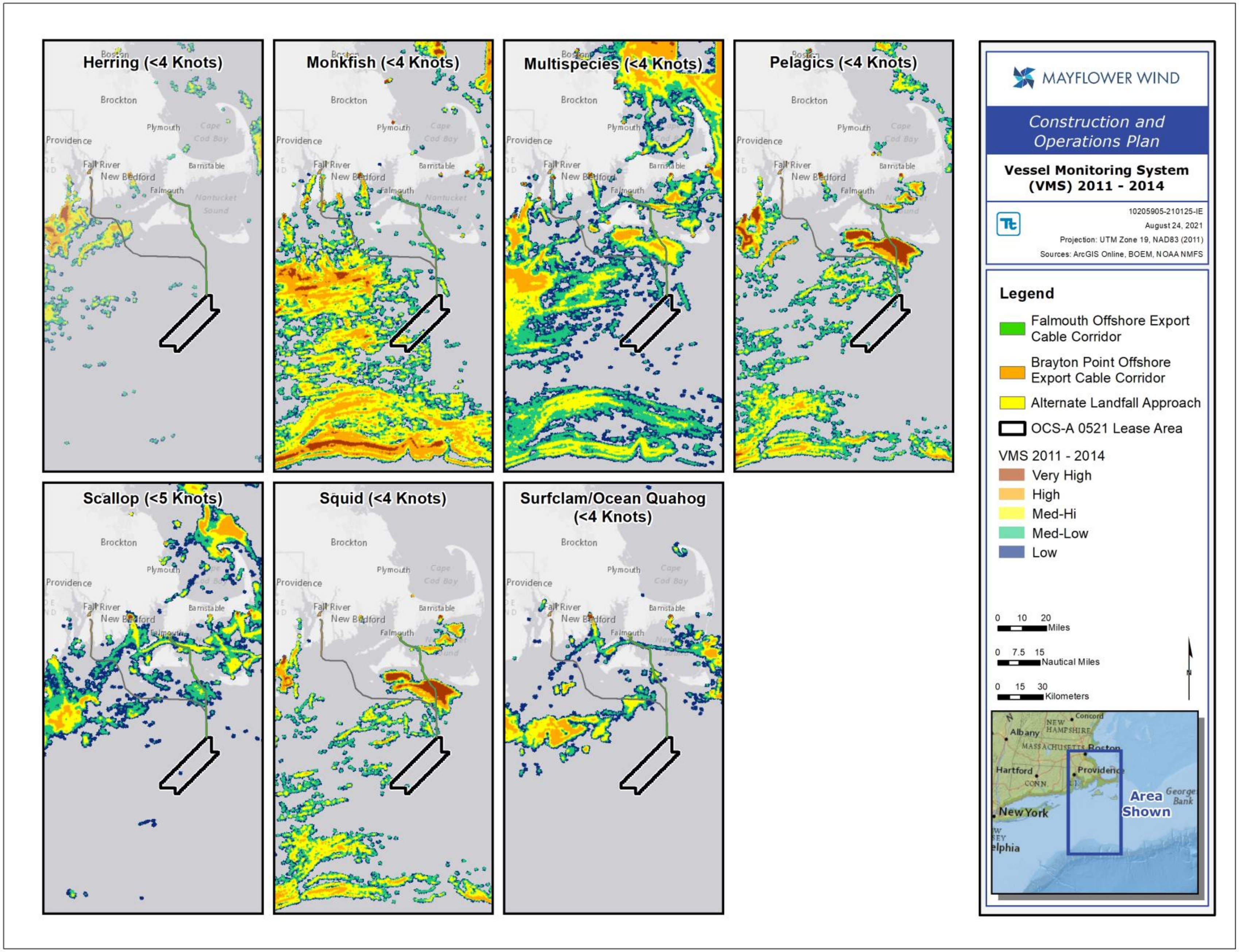


FIGURE 11-12. VESSEL MONITORING SYSTEM PRESUMED FISHING (<4 KNOTS) DENSITY FOR THE YEARS 2011-2014

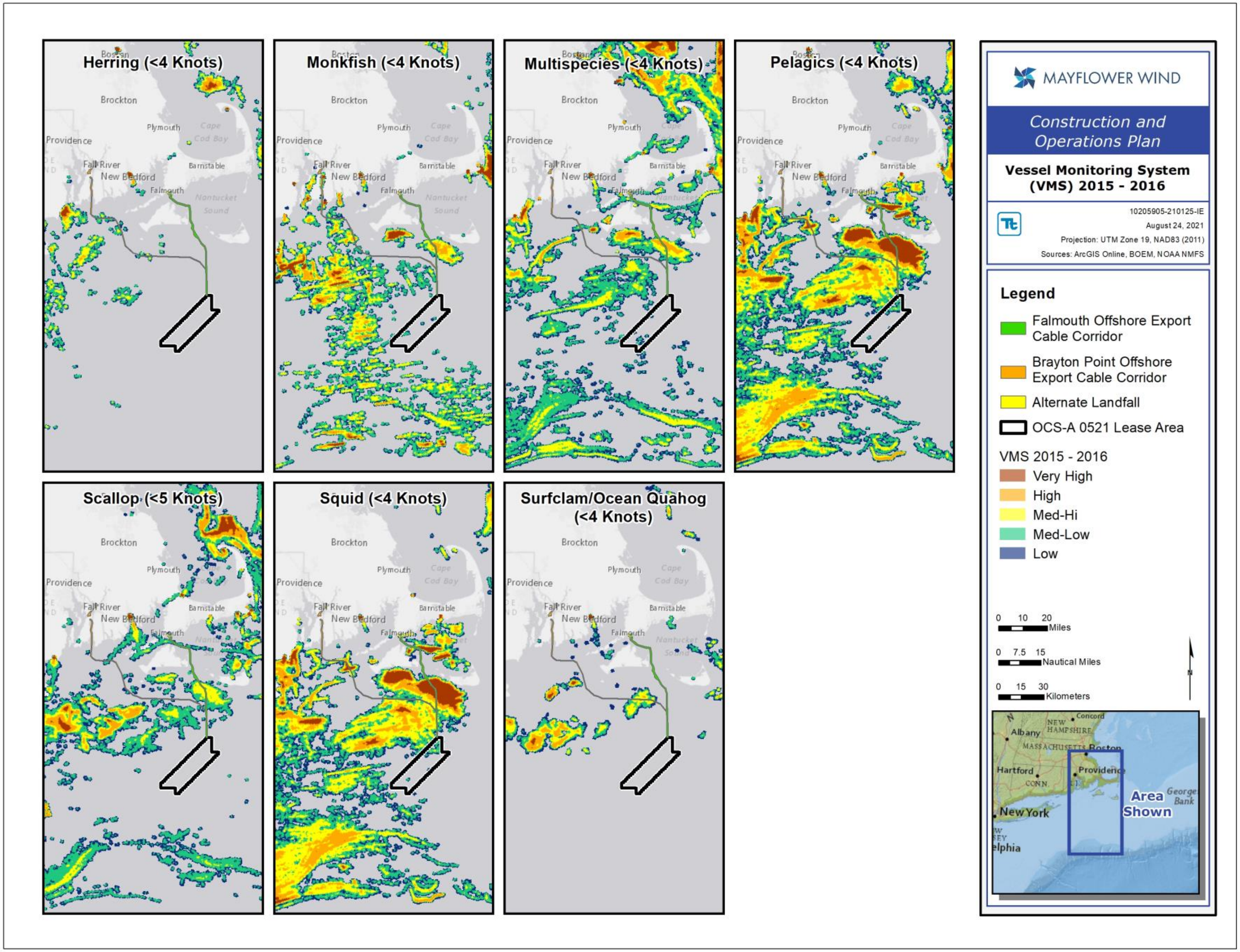


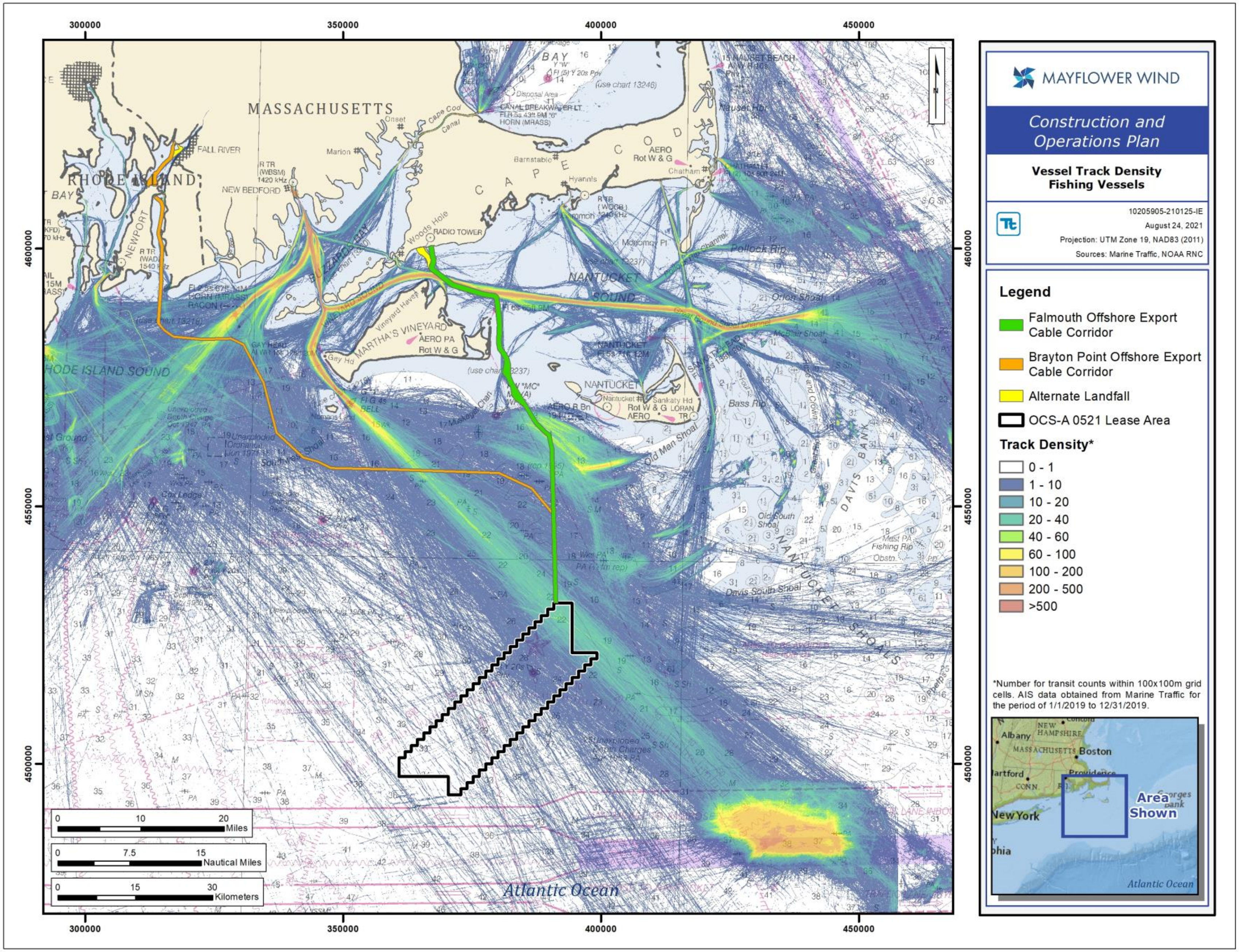
FIGURE 11-13. VESSEL MONITORING SYSTEM PRESUMED FISHING (<4 KNOTS) DENSITY FOR THE YEARS 2015-2016

In general, these figures present a varied density of commercial fishing vessel activity within the applicable fisheries; squid, Northeast Multispecies, monkfish, Atlantic herring, Atlantic sea scallop, Atlantic surfclam, and Atlantic mackerel fisheries in the northeast and mid-Atlantic regions, based on NROC VMS data for two time periods (2011-2014, 2015-2016; Shmookler, 2015). However, there is a comparatively higher density of fishing activity in the export cable corridors, due to their variety of favorable benthic habitat characteristics (for more information on benthic characterization within the export cable corridors, see Section 6.6 and Appendix M, Benthic and Shellfish Resources Characterization Report). Overall, these maps representing VMS data show primarily low densities, with some medium densities in the southwest portion of the Lease Area.

11.1.1.4.3 Automatic Identification System Data Analysis

AIS is an automated, continuous tracking system that provides a record of the operational history of an AIS-transmitting system, whether it is affixed to a vessel or a navigational mark. AIS operates in the VHF mobile maritime band and uses GPS to broadcast a vessel's course, position, speed, dimension, name and destination, and other characteristics. Because AIS signals are transmitted frequently, it can be considered as the most precise tracking mechanism for those vessels required to use it. AIS must be turned on or information cannot be exchanged. Federal regulations (33 CFR § 164.46) mandate which vessels are required to carry AIS; this includes fishing vessels that are greater than 65 feet (20 m) in length and are self-propelled. More detailed information on AIS carriage requirements is provided in Section 11.1.2 of Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

AIS data shows relatively low fishing vessel transit activity through the Offshore Project Area, compared to other areas in the region, with essentially the entire Lease Area showing between 0 and 10 transit counts within 100 m by 100 m grid cells in the Lease Area. Exceptions include moderately higher densities in the northeast corner of the Lease Area (which is an area with known fishing vessel transit activity), and higher but localized activity near the Falmouth export cable corridor, particularly in Nantucket Sound (**Figure 11-14**). The Brayton Point export cable corridor passes two areas of high fishing vessel transit activity, including vessels transiting to and from New Bedford going south and southeast. As a caveat, not all fishing vessels carry AIS transponders or have them actively recording vessel locations outside of 12 nm (22 km) from the coastline.



Source: Northeast Regional Ocean Council, 2018

FIGURE 11-14. AUTOMATIC IDENTIFICATION SYSTEM FISHING VESSEL TRANSIT COUNTS 2019

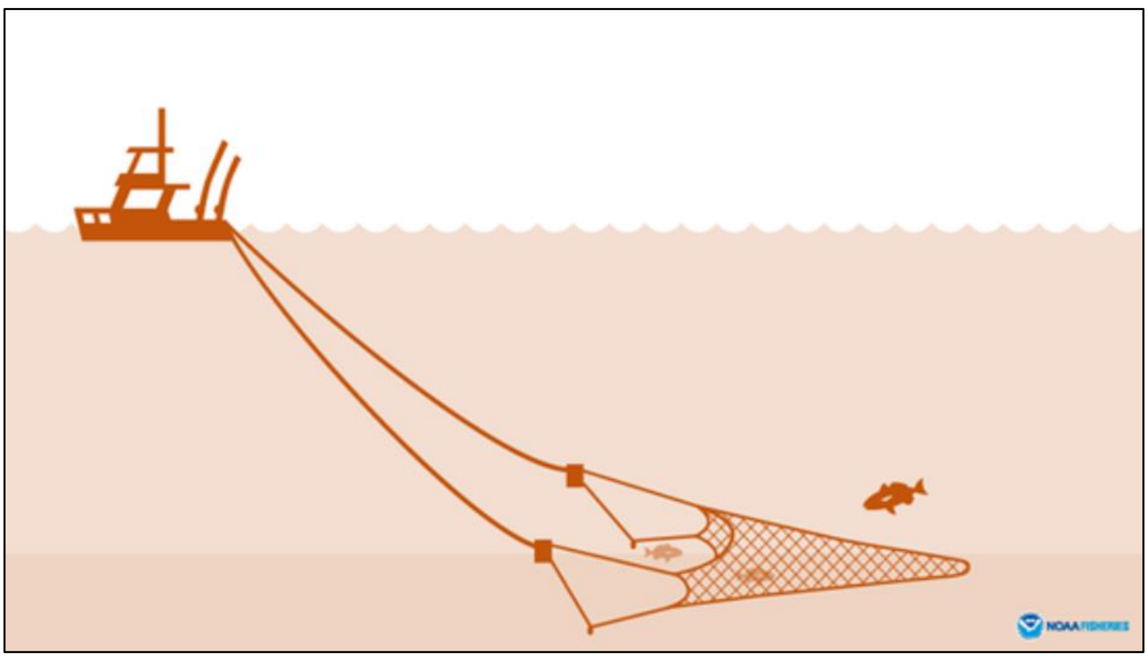
TABLE 11-13. COMMON COMMERCIAL GEAR TYPES USED IN THE OFFSHORE PROJECT AREA BY AVERAGE LANDINGS (2008-2018)

Gear Type	Average Landings/Year (lbs.)	Average Value/Year ($)
Bottom trawl	1,535,465	$ 1,363,389
Midwater trawl	541,160	$ 53,023
Pots and traps	226,986	$ 557,676
Gillnetting	180,895	$ 143,002
All Others	139,934	$ 167,780
Hydraulic clam dredge	71,999	$ 51,406
Total for All Gear Types	**2,694,439**	**$ 2,338,277**

Source: B. Galuardi, personal communications, 6 October 2020 and 2 July 2021.

11.1.1.5 Bottom Trawling

Bottom trawling (also referred to as otter trawling or dragging) is a common mobile gear type in the Northeast used for catching target species that live on the seafloor (**Figure 11-15**). Each trawl fishery utilizes unique gear designed specifically to capture the target species (i.e., various mesh sizes, often different within various panels of the same net, different panel configurations, various sizes, designs, and varied doors and door spreads). Modern trawling operations sometimes employ sensors that can be monitored from the wheelhouse in real-time to verify that the gear is properly deployed and fishing effectively as it is towed.



Source: NMFS, 2019b.

FIGURE 11-15. BOTTOM TRAWL DIAGRAM

Common species commercially caught in southern New England and within the Offshore Project Area (but more concentrated in the export cable corridors) using bottom trawls include butterfish, flounder species, scup, cod, silver hake, monkfish, and other species (see **Figure 11-12** and **Figure 11-13**). Particularly in and around the Falmouth export cable corridor, the Massachusetts longfin squid fishery utilizes small, mesh bottom otter trawls (MA DMF, 2020). These species are also captured using other gear types, such as gillnets, with many overlapping fishery management and regulatory mechanisms in-place throughout the year. VTR data demonstrates that between 2008 and 2018, annual average landings from bottom trawl activity in the Offshore Project Area was 1,535,465 pounds per year (**Table 11-13**).

11.1.1.6 Pots and Traps

Pots and traps are submerged wire cages that attract target species (usually by bait) and allow them to enter but make it difficult to exit (NMFS, 2019c). Fishermen haul the traps back onto their vessel typically using lines attached to the trap with a marker buoy or a high-flyer buoy at the surface to mark its location. Traps can be set individually or strung together in what are called "trawls" (**Figure 11-16**). Trawls can be quite long, and pots and traps can be set in waters up to 2,400 feet (730 m) deep (NMFS, 2019c). Target species for pots and traps include crabs, lobsters, whelk, scup, black sea bass, and eels (NMFS, 2019c).

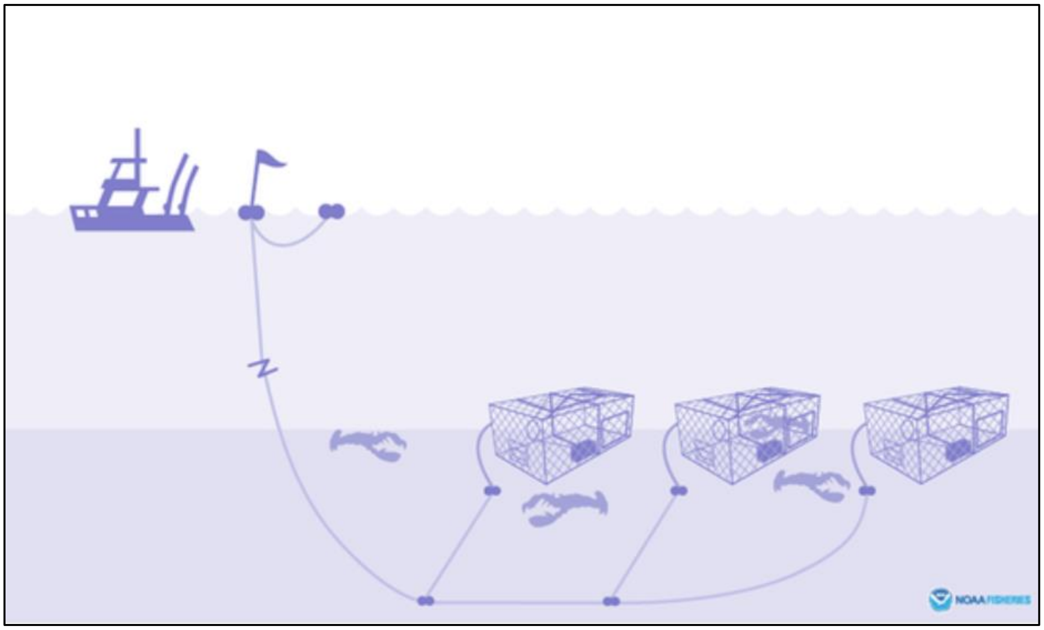
Particularly for fixed gear commercial fisheries, there is a well-established, well-organized pattern in which this gear is fished, and this is expanded on in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report. In the Lease Area and other offshore areas nearby, this pattern results in pot and trap gear being set in an approximately east-west orientation at regular intervals. Additionally, engagement by Mayflower Wind with individual fishing vessels has confirmed that gear configurations and deployment/hauling methods are consistent with standards in the region.

In southern New England, lobsters are the primary species targeted by pots and traps, although whelk is becoming increasingly more common as lobster populations have been declining in recent decades in this area (ASFMC, 2019b; Gomez-Chiarri, and Cobb, 2012; Giannini and Howell, 2010). Whelk (species of the family Buccinidae) are referred to as "conch" by fishermen, therefore these terms may be used interchangeably in this section.

In Massachusetts, the whelk fishery is concentrated in Nantucket Sound, Vineyard Sound, and Buzzards Bay (MA DMF, 2018b), overlapping the Offshore Project Area primarily within the inshore portion of the Falmouth export cable corridor. Engagement with individual vessels targeting whelk in the Falmouth export cable corridor has confirmed that gear configurations and deployment/hauling methods are consistent with standards in the region. Through engagement with individual vessels targeting whelk in the Brayton Point export cable corridor, similar information has been confirmed, although the whelk effort in the Sakonnet River is reported to currently be lower than it had been in recent years. This is supported by the landings data seen in **Table 11-12**, discussed further in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report, and in whelk landings recorded in Rhode Island (ACCSP, 2021).

Most of the lobster fishing activity in southern New England is concentrated outside of the Offshore Project Area (Kirkpatrick et al., 2017), but there is commercial lobster fishing activity in the Lease Area by a small number of vessels. There is some commercial and recreational fishing activity by a larger number of vessels in the Falmouth and Brayton Point export cable corridors.

Jonah crab is another species that has seen targeted increases in southern New England in recent years. The increase in Jonah crab landings is generally attributed to the decrease in the abundance of southern New England lobsters, resulting in a shift in fishing activity and an increase in the price of other crab species, creating a substitute market for Jonah crab meat (ASMFC, 2019a, b). Landings of Jonah crab in the U.S. predominately come from Massachusetts (approximately 70 percent) and Rhode Island (approximately 25 percent). However, most of the fishery is concentrated in federal waters southwest of Buzzards Bay, well outside of the Offshore Project Area (ASFMC, 2017).



Source: NMFS, 2019c.

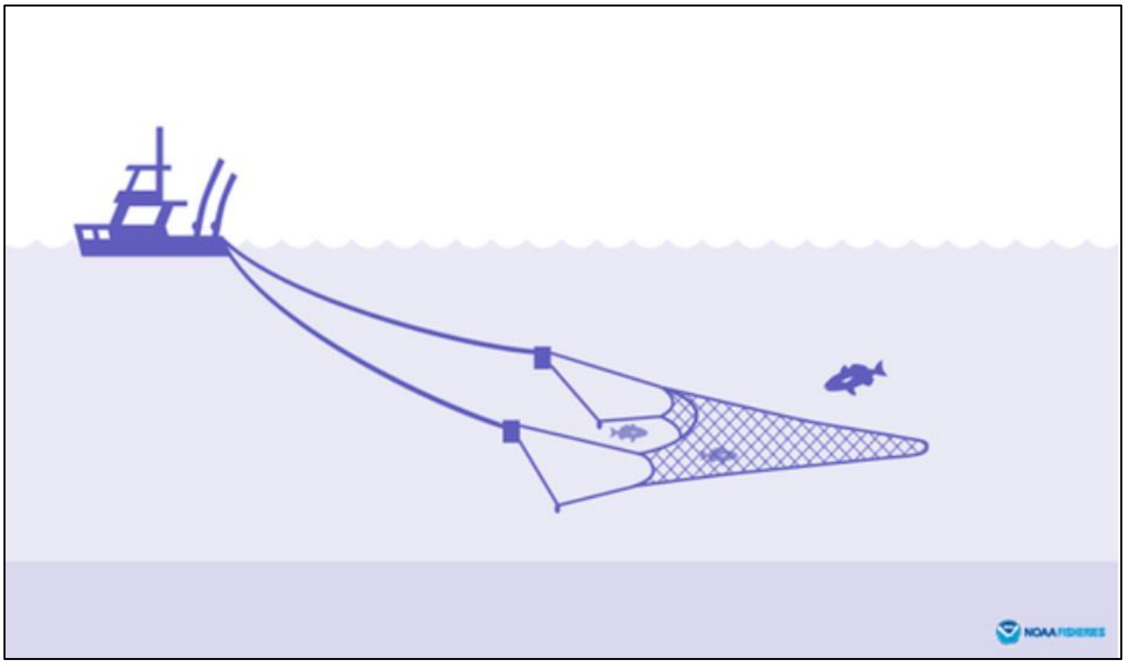
FIGURE 11-16. POTS AND TRAPS DIAGRAM

VTR data demonstrates that pot and trap fishing in the Offshore Project Area between 2008 and 2018 landed an annual average of 226,986 pounds worth $557,676 per year (**Table 11-13**). During this same timeframe, fishermen landed an annual average of 96,463 pounds of Jonah crab, 6,522 pounds of American lobster, and 122 pounds of whelk (channeled and knobbed) within the Lease Area. Within the Falmouth export cable corridor during this same timeframe, fishermen landed an annual average of 5,375 pounds of Jonah crab, 18,250 pounds of whelk (channeled and knobbed), and 1,485 pounds of American lobster (**Table 11-11**). Within the Brayton Point export cable corridor, fishermen landed an annual average of 43,638 pounds of American lobster, 18,843 pounds of Jonah crab, and 6,440 pounds of whelk (channeled and knobbed, **Table 11-12**).

11.1.1.7 Midwater Trawl

Midwater trawls are similar to bottom trawls that utilize the same general types of equipment (net, doors, etc.), but utilize doors that are configured to allow the gear to be towed at varying levels in the water column off bottom (**Figure 11-17**). Common species targeted by midwater trawls include squid, shrimp, and pelagic schooling fish (NMFS, 2019d). In southern New England and within the Offshore

Project Area, squid are the primary species targeted with midwater trawl gear. Squid trawling within the Offshore Project Area generally occurs in federal waters, however, the spatial densities of squid assemblages can vary widely from year to year (NMFS, 2017a). Commercial squid trawling comprises a substantial percentage both by value and by weight of commercial catch landed in Rhode Island and to a lesser degree in Massachusetts (Liberman, 2017). Engagement by Mayflower Wind with the squid fishery in the Offshore Project Area has confirmed that gear configurations and fishing patterns are consistent with standards for the region. Squid are captured by trawling in either a directed fishery or a mixed species fishery, often with mackerel or butterfish, which is broadly the reason for those species being managed under a shared FMP. In the Offshore Project Area, midwater trawling is far more concentrated in state and federal waters along the export cable corridors (especially the Falmouth export cable corridor), compared to within the Lease Area (**Figure 11-12** and **Figure 11-13**), which depict squid trawling data from 2011 to 2016, using VMS data.



Source: NMFS, 2019d.

FIGURE 11-17. MIDWATER TRAWL DIAGRAM

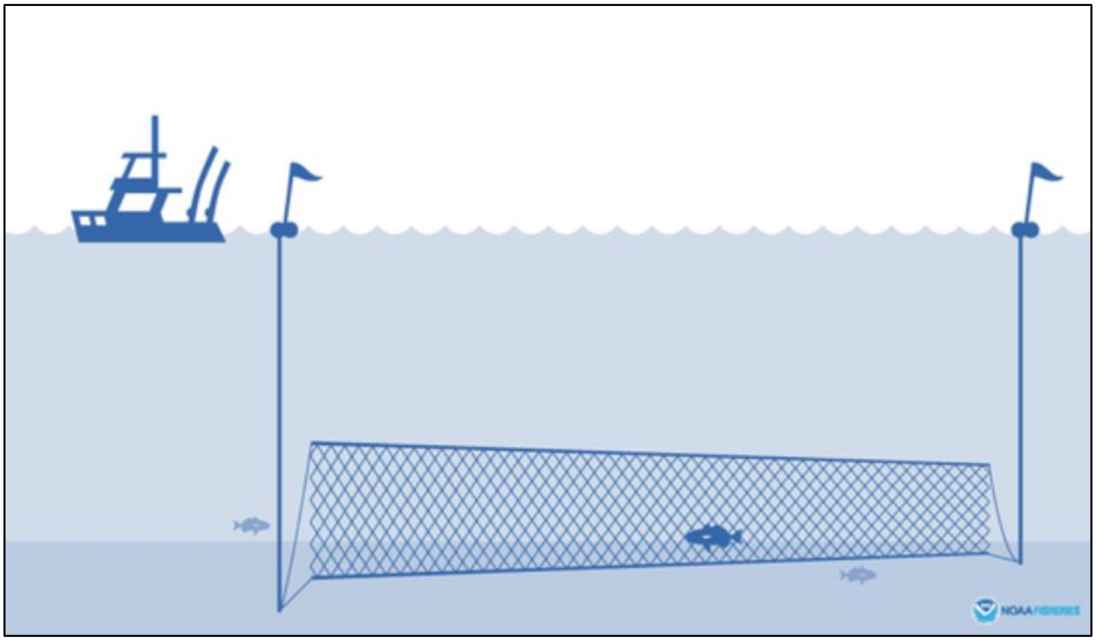
VTR data demonstrates that between 2008 and 2018, annual average landings from midwater trawls were 541,160 pounds per year within the Offshore Project Area (**Table 11-13**).

11.1.1.8 Gillnetting

Gillnets trap fish by their gills as they try to swim through (NMFS, 2019e). The size of the gaps in the net determine which species will get caught and which will be able to swim through freely. Gillnets can be configured in a variety of ways, but typically consist of floats along the top of the net and weights along the bottom to keep the panel aligned vertically in the water column **Figure 11-18**.

Different regulations control the allowable mesh size. Common gillnet target species include, but are not limited to: groundfish (cod, haddock, pollock, flounder, hake), herring, black sea bass, sharks, and other species, depending on the region (NMFS, 2019e). In southern New England, gillnets are typically tended on a daily to semi-weekly basis for groundfish species, managed under the Northeast Multispecies FMP. Anchored gillnets set very near the seabed are known as ‘bottom gillnets or ‘sink gillnets’ and represent the most common type of gillnetting in the New England commercial fishing industry (NMFS, 2019e; Pol and Carr, 2000).

In the Offshore Project Area, the multispecies fishery is far more concentrated in state and federal waters along the export cable corridors, compared to within the Lease Area (**Figure 11-12** and **Figure 11-13**), which depict multispecies data from 2011 to 2016, using VMS data. However, most of this activity is from bottom trawling, with the gillnetting activity concentrated outside of the Offshore Project Area.



Source: NMFS, 2019e

FIGURE 11-18. GILLNETTING DIAGRAM

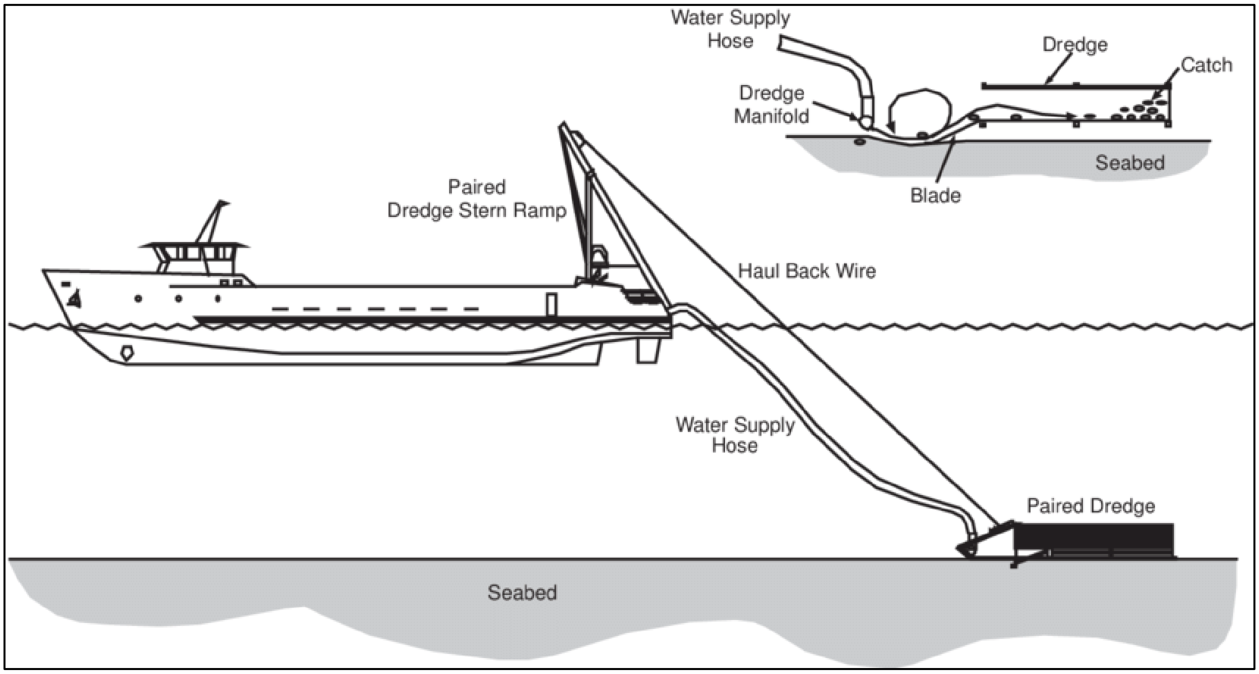
VTR data demonstrates that between 2008 and 2018 fishermen landed on average 176,153 pounds of fish per year in the Offshore Project Area using gillnets (**Table 11-13**).

11.1.1.9 Hydraulic Clam Dredge

Hydraulic clam dredges harvest bivalves from the soft bottom sediments in which they are buried. This technique of harvesting Atlantic surfclams and ocean quahogs is utilized where soft bottom conditions allow for the gear to penetrate the seafloor enough to make this method efficient for capturing clams. The hydraulic dredges are dragged slowly along the bottom by the fishing vessel as a large hydraulic pump on the fishing vessel pumps sea water through a hose to a manifold on the front of the dredge (**Figure 11-19**).

The manifold jets the water into the sand, temporarily fluidizing the sand and allowing the dredge to penetrate the sediment to a depth below the seafloor of approximately 1 foot (0.3 m), capturing bivalves (and similarly sized rocks, debris, or fish) in the process.

As this is a depletion fishery, these vessels will make repeated passes through an area until the clam numbers drop. In addition, clams are long-lived bivalves, and it has historically proven difficult to predict where commercially viable volumes may be found, resulting in a high degree of inter-annual variation in landings.



Source: Gilkinson et al., 2003.

FIGURE 11-19. HYDRAULIC CLAM DREDGE DIAGRAM

Atlantic surfclams and ocean quahogs are the most common species commercially targeted by this gear in southern New England, but fishing activity is more concentrated outside of the Offshore Project Area than in it, although there is some activity concentrated along inshore portions of the Falmouth export cable corridor within Nantucket/Vineyard Sound as well as some activity within Narragansett Bay (see **Figure 11-12** and **Figure 11-13**). VTR data demonstrates that between 2008 and 2018, annual average landings from hydraulic dredging activity in the Offshore Project Area was 71,999 pounds per year (**Table 11-13**).

11.1.2 Summary of Commercial Fishing in the Offshore Project Area

This section summarizes commercial fishing in the Offshore Project Area and the exposure of these fisheries to the proposed Project. Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report provides a more in depth look at these fisheries and the fishing activity that targets them. For commercial fisheries, exposure does not measure economic impact or loss but is defined as the potential for a fishery to see an impact from offshore wind development (Kirkpatrick et al., 2017). The species commonly caught by commercial fisheries in and around the Offshore Project Area are described in Appendix V and are targeted during different seasons within different parts of the Offshore Project Area. This fishing activity is impacted by species abundance, market forces, regulations, and a large number of other variables.

11.1.2.1 Lease Area

Commercial fisheries in the Lease Area target different species with different gear types and have been summarized in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report. Data analyzed includes VMS (**Figure 11-12** and **Figure 11-13**), VTR (**Figure 11-7** and **Figure 11-8**), and AIS (**Figure 11-14**) as provided by NMFS and BOEM. These data sources, described in full in Appendix V, were also used in Appendix X, Navigation Safety Risk Assessment. Appendix X shows that commercial fishing vessels routinely transit through the Lease Area, primarily through the northern portion as a transit route to fishing grounds further offshore.

A series of reports in 2020 prepared by NMFS (Socioeconomic Impacts of Atlantic Offshore Wind Development) detailed commercial fishing effort in the Lease Area including species caught, volume and value of landings, gear types used, ports used, and the broad geographic location of catch at the level of individual Atlantic OCS Lease Areas (NMFS, 2020a). Trawling gear (bottom and midwater) targeting squid, mackerel, and butterfish is used most frequently in the Lease Area (NMFS, 2020a). Trap and pot gear targeting lobster and crab species are also used, predominately in the southern part of the Lease Area (NMFS, 2020a). Appendix V highlights the most current information, including these NMFS reports that show the number of commercial fishing vessels reported to be actively fishing in the Lease Area and which fish species they were targeting (NMFS, 2020a).

11.1.2.2 Export Cable Corridors

The same data sources (VMS, AIS, and VTR) were used to evaluate fishing activity in the export cable corridors. In addition to actively fishing in the export cable corridors, commercial fishing vessels also transit through this area throughout the year. This is represented as charts of AIS tracks overlaid on the proposed export cable corridors and discussions of relative fishing effort via VMS and VTR data analysis (see Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report and Appendix X, Navigation Safety Risk Assessment). Based on the time ranges of these datasets, Mayflower Wind anticipates that fishing vessel transit and activity will continue in this area for the lifetime of the proposed Project. Section 11.2 discusses the potential effects this will have and the risk of exposure to these fishing fleets. **Figure 11-7** and **Figure 11-8** show historical data for commercial pot and trap gear in/near the export cable corridors. Benthic habitats are variable along the Falmouth export cable corridor approaching the channel, the Brayton Point export cable corridor, and the proposed landfall locations (see Sections 6.6, 6.7, and Appendix M, Benthic and Shellfish Resources Characterization Report). In addition, VTR data demonstrate that fishing activity in terms of landings (pounds and dollars) is higher in the export cable corridors compared to the Lease Area (**Table 11-10** and **Table 11-11**).

11.1.2.3 Landfall Locations

VTR data shows low densities of fishing effort from both mobile and static gear near the landfall locations, with some activity occurring in Nantucket Sound. VMS maps (**Figure 11-12** and **Figure 11-13**) show the higher density of fixed gear such as pots and traps closer to shore (see Section 6.6 and Appendix M, Benthic and Shellfish Resources Characterization Report) (**Figure 11-12** and **Figure 11-13**).

Regarding the Brayton Point landfall(s), VTR data shows bottom trawl and pots and trap fishing activity within the Sakonnet River near the cable landfall location (**Figure 11-7** and **Figure 11-8**).

11.1.2.4 Fishing Ports

Several ports serve vessels that target fish in the Lease Area (**Table 11-4**). Data showing revenue earned and recorded landings is presented in Appendix V. Point Judith, Rhode Island and the Port of New Bedford in Massachusetts receive the highest revenue from commercial fish caught and landed from the Lease Area (B. Galuardi, personal communication, 6 October 2020). This was also supported by custom VTR data provided by NMFS.

The Port of New Bedford is identified as a potential port for Project construction, O&M, and decommissioning activities. The existing data identifies commercial fishing vessels that transit and actively fish in the Offshore Project Area. However, the nature and granularity of fisheries data is not sufficient to directly tie most catch data to landings data. Vessels that fish in different areas dock in New Bedford, Massachusetts versus in Point Judith, Rhode Island, and so on, cannot be derived accurately from this data (see Appendix V for further information). The data do provide insight into patterns of fishing activity that Mayflower Wind has validated with field observations from geophysical surveys, consultation with fishing stakeholders, including FRs, fishing organizations, and individual vessels. Further consultation with the fishing stakeholders will determine the level of exposure that exists for boats using the ports and their use of the Offshore Project Area (see Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report).

11.1.2.5 Prominent Gear Types in the Offshore Project Area

Based on the exposed fisheries within the Kirkpatrick Study Area and the Offshore Project Area (**Table 11-11** and **Table 11-13**), bottom trawling, midwater trawling, gillnetting, and pots and traps are the most prominent gear types utilized in the area.

Bottom trawlers in the Kirkpatrick Study Area target species within the Small Mesh Multispecies FMP (silver hake, red hake, offshore hake) as well as Squid, Mackerel, Butterfish FMP (Atlantic mackerel, chub mackerel, longfin squid, shortfin squid, and butterfish) (Kirkpatrick et al., 2017; NEFMC, 2021; MAFMC, 2021a). Gillnetters in the Kirkpatrick Study Area primarily target monkfish, skates, and spiny dogfish, as well as summer flounder, scup, and black sea bass (Kirkpatrick et al., 2017). Pots and traps catch species in the Offshore Project Area including Jonah crab, American lobster (ASFMC, 2019a, 2021a), whelks (MA DMF, 2021a), rock crabs (Maine Sea Grant, n.d.), and black sea bass (ASFMC, 2021b).

Species-specific life history information and fishing effort within the Kirkpatrick Study Area is available in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report. The most common gear types in the Offshore Project Area are shown in **Table 11-13**, with each of those gear types discussed in Sections 11.1.1.5 through 11.1.1.9.

11.1.2.6 Aquaculture

Massachusetts cities and towns manage the aquaculture resources and activities in all waters within their boundaries that are not closed by the MA DMF for public health or other reasons; except for the commercial harvest of Atlantic surfclams and ocean quahogs which remain under federal control. The Offshore Project Area includes two proposed landfall locations that may affect nearshore commercial shellfish activities in Falmouth, Massachusetts (**Figure 11-20**). The Massachusetts Wetlands Protection Act Regulations (310 Code of Massachusetts Regulations 10.34) lists nine species of regulated commercial shellfish; fisheries for seven of these species are likely to be exposed to Project activities. This is discussed further in Appendix V, which shows that no aquaculture leases exist near the proposed landfall locations in Falmouth, but some are located within Buzzards Bay, Waquiot Bay, and further east. Mapping these habitats indicate potential shellfish habitat areas, even though not all areas will support shellfish propagation. There are no aquaculture lease sites by the Brayton Point cable landfall location(s) (**Figure 11-21**).

The CRMC is the regulatory body that manages aquaculture leasing and permits within Rhode Island waters. Much of the Rhode Island aquaculture activities occur within the State's several inland salt ponds, but aquaculture is also scattered nearshore in Narragansett Bay (RIDEM, 2021b). Although there are several approved aquaculture areas within The Cove on Aquidneck Island and adjacent to Hog Island, the export cable route is not directly adjacent or collocated with any of these sites (**Figure 11-21**).

The floating fish trap fishery in Rhode Island is a fishery and gear type unique to Rhode Island. Essentially a hybrid of a fishing weir and a fish trap, this gear is predominantly fished in shallower, inshore areas close to shore. While this is a wild capture fishery, it is in some ways permitted and operated as an aquaculture activity. Permits to operate fish traps are tied to specific, permanent locations which offer certainty in the spatial extent of fishing effort, unlike other wild capture fisheries. However, while fish trap locations offer spatial certainty, the issuance of a permit or appearance of a fish trap on the RIDEM Marine Fisheries Map does not necessarily mean that that fish trap is being actively fished. Fish traps may become actively fished at any time, although there are requirements for the fisherman to provide the necessary notifications (J. Livermore, personal communication, July 22, 2021). Mayflower Wind has conducted outreach, including to the Rhode Island Division of Marine Fisheries, and performed scouting in advance of geophysical and geotechnical surveys to gain temporal knowledge of the location of fish traps in addition to the spatial certainty offered by permit location information.

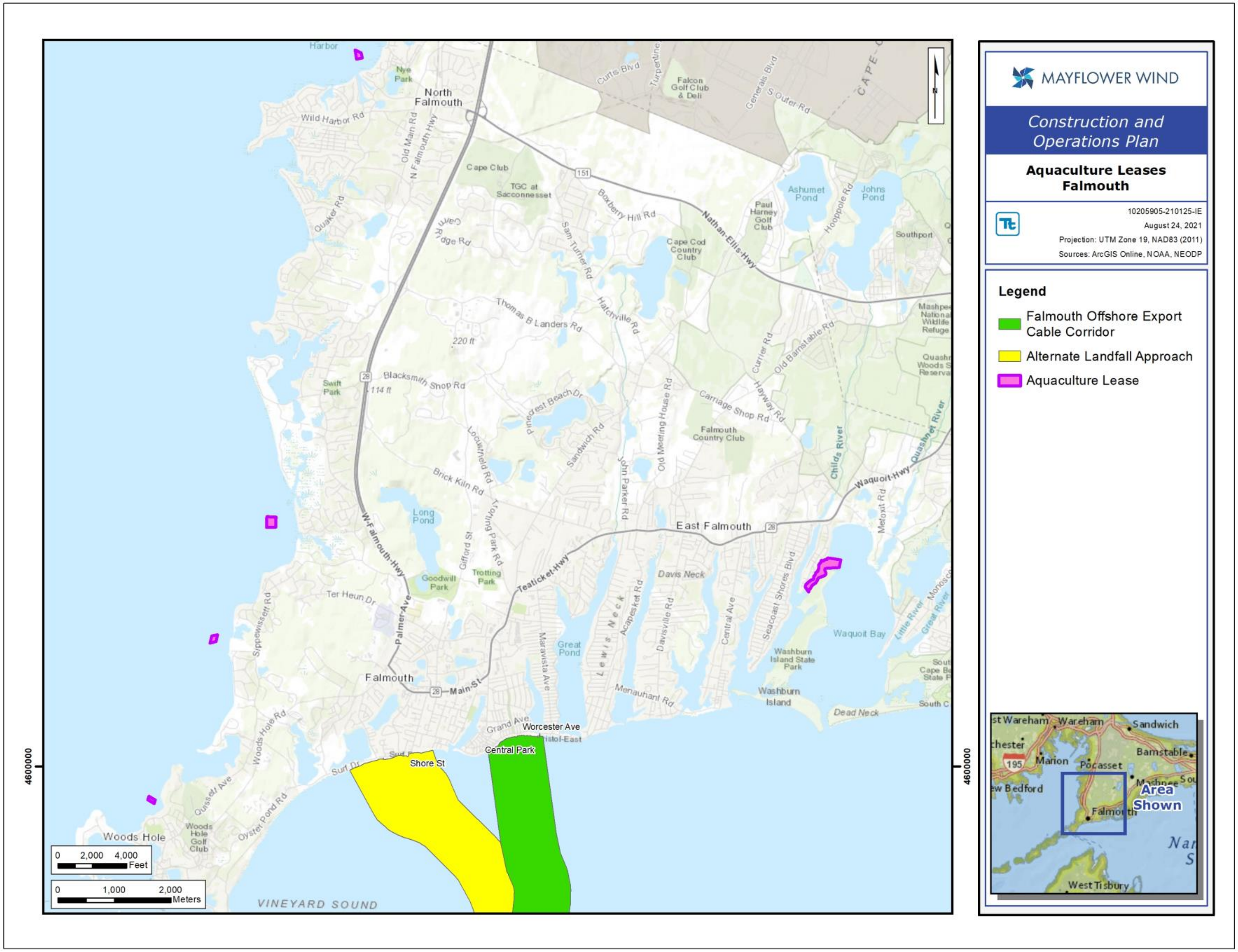


FIGURE 11-20. AQUACULTURE LEASES NEAR THE FALMOUTH EXPORT CABLE CORRIDOR

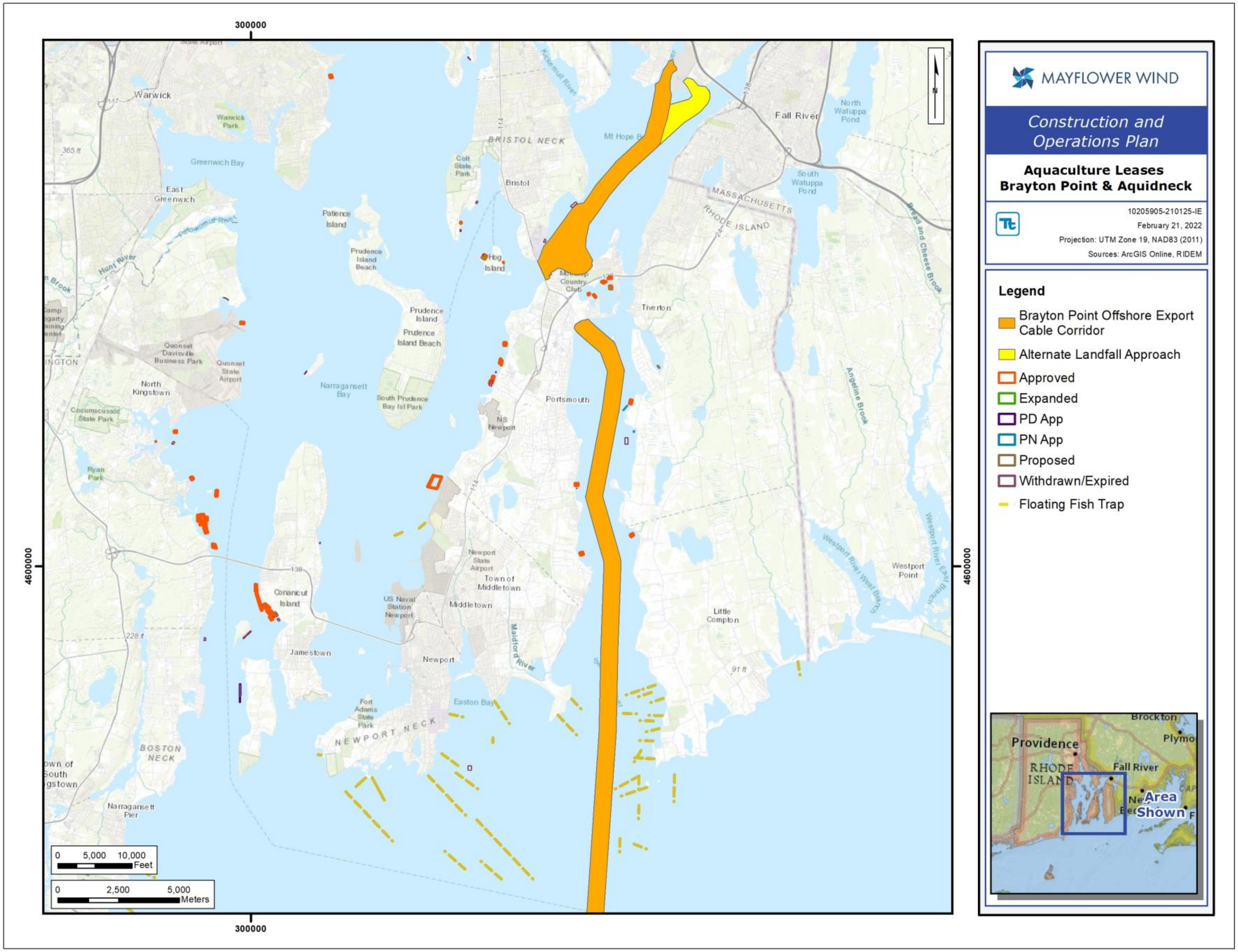


FIGURE 11-21. AQUACULTURE LEASES NEAR THE BRAYTON POINT EXPORT CABLE CORRIDOR

11.1.3 Recreational Fishing

For the purposes of this section, recreational fishing is referred to as saltwater fishing for sport or pleasure, either by for-hire boats or by private anglers (NMFS, 2020c). Recreational fishing is considered exposed in the 2017 Kirkpatrick et al., study if it occurs within 1 nm (1.9 km) of a Wind Energy Area, which, for the purposes of the proposed Project, is the Kirkpatrick Study Area (Kirkpatrick et al., 2017). The two types of recreational fishing evaluated include:

- For-hire boats, which provide, for a fee, the ability, privilege, or physical boat space to fish recreationally on a vessel that is operated by a licensed captain or crew. There are also charter boats where the boats are hired for a price and time, with participants comprising of a pre-formed group of anglers (NOAA, 2016).
- Private anglers, which are recreational fishermen who use the technique of angling, meaning they use a hook and line and fish on an angle which is a principal method of sport fishing. They also have no intent to sell the fish (NOAA, 2016).

Saltwater recreational fishing takes place from shore, aboard private or rented boats, and on boats that take passengers for hire. For-hire boats include charter boats, which generally carry six or fewer passengers and charge a boat rental fee, as well as head boats (also known as party boats), which generally carry 10 or more passengers and charge by the person (Holland et al., 2012). For-hire recreational fishing is an important economic activity throughout the Kirkpatrick Study Area and at associated onshore facilities. For-hire recreational fishing can be assessed from either a boat level or angler level. Boat level recreational fishing activity is assessed in terms of the average annual number and percentage of exposed boats, trips, and revenues. Angler level recreational fishing activity is assessed in terms of average annual number and percentage of exposed angler trips and expenditures. Approximately 430 such boats are ported in Massachusetts and 96 are ported in Rhode Island (Steinback and Brinson, 2013). Species targeted by this fishing community exist throughout the entire near-coastal region and within the Kirkpatrick Study Area. Commonly caught species for recreational fishing include striped bass, Atlantic mackerel, scup, black sea bass, and haddock (**Table 11-4**).

11.1.3.1 Recreational Economic Overview

In 2016, across New England, for-hire fishing trip expenditures were approximately $48 million, representing approximately 226,000 angler trips (NMFS, 2016). Shore and private boat recreational fishing trip expenditures in New England were approximately $215 million in 2016, representing approximately six million angler trips (for further socioeconomic data, see **Table 11-14**). Sales in 2016 (encompassing direct sales from anglers (for-hire and private) and indirect sales resulting from the original angler sale) for Massachusetts, Connecticut, and Rhode Island were approximately $1 billion, $430 million, and $412 million, respectively (NMFS, 2016).

TABLE 11-14. RECREATIONAL FISHERY TRIPS AND JOBS GENERATED IN SOUTHERN NEW ENGLAND IN 2016

State	Trips	Jobs Generated
For-Hire		
Massachusetts	93,000	350
Rhode Island	45,000	113
Connecticut	38,000	63
Shore and Private Anglers		
Massachusetts	2,000,000	1,109
Rhode Island	1,000,000	198
Connecticut	1,000,000	295

Source: NMFS, 2016

The average number of angler trips in Massachusetts is 2 million per year, with 3,972 of those from for-hire boats (Kirkpatrick et al., 2017). Total expenditures of recreational fishing between 2007 and 2012 in Massachusetts were close to $140 million, with 1.8 percent of those expenditures exposed to WEAs (Kirkpatrick et al., 2017).

Total expenditures of recreational fishing between 2007 and 2012 in Rhode Island were $1.1 million with 3.8 percent exposed to WEAs (Kirkpatrick et al., 2017).

Recreational fishing aboard and private boats is considered exposed if it occurs within 1 nm (1.9 km) of the Offshore Project Area (Kirkpatrick et al., 2017).

In 2019, 7,422,488 angler trips were estimated to occur in state and federal waters off the coast of Massachusetts (NMFS, 2019a) and 3,739,018 angler trips were estimated to occur off the coast of Rhode Island (**Table 11-15**). Recreational fishing also includes private anglers not involved in for-hire fishing activity from the shore or private vessels in the area.

TABLE 11-15. RECREATIONAL FISHING TRIPS IN MASSACHUSETTS AND RHODE ISLAND BY MODE IN 2019

Fishing Mode	Massachusetts Angler Trips	Rhode Island Angler Trips
Shore Fishing	4,712,501	2,320,516
Private/Rental Boat	2,510,764	1,384,014
Charter Boat	114,702	18,053
Party Boat	84,520	16,435
Total for All Fishing Modes	7,422,487	3,739,018

Source: NMFS, 2019a

11.1.3.2 Recreational Fishing in the Offshore Project Area

Four of the ten most commonly caught recreational species caught in Massachusetts and Rhode Island were also recorded caught within the Offshore Project Area (**Table 11-16** and **Table 11-17**). Atlantic mackerel, scup, back sea bass, and bluefish were caught in the Lease Area and/or the export cable corridors.

TABLE 11-16. COMMONLY CAUGHT RECREATIONAL FISH SPECIES IN MASSACHUSETTS (2019)

Rank	Species	Pounds (lbs.)
1	Striped bass	2,697,766
2	Atlantic mackerel	2,340,416
3	Scup	1,924,223
4	Black sea bass	1,361,124
5	Haddock	1,233,756
6	Atlantic menhaden	846,444
7	Bluefish	719,137
8	Tautog	646,039
9	Acadian redfish	618,604
10	Little tunny	227,636

Source: NMFS, 2019a

TABLE 11-17. COMMONLY CAUGHT RECREATIONAL FISH SPECIES IN RHODE ISLAND (2019)

Rank	Species	Pounds (lbs.)
1	Scup	2,856,492
2	Striped bass	2,299,617
3	Tautog	1,483,139
4	Black sea bass	1,225,072
5	Bluefish	932,001
6	Summer flounder	837,116
7	Atlantic cod	143,753
8	Atlantic menhaden	135,763
9	Atlantic bonito	102,213
10	Striped sea robin	53,819

Source: NMFS, 2019a

Recreational fishing locations occur near Nantucket Sound, in and around various shoals, within the Sakonnet River, and in and around the Offshore Project Area. Recreational fishing boats may transit through the Offshore Project Area to reach a site, but their exact transit routes are not represented on commonly used, publicly available datasets, as these vessels do not have the VMS or VTR requirements discussed previously for commercial fishing vessels. Many recreational fishing vessels do not have AIS carriage requirements and so are not represented in datasets summarizing AIS vessel activity. More specifics on these limitations are provided in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report). There are ten fishing locations in the vicinity of the Offshore Project Area, as well as shipwrecks in the Lease Area and export cable corridors.

Figure 11-22 and **Table 11-18** below, show known recreational fishing areas in relation to the Offshore Project Area.

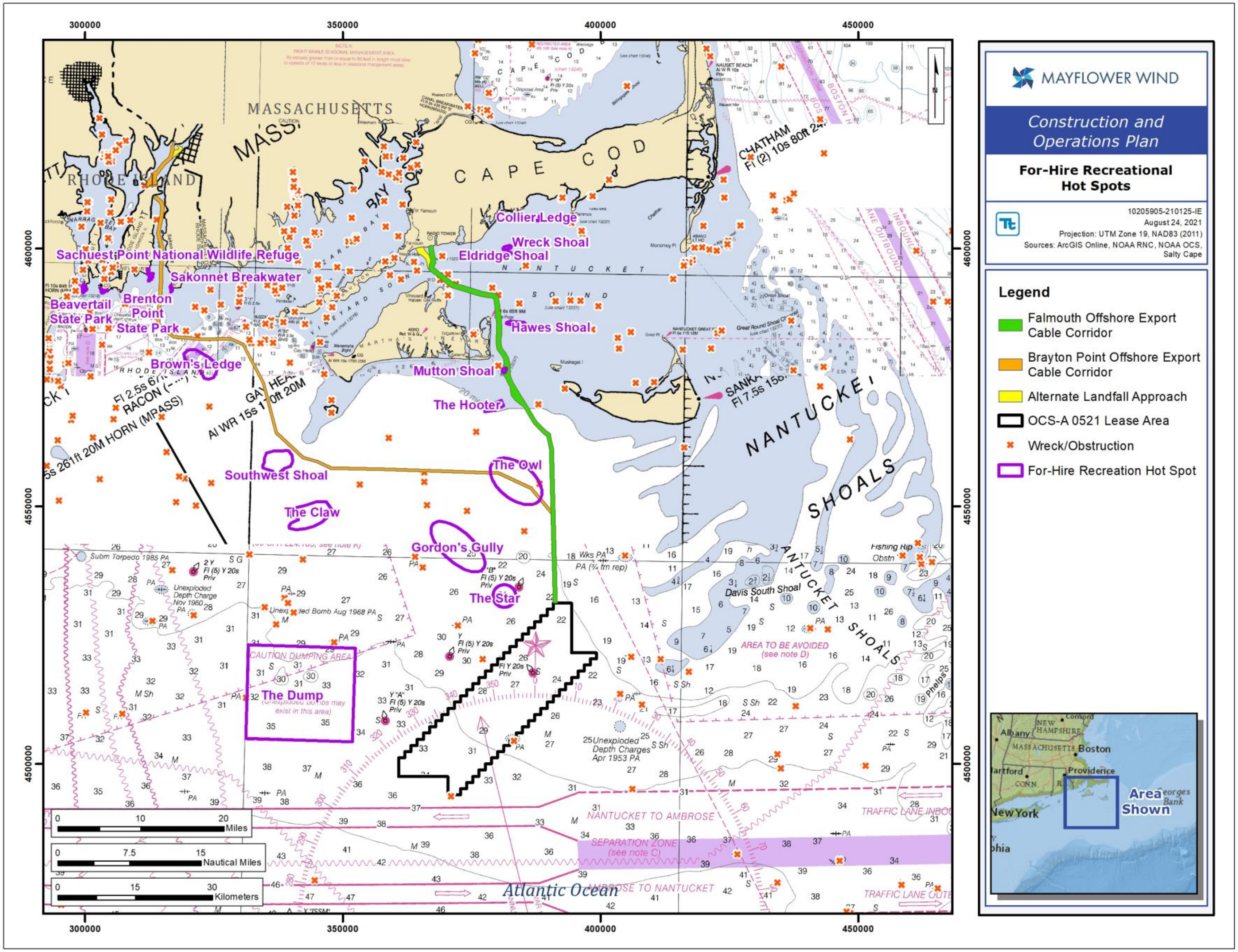


FIGURE 11-22. RECREATIONAL FISHING LOCATIONS NEAR THE OFFSHORE PROJECT AREA

TABLE 11-18. FOR-HIRE RECREATIONAL FISHING LOCATIONS WITHIN OR NEAR THE OFFSHORE PROJECT AREA

Name of Fishing Location	Location	Fish species targeted a/
The Dump	Approximately 100 mi^2 (260 km^2) in size. According to NOAA charts located west of the Lease Area	Yellowfin tuna, albacore tuna, and mahi-mahi
The Star	Along 25 fathom line outside the Offshore Project Area	Yellowfin tuna
Gordon's Gully		Bluefin tuna, Mako, and thresher sharks
The Owl	Along 20 fathom line outside the Offshore Project Area	
Mutton Shoal	Located in Muskeget Channel	Striped bass, bluefish, false albacore, bonito, summer flounder, black sea bass, and scup.
Hawes Shoal	North of Muskeget Channel	
Eldridge Shoal	In Nantucket Sound	
Wreck Shoal		
Colliers Ledge		
The Hooter	Marker for the end of Muskeget Channel southwest of Martha's Vineyard	Striped bass, bluefish, bonito, and false albacore
Brown's Ledge	Offshore of Sakonnet Point	Scup, black sea bass, striped bass, summer flounder, bluefish
Southwest Shoal	Southwest of Martha's Vineyard	Scup, black sea bass, striped bass, summer flounder, bluefish
Beavertail State Park	The opening of the West Passage, inshore	Scup, black sea bass, striped bass, summer flounder, bluefish
Brenton Point State Park	The opening of the West Passage, inshore	Scup, black sea bass, striped bass, summer flounder, bluefish
Sachuest Point National Wildlife Refuge	The opening of the East Passage, inshore	Scup, black sea bass, striped bass, summer flounder, bluefish
Breakwater at Sakonnet	Inshore of the East Passage, Sakonnet River	Scup, black sea bass, striped bass, summer flounder, bluefish

Sources: CRMC, 2010; Google, 2021.
Note:
a/ For-hire recreational fishing typically occurs from spring through fall for summer flounder, black sea bass, and scup and in late summer/early fall for yellowfin, bluefin, and albacore tuna, sharks, bonito, and false albacore. Striped bass recreational fishing typically occurs in the spring summer and fall.

11.1.3.3 Summary of Recreational Fishing in the Offshore Project Area

This section summarizes recreational fishing activity in the Offshore Project Area and the exposure of these fisheries to the proposed Project. As previously defined, recreational fishing activity is considered to be exposed in the Kirkpatrick et al., study if it occurs within 1 nm (1.9 km) of a WEA, which, for the purposes of the proposed Project, is the "Kirkpatrick Study Area". Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report provides a more in depth look at these fisheries and the fishing activity that targets them. The species commonly caught by recreational fisheries in and around the Offshore Project Area are described in Appendix V. Each are targeted during different seasons within different parts of the Offshore Project Area. This fishing activity is impacted by species abundance, locations of structure, and regulations.

11.1.3.3.1 Lease Area

As shown in **Figure 11-22**, there are no commonly targeted recreational fishing locations in the Lease Area. However, there is some level of recreational fishing effort in the Lease Area, primarily for HMS. This effort is limited in duration and overlaps with the presence of HMS in the Lease Area that is being studied by the Anderson Cabot Center with support from Mayflower Wind that is discussed above in Section 11.1.5. Therefore, there are limited impacts presented to for-hire vessels since it is unlikely that many will be transiting through the Lease Area to fish. However, there are known shipwrecks within the Lease Area that may attract recreational fishing within the Offshore Project Area as shown on **Figure 11-22**.

11.1.3.3.2 Export Cable Corridors

The known, commonly targeted recreational fishing locations shown in **Figure 11-22** in and around the export cable corridors indicate that recreational fishing boats will transit through these areas. The precise frequency of these boats is not captured in existing data, but recreational fishing effort is known to exist in and around the export cable corridors. Much of the effort is clustered in several locations as these boats target these locations (see Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report). There are also known shipwrecks within the export cable corridors that may attract recreational fishing within the Offshore Project Area (**Figure 11-22**). In the Sakonnet River, there are relatively low levels of recreational shellfishing, notably for hard clams. Rhode Island allows for recreational harvesting of whelk and bay scallops by Rhode Island residents (with no license requirement), and for the recreational harvesting of lobster and crabs (with a license requirement; RIDEM, 2021c).

11.1.3.3.3 Landfall Locations

Finfish and shellfish are targeted by recreational fishermen near the landfall locations (see Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report). American lobster occur near the landfall locations, and bay scallops and oysters are harvested under a permitted fishery from April-October in Massachusetts (RIDEM, 2021, MA DMF, 2021b; see also Appendix V). In Rhode Island waters, oysters may be harvested with a state permit from September-May, and bay scallops may be harvested in November and December, depending on the gear type (RIDEM, 2018).

11.1.3.3.4 Fishing Ports

Recreational fishing vessels belonging to both charter companies and private anglers often dock at various locations, such as Martha’s Vineyard, Nantucket, Newport, and smaller docks and marinas not used by the commercial fishing fleets (Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report). The Offshore Project Area will not be using these smaller docks or marinas for general Project activities.

11.1.4 Fisheries Outreach

Mayflower Wind is actively engaged in outreach and two-way communication with the fishing community and with organizations that work on the overlap of fishing and offshore wind. Those in the fishing community that Mayflower Wind has communicated with range from individuals to fishing captains to large businesses. The organizations with whom Mayflower Wind have communicated with range from federal agencies to non-profits to task forces. Mayflower Wind is currently working with three FRs, the Massachusetts Lobstermen's Association (MLA), the New Bedford Port Authority (NBPA), and the Commercial Fisheries Center of Rhode Island (CFCRI).

Mayflower Wind's FLO and other members of the Fisheries Communication Team talk directly with fishermen, sit on boards and working groups of organizations alongside fishermen, and engage directly with fishermen in scientific research and other efforts. Project development has been and will continue to incorporate input from stakeholders in the fishing industry in a way that allows it to minimize interference with fishermen that have been fishing in the regional area for hundreds of years. Mayflower Wind will continue to strengthen existing and build new relationships with fishing organizations throughout Project development, construction, and operations. A list of outreach engagements with entities involved in the overlap of fisheries and offshore wind to date is provided in **Table 11-19**.

Mayflower Wind's FRs, the MLA, the NBPA, and the CFCRI, collaborate on initiatives that minimize impacts to fisheries in the Offshore Project Area, provide information to Mayflower Wind from the fishing industry, and disseminate information from Mayflower Wind to the fishing industry. The MLA is a member-driven organization that accepts and supports the interdependence of species conservation and the members' collective economic interests (MLA, 2021).

Mayflower Wind and the MLA will work together to identify potential impacts to the lobstering community in the Offshore Project Area and collaborate on science initiatives that will help to better understand natural impacts to lobster in the region and to investigate potential impacts or changes to lobster populations with the introduction of offshore Project infrastructure.

The NBPA focuses on industry outreach and collaboration by implementing the best management practices over port resources and developing economic growth strategies for New Bedford (The Port of New Bedford, 2021). The number of boats utilizing the port provides strong representation of the local commercial fishing industry. Mayflower Wind's relationship with the Port and its vessels is critical to collaboratively minimizing potential impacts to fishermen.

The CFCRI was founded to preserve commercial fishing as a profession, culture, and way of life through promoting the sustainability of the resource. The CFCRI brings fishermen, scientists, managers, and elected officials together in a collaborative effort to improve fisheries and the understanding of the marine environment (CFCRI, 2021).

In addition to the MLA, the NBPA, and the CFCRI, Mayflower Wind has engaged with the following efforts and organizations, including:

- The Responsible Offshore Development Alliance Joint Industry Task Force
- The Responsible Offshore Science Alliance (ROSA)

- New York State Renewable Energy Development Authority's (NYSERDA's) Fisheries Technical Working Group
- Commonwealth of Massachusetts Fisheries and Habitat Working Groups on Offshore Wind Energy

This list does not include federal (BOEM, NMFS, USCG) or state (MA DMF, MA CZM, CRMC, RI DMF) agencies that Mayflower Wind has engaged with specific to the COP or other specific Project permit meetings or individual fishermen/fishing companies Mayflower Wind has engaged with to coordinate geophysical and geotechnical surveys and other activities.

TABLE 11-19. MAYFLOWER WIND OUTREACH TO ENTITIES INVOLVED IN THE OVERLAP OF FISHERIES AND OFFSHORE WIND TO DATE

Entity	Regional	Massachusetts	Rhode Island
Anderson Cabot Center for Ocean Life at the New England Aquarium	✓		
Cape Cod Fisherman's Alliance		✓	
CFCRI			✓
Commercial Fisheries Research Foundation			✓
Coonamessett Farm Foundation	✓		
Fisheries Survival Fund	✓		
Massachusetts EEA Fisheries Working Group on Offshore Wind Energy		✓	
MLA		✓	
Mid-Atlantic Fishery Management Council	✓		
NBPA		✓	
NEFMC	✓		
NYSERDA's Fisheries Technical Working Group	✓		
Patriot Party Boats		✓	
Recreational Fishers Association	✓		
Responsible Offshore Development Alliance			
ROSA	✓		
Rhode Island Commercial Fishermen's Association			✓
Seafreeze Ltd. and Seafreeze Shoreside			✓
The Town Dock			✓
University of Massachusetts Dartmouth School for Marine Science and Technology (SMAST)	✓		

Mayflower Wind has conducted and continues to conduct stakeholder outreach in advance of and during geophysical and geotechnical surveys to further understand the multifaceted components that make up the regional fishing industry. This has involved the Mayflower Wind FLO communicating directly with the fishing industry, including with individual fishing vessels in and around survey areas, to gather area and vessel-specific information to design surveys in a way that understands and incorporates fishing activity and to coordinate survey activities with fishing activities. Additionally, Mayflower Wind has hired local fisherman to conduct pre-survey scouting via the MLA in its role as an FR for Mayflower Wind; this informs Mayflower Wind's survey activities. This includes both the identification of fixed fishing gear and also provides local knowledge of fishing activity. When practicable, Mayflower Wind has also added fishermen with local experience as Fisheries Onboard Representatives (FORs) on survey vessels to coordinate survey activities with fishing activities. FORs communicate directly with fishing vessels in real time, providing input to the Mayflower Wind FLO and the survey vessel based on their experience as commercial fishermen in the area, and recording the presence of fishing vessels and activity.

Work completed by FORs during geophysical and geotechnical surveys has provided very useful information to survey vessels to deconflict surveying and fishing activities, confirming generally known information about fishing activity in the area, and providing Mayflower Wind with significant additional knowledge of fishing activity in the area. This real-time coordination supplements the advance coordination outreach efforts made by the Mayflower Wind FLO. A more complete discussion of this and other Mayflower Wind outreach to the fishing community is provided in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report, and Appendix W, Fisheries Communication Plan.

11.1.5 Proposed Fisheries Monitoring Research and Activities

Mayflower Wind will be working with the University of Massachusetts Dartmouth's School for Marine Science and Technology (SMAST) and the Anderson Cabot Center of Ocean Life at the New England Aquarium to conduct baseline of existing fisheries information in and around the Lease Area and establish monitoring plans for pre-construction, construction, operations, and decommissioning phases of the Project Area. Mayflower Wind is working with SMAST, the Anderson Cabot Center, and federal and state agencies to prepare fisheries monitoring plans that are aligned with BOEM guidelines (BOEM, 2020a), and additional recommendations provided by the ROSA Fisheries Monitoring Working Group.

These plans will incorporate coordination with neighboring lease holders and agencies' research and monitoring, leverage existing surveys and control sites based on previous work conducted by both institutes, and provide adaptability and flexibility to adjust as new information is learned and/or new regional programs are established. Fisheries surveys being considered are detailed in **Table 11-20**.

Additionally, Mayflower Wind is working with adjoining lease holders to share fisheries survey data and is participating in the Commonwealth of Massachusetts Fisheries Working Group on Offshore Wind Energy to help establish state-wide offshore survey consistency for fisheries. Furthermore, Mayflower Wind plans financial and in-kind support to advance the collective understanding of Massachusetts fisheries ecology, ecosystems, and management.

Mayflower Wind's fisheries-focused efforts to fueling innovation, advancing research, and building consistency across modeling, monitoring and research efforts are further detailed below in **Table 11-20**.

TABLE 11-20. FISHERIES SURVEYS BEING CONSIDERED BY MAYFLOWER WIND

Marine Fish Surveys and Studies in Planning Stage	Focus
Trawl surveys	Collect baseline data and to evaluate changes to mesoscale abundance and distribution of fish (demersal and benthic species) within Offshore Project Area. Trawl surveys will be video trawls of finfish and squid resources in the Lease Area and control areas.

Marine Fish Surveys and Studies in Planning Stage	Focus
Acoustic surveys	Collect baseline data and to evaluate changes to abundance and distribution of fish (pelagic and highly migratory species) around offshore structures. These surveys will be incorporated into innovation and environmental research partnerships.
Underwater video/photography surveys (drop camera system, remotely operated vessels [ROVs])	Collect baseline data and to evaluate changes to abundance and distribution of invertebrate (scallops, etc.) and benthic habitats. Monitor reef effects of offshore structures and foundations. Surveys utilize SMAST drop camera and net camera technology. A component of these is incorporated into innovation and environmental research partnerships.

Mayflower Wind's scientists have been working closely with fishing organizations and government agencies to identify pathways to initiate research, standardize monitoring, minimize duplication of effort, and explore avenues to ultimately maximize effectiveness across regulatory requirements related to fisheries.

Through early engagement with fisheries managers, regulators, and fishermen, Mayflower Wind understands the importance and urgency for research to answer outstanding questions on potential impacts to fish and their habitats from offshore wind development. As identified by the MA DMF, there are opportunities for wind developers conducting site characterizations and impact assessment research to coordinate and leverage resources to enable a broader understanding across wind energy areas and leases. In addition to participation in ROSA, Mayflower Wind is participating in the following research efforts to bring action and address the urgency expressed by stakeholders.

Mayflower Wind provides the oceanographic data from the floating LiDAR metocean buoy in real-time through NOAA's Integrated Ocean Observing Program region - Northeastern Regional Association of Coastal Ocean Observing Systems Mariners Dashboard. Researchers and fishermen can access the real-time information to supplement projects and inform fishing activities. Mayflower Wind has also allowed researchers to add sensors to the buoy.

In 2019, Mayflower Wind supported extension of the geographic range a study executed by the MA DMF, SMAST, the Anderson Cabot Center, and the NEFSC. The study is designed to map cod spawning habitat around the offshore wind areas in southern New England. Specifically, acoustic telemetry devices used to track tagged fish were added to Mayflower Wind's metocean buoy to document presence of tagged cod that crossed into the Lease Area.

Mayflower Wind, as part of its 83C II bid, is contributing $10 million in environmental research funding that will include support to ROSA and the Anderson Cabot Center. The intent of this funding is to improve coexistence of offshore wind and fisheries. This contribution will help to fund regional fisheries science and monitoring and will be committed to increasing understanding highly migratory fish species that transit in and around the Mayflower Wind Project area, as well as test and explore new technologies for monitoring and detection of fish species.

This funding will also support the collection of data related to movement ecology, biology, and population structure of fish species and other efforts to increase the understanding of how migratory species may respond to installation and operations of WTGs.

11.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's *2020 Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

This section also draws from related analysis provided in other sections and appendices, including Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report; Appendix X, Navigation Safety Risk Assessment; Appendix M, Benthic and Shellfish Resources; Appendix N, Essential Fish Habitat Assessment; Appendix W, Fisheries Communication Plan; Appendix F1, Sediment Plume Impacts from Construction Activities; Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment; and Appendix U2, Underwater Acoustic Assessment.

As described earlier in this section, this analysis includes potential impacts to commercial and recreational fishing (both for-hire and private anglers).

Project activities that may displace or impact commercial and recreational fishing are listed in **Table 11-21** and further described in Section 3, Description of Proposed Activities. The construction, operations and maintenance, and decommissioning phases of the proposed Project will introduce IPFs that may result in impacts to commercial or recreational fisheries and fishing activity described in this section. Mayflower Wind will develop and implement measures to avoid, minimize, and mitigate the potential for impacts that may occur as a consequence of these factors.

TABLE 11-21. IPFS AND POTENTIAL EFFECTS ON COMMERCIAL AND RECREATIONAL FISHERIES

IPF	Potential Effects		Period of Effect		
	Project Components		Project Phase		
	Lease Area	ECCs	Construction	O&M	Decomm.
Actions that may displace biological resources, cultural resources, or human uses	Vessel activity and presence of infrastructure	Vessel activity and presence of infrastructure	X	X	X
Activities that may displace or impact fishing, recreation, and tourism	Vessel activity and presence of infrastructure, gear interactions	Vessel activity and presence of infrastructure, gear interactions	X	X	X

11.2.1 Vessel Activity and Presence of Infrastructure

11.2.1.1 Construction

Project construction activities will result in an increase in Project vessel traffic while offshore Project components are transported by vessel(s) to, and installed within, the Offshore Project Area during the construction phase, as described in Section 3, Description of Proposed Activities. Vessels delivering and installing Project components may result in temporary navigation impacts to commercial or recreational vessels around areas with confined channels, such as at the Port of New Bedford or the Sakonnet River. The increase of vessel traffic in the Offshore Project Area may impact inshore traffic zones along the export cable corridors to the Lease Area. See the NSRA (Appendix X, Navigation Safety Risk Assessment) for further details on the anticipated increase in vessel activity during the various Project phases.

Mayflower Wind conducted an NSRA (Appendix X) to calculate future risks to mariners and determine fishing activity and ports in the area. During construction, the short-term increased Project-related vessel traffic may result in increased collision risk, relative to the existing levels of vessel traffic in the Offshore Project Area, as described in Rawson et al., (2015; see Section 13, Navigation and Vessel Traffic). The NSRA indicates the change in vessel traffic for the Lease Area during the construction phase will result in a modeled collision risk for fishing vessels occurring at a rate of less than 5 incidents in 10,000 years, representing a negligible increase in collision risk during the construction phase. Project-related vessels will be required to follow the appropriate (existing) transit lanes and fairways, navigational routes (where appropriate, during transit) and communicate to other mariners via Local Notice to Mariners (LNMs) and/or radio communications to minimize risks to the commercial and recreational fishing industries, as well as other mariners.

Commercial and recreational fishermen may be temporarily excluded from actively fishing within or transiting through the localized construction areas and safety exclusion zones during this phase of the proposed Project. This may result in a temporary loss of access to fishing grounds. While construction activities are expected to cover a total duration of up to 3 years, each construction activity (e.g., WTG installation, cable lay, etc.) will only cover discrete and localized portions of the Offshore Project Area on a temporary basis, relative to the available open water to navigate through, or grounds to fish within, as detailed in Section 3, Description of Proposed Activities. Once construction activities are completed within safety exclusion zones, marine activities, including commercial and recreational fishing, will be allowed to continue as they were prior to construction. As shown in **Figure 11-14**, the Offshore Project Area is more frequently used for vessels transiting through to their desired fishing locations than for active fishing.

As construction begins, commercial and recreational fishermen may find their route extended at times to accommodate certain construction activities, which could temporarily increase their steam times to access fishing grounds. The 1 nm x 1 nm (1.9 km x 1.9 km) grid spacing of WTGs, even while partially installed during the construction phase, will allow commercial and recreational fishing vessels the ability to maneuver around (and within) the Offshore Project Area in a safe manner. As discussed in the Fisheries Communication Plan (Appendix W), Mayflower Wind will coordinate with fishermen and the USCG ahead of marine construction operations to review operational planning and schedules to identify areas where fishing operations may be temporarily displaced. These strategies include broad communication strategies (e.g., LNMs) and also targeted, direct outreach to coordinate construction and fishing activities in order to minimize risks to the commercial and recreational fishing industries, as well as other mariners. Mayflower Wind will continue to participate in the MA/RI WEA joint developer Marine Affairs Working Group.

Mayflower Wind has formed agreements with the Port of New Bedford for the docking of Project vessels. The Mayflower Wind team has analyzed specific vessel traffic during construction to mitigate and plan for the increase in vessel volume as a result of the construction phase. See Section 3, Description of Proposed Activities, for more information on potential ports to be used for Project activities. Commercial and recreational fishermen will be notified about Project port use and how vessels will be accommodated via the methods described within the Fisheries Communication Plan (Appendix W). Information on port activities, locations of partially installed structures, offshore construction activities, as well as the locations and schedules of safety zones, will be communicated directly to fishermen. This information will also be published on the Mayflower Wind website, social media channels, and in LNMs.

11.2.1.2 Operations and Maintenance

During routine O&M activities of the proposed Project, it is expected that increased vessel traffic due to regular maintenance efforts will be present around the area. Mayflower Wind has completed a NSRA (Appendix X) which includes identification of possible navigation risks and potential mitigation measures.

Project vessels will be used to perform routine maintenance on the offshore Project components. However, as described in the Section 13, Navigation and Vessel Traffic Section, vessel traffic generated will be an order of magnitude lower than vessel traffic generated during construction of the proposed Project. Vessel activity during the O&M phase will typically involve single vessels transiting at far less frequent intervals than during construction (or decommissioning phases), and therefore is not expected to create measurable interference with commercial or recreational fisheries activities. Therefore, once the proposed Project is operational, fishing vessels will not be considerably impeded from accessing their home ports or their fishing grounds within or outside of the Lease Area or export cable corridors. Vessels anticipated to be used during the O&M phase of the proposed Project are included in Section 3, Description of Proposed Activities.

For unplanned maintenance of the offshore export cables, a vessel may require anchoring within the export cable corridors. If required, this would also be a low-frequency, short-term activity. In addition, Mayflower Wind will continue to ensure that all Project-related vessels follow appropriate navigational routes and other USCG requirements, communicate via USCG LNMs, issue regular mariner updates and/or direct offshore radio communications to help mitigate risks to the commercial and recreational fishing industries, as well as other mariners.

During the O&M phase of the proposed Project, there will be permanent infrastructure installed within the water column, on the seafloor, and beneath the seafloor within the Lease Area and the export cable corridors. This may lead to potential displacement from fishing grounds if some portion of commercial and recreational fishermen choose to not transit or fish within the Offshore Project Area once infrastructure is installed and operational. This may also concentrate vessel activity to locations just outside of the Offshore Project Area or in the transit corridors within the WTG array, which may lead to a potential increase in the long-term risk of vessel collision or allision.

However, there are 231 transit corridors in four cardinal directions within the 1 nm x 1 nm WTG array in the MA/RI WEA to promote safe transit and navigation. adequate marking and lighting in accordance with BOEM, USCG, and there will also be long-term allision risk (vessel to static hazard) when transiting through the Lease Area during the operational phase (see the NSRA, Appendix X). Mayflower Wind will ensure that the operational WTGs and OSPs include FAA approved measures to promote and allow for safe vessel operation.

To minimize displacement of fishing activity within the Offshore Project Area, Mayflower Wind has signed an agreement with the other New England lease developers (Orsted, Vineyard Wind, and Equinor Wind) to standardize the collective grid layouts to 1 nm x 1 nm (1.9 km x 1.9 km) in east-to-west rows (Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC, 2019). This proposed layout was designed with input from the Rhode Island Fisheries Advisories Board, the Massachusetts Fisheries Working Group on Offshore Wind, offshore wind developer FLOs and FRs, fishing fleet operators, fish processing companies, and NMFS.

The purpose of this standardized grid layout is to design the Offshore Project Area to the grid layout preferred by many stakeholders (including fishermen) to provide safe transit through adjacent Lease Areas without the need for designated transit corridors. The regular orientation of the grid follows a historical pattern of fixed gear deployment to minimize conflict between mobile and fixed gear users. The identification of this pattern and the implementation of the 1 nm x 1 nm grid as a mitigation strategy was conducted via outreach to the fishing industry. With this design, it is expected that commercial and recreational fishing (and transits) will still occur safely within the Lease Area during operations and that navigational risk will be low.

The NSRA indicates the change in vessel traffic for the Lease Area during the operational phase would result in a modeled allision risk for fishing vessels occurring at a projected rate of less than 0.4 incidents per year, which represents a minor increase in allision risk relative to the approximately 30-year operational period of the proposed Project (see Appendix X, Navigation Safety Risk Assessment). In the Lease Area, safety zones will be instituted immediately surrounding each of the installed WTGs and OSPs and associated with O&M vessel activities. However, these safety zones will generally be located only within the immediate vicinity surrounding each of the WTG and OSP substructures. Mayflower Wind will maintain regular communications and updates with stakeholders on timing and locations of maintenance activities in order to avoid, minimize, and mitigate impacts, as discussed in Appendix W, Fisheries Communication Plan.

Recent reports have depicted the size and scale of safe fishing navigation within offshore wind farm areas. As part of the New York Offshore Wind Master Plan (2017), NYSERDA produced scaled drawings to provide stakeholders with a better understanding of the area between WTGs relative to typical vessel and gear spreads, and to provide context for the scale of representative vessels (an 87-foot [27 m]-long otter trawler and a 120-foot [37 m]-long clam dredge vessel) while transiting and fishing within a turbine spacing layout of 0.78 nm (NYSERDA, 2017).

The 1 nm x 1 nm (1.9 km x 1.9 km) layout provides even greater separation between vessels and WTGs/OSPs, reinforcing the concept that this layout will promote and allow for safe fishing operation (including vessel turns) within the Lease Area. The findings of the Massachusetts Rhode Island Port Access Route Study (MARIPARS) and other studies suggest that commercial and recreational fishing vessels will be able to operate safely within the 1 nm x 1 nm (1.9 km x 1.9 km) layout once the proposed

Project is operational. More information on vessel collision/allision risk can be found in Appendix X, Navigation Safety Risk Assessment.

VMS, VTR, and AIS data demonstrate that fishing activity and transit activity are generally lower within the Lease Area compared the export cable corridors with higher activity adjacent to Martha's Vineyard and Nantucket (see **Figure 11-7** through **Figure 11-14**). The export cable corridors are used more frequently by vessels actively fishing, compared with the Lease Area, which has less fishing activity (see **Figure 11-7** through **Figure 11-14**). The Lease Area is primarily used by fishing vessels transiting through it to their desired fishing areas located outside of the Offshore Project Area (see **Figure 11-14**). These activities are expected to continue while the proposed Project is operational and Mayflower Wind will not exclude or restrict fishing activity from the Offshore Project Area, except for safety zones in the immediate vicinity of installed in-water structures (e.g., WTGs, OSPs) within the Lease Area.

During the O&M phase, commercial fishermen may find their route extended if they choose to avoid the WTG array, which could increase their transit times to locations offshore from the proposed Project by up to 30 minutes (Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC, 2019). The USCG conducted the MARIPARS study in 2019 to address questions around navigation in the MA/RI WEA. Through various consultations and meetings, the USCG determined that if a WTG layout within the MA/RI WEA is developed in a standard and uniform grid patterns among Lessees, this will accommodate safe navigation corridors for vessels transiting through and fishing within the MA/RI WEA (USCG, 2020). A separate analysis conducted by Baird (2019) concluded that an agreement of WTG spacing of 1 nm X 1 nm (1.9 km x 1.9 km) will allow for these vessels to more easily maneuver through the sites (Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC, 2019), as compared to a non-grid layout optimized for power generation potential.

The Lease Area itself was sited by BOEM in an appropriate location regarding the avoidance and minimization of impacts to the commercial and recreational fishing industry, as described in BOEM (2013). The Kirkpatrick Study Area, inclusive of the Mayflower Wind Lease Area, exhibits low fishing intensity relative to other areas in the region. The average annual revenue intensity in the Kirkpatrick Study Area is $1,009 per square km as compared to other areas of state and federal waters in southern New England that exhibit fishing intensities as high as $21,644 per square km (Kirkpatrick, 2017). This is further supported by VTR landings data specific to the Offshore Project Area (provided by NMFS) showing that the average annual landings of all fish species caught in the Lease Area between 2008 and 2018 was valued at $403,983 per year, with no single species accounting for more than 1.0 percent exposure within the Lease Area during that same time period (see **Figure 11-7**).

For the Falmouth export cable corridor, the same data shows that the average annual landings of all fish species caught in the Falmouth export cable corridor between 2008 and 2018 was valued at $952,553 per year, with no single species accounting for more than 3.9 percent exposure within the export cable corridor during that same time period (see **Table 11-11**). While exposure for all species from the Lease Area is 1 percent or less, there are higher levels of exposure within the Falmouth export cable corridor for individual species, namely:

- Longfin squid in the Falmouth export cable corridor = 0.6 to 3.9 percent exposure
- Channeled whelk in the Falmouth export cable corridor = 0.6 to 2.4 percent exposure

Within the Brayton Point export cable corridor, the annual yearly landings for all species was valued at $910,751. There were no species with a maximum exposure within the export cable corridor over 1 percent.

Longfin squid and channeled whelk represent the highest levels of exposure in the Offshore Project Area, which is reflective of the concentration of fishing activity for these species shown in (**Figure 11-9** and **Figure 11-10**). However, once the proposed Project is operational, the gear types used by these fisheries (e.g., midwater trawls for squid, pots for whelk) are not expected to be impacted by the presence of the buried offshore export cables within the export cable corridors. Therefore, following installation of the proposed Project, these fisheries are expected to continue to account for landings within the ranges reported from 2008 to 2018, barring outside sources of variance (e.g., inter-annual variation of population abundance, geographic shifts, climate change, or other factors, such as market forces or regulations). **Table 11-10** and **Table 11-11** provide additional breakouts of VTR species-level exposure data within the Offshore Project Area.

Furthermore, in the Lease Area, the 1 nm x 1 nm spacing of substructures is expected to minimize the impact to the squid fishery as well as other vessel fishing in or transiting through the Offshore Project Area.

Assuming that current transit patterns continue following Project installation, the findings of the MARIPARS and other studies suggest that commercial fishing vessels will be able to operate safely within the 1 nm x 1 nm layout once the proposed Project is operational. This is described in more detail in Appendix X, Navigation Safety Risk Assessment. The Baird study (2019) concluded that fishing vessels will be able to safely transit through the MA/RI WEA, including the Mayflower Wind Lease Area. That study also concluded that the presence of structures during the O&M phase of the proposed Project is expected to represent zero to negligible increases in transit times for fishing vessels; with a maximum increase of 30 minutes for vessels that choose to avoid the MA/RI WEA while transiting to locations offshore from the Lease Area (Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC, 2019).

As discussed previously, higher levels of fishing activity occur outside of the Lease Area than in it so more vessels will be transiting through or around, rather than fishing within the Lease Area, as highlighted in **Figure 11-14**.

The presence of installed structures in the Lease Area may result in an increase in the use of the Lease Area by recreational fishermen. This has been observed at previously installed offshore wind developments due to a well-known interplay between the introduction of structure and the populations of species commonly caught by recreational fishermen (Moore, 2020).

To reduce the potential for displacement of fishing activity, Mayflower Wind, the Mayflower Wind FLO, and Mayflower Wind FRs have been in close communication with industry stakeholders to share information, and to avoid sensitive areas and common fishing grounds inshore and offshore to the extent practicable. Mayflower Wind remains committed to minimizing the extent of potential impacts where feasible by working directly with fishermen to resolve potential gear conflicts.

It is expected that commercial fishing and transiting within the Lease Area will remain safe and viable once the proposed Project is constructed and may improve conditions for fixed gear fishermen or recreational fishermen that utilize the Offshore Project Area. Mayflower Wind will continue to coordinate with commercial fishermen that utilize the Offshore Project Area to ensure they can operate safely during O&M.

The potential for WTGs to impact the accuracy and efficacy of marine radar is understood following decades of vessel operational experience within and near large offshore wind facilities in Europe, as discussed in Appendix X, Navigation Safety Risk Assessment. Experience in the United Kingdom has shown that mariners have gained knowledge of predictable radar effects as more offshore wind facilities become operational. Based on this knowledge, mariners can interpret the anticipated effects accurately, noting that interference effects are like those experienced by mariners in other environments, such as near other vessels or offshore structures.

These effects can be mitigated through careful adjustment of radar controls and compliance with Convention on the International Regulations for Preventing Collisions at Sea regulations. A study conducted in 2009 by the USCG found that the presence of WTGs had an effect on marine radar, but the impacts were both predictable and manageable with training and technology (Minerals Management Service, 2009). Mayflower Wind will work with the USCG and the local fishing community to refine site-specific controls or settings that may help to mitigate potential interference of marine radar associated with the presence of offshore Project components.

11.2.1.3 Decommissioning

Impacts resulting from decommissioning of the proposed Project are expected to be similar to or less than those already described in Section 11.2.1.1 for construction. It is expected that the same number of vessels will be used to decommission WTGs and OSPs in the Offshore Project Area as during construction. The proposed Project's offshore export cables may be left in place to minimize environmental impact, which will also result in a reduction in vessel traffic along the export cable corridors. If cable removal is required, vessel activity for removing the offshore export cables will be limited temporally to the cable removal process, limited spatially to the offshore export cable routes, and similar to those experienced during cable installation.

Under the same safety requirements and obligations applied to the construction phase, the safety risks to fishing vessels during decommissioning will not exceed those of the construction phase. Furthermore, decommissioning techniques are expected to advance during the lifetime of the proposed Project. Prior to the decommissioning phase, a full decommissioning plan will be provided to the appropriate regulatory agencies for approval, along with a re-evaluation of potential impacts within the context of the best available science to be considered at that time.

11.2.2 Actions that may Displace Biological Resources

11.2.2.1 Construction

Short-term disturbance of species targeted by commercial or recreational fisheries may occur during the construction phase of the proposed Project, resulting from pile-driving, cable burying, and disturbance to the seafloor. However, these impacts will be temporary and localized to discrete zones within the Offshore Project Area (see Section 6.6, Benthic and Shellfish; Section 6.7, Finfish and Invertebrates; Section 5.2, Water Quality; Appendix N, Essential Fish Habitat; and Appendix U2, Underwater Acoustic Modeling Report).

While some commercially or recreationally targeted species could be exposed to pile-driving noise, most mobile fishes and invertebrates will be expected to temporarily move outside the ensonified construction areas before redistributing throughout the Offshore Project Area after the activity ceases. Sessile and slow-moving invertebrates and life stages (e.g., sea scallops, Atlantic surfclams and ocean quahogs, squid egg mops, some demersal fish eggs/larvae) will be exposed to sound pressure, particle motion, and substrate vibrations. Limited studies indicate that some crustaceans and mollusks may detect underwater noise (Edmonds et al., 2016; Roberts et al., 2016) but are not expected to be measurably affected by the temporary disturbance during construction. No population-level effect on fishes or squid or other invertebrates is expected to occur given the limited temporal and spatial extent of Project-related noise during each individual foundation installation, relative to available habitat for these species, as described in Appendix U2, Underwater Acoustic Modeling Report.

Only a small fraction of the overall range of managed species will be exposed to pile-driving noise from the foundation installation. Therefore, impacts will be temporary and localized. These conclusions are consistent with modeling and field measurements for other northeast U.S. offshore wind projects that reported only short-term adverse effects on fishes, invertebrates, and EFH exposed to pile-driving (BOEM, 2015, 2018). To mitigate impacts of vibration from pile-driving activities, Mayflower Wind will utilize noise abatement systems around relevant construction activities, as described in Appendix U2, Underwater Acoustic Modeling Report.

Pile-driving and cable installation activities may increase the amount of suspended sediment in the water column and deposited on the seafloor. To assess the potential impacts from cable placement (including the HDD exit pit), Scour Modeling and a Sediment Plume Impact Models were conducted for this Project (Appendix F1, Sediment Plume Impacts from Construction Activities and Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment). The modeling calculated both plume dispersion (total suspended solids mg/L in the water column) and areas of accretion where suspended sediments are redeposited. In all simulated scenarios along the Falmouth export cable corridor, the maximum total suspended solids level dropped below 10 mg/L within two hours and below 1 mg/L after less than four hours. These effects are expected to be temporary, short-term, and localized (see Appendix F1, Sediment Plume Impacts from Construction Activities). However, along the Brayton Point export cable corridor it may take up to 50 hours for total suspended solid levels to drop below 10 mg/L in areas with high clay and silt content due to resuspension of bottom sediments (Appendix F3, Hydrodynamic and Sediment Transport Modeling for the Brayton Point Export Cable Burial Assessment). In nearshore areas, HDD will be used to bring the offshore export cables onshore, minimizing the disturbance to sediments within that portion of the export cable corridors, inshore of the HDD punchout locations (see Appendix F2, Scour Potential Impacts from Operational Phase and Post-Construction Infrastructure).

Commercially and recreationally targeted species may be temporarily displaced from the construction zone but will be expected to disperse to other locations within the Offshore Project Area accessible by commercial or recreational fishing vessels. In addition, certain construction activities have time-of-year restrictions to avoid, minimize, and mitigate impacts to marine organisms, such as sturgeon and winter flounder, which will also be protective of other demersal groundfish species. More information on disturbance of target species from construction activities can be found in Section 6.6, Benthic and Shellfish, Section 6.7, Finfish and Invertebrates, and Appendix N, Essential Fish Habitat.

Mayflower Wind will apply construction methods for cable laying activities that align with regulatory guidance.

11.2.2.2 Operations and Maintenance

The addition of new, hard substrates (e.g., WTGs, scour protection, cable protection) will modify the existing pelagic water column habitat and benthic habitat on the seafloor (see Section 3, Description of Proposed Activities, regarding seabed disturbance in the Offshore Project Area). Secondary cable protection (i.e., mattresses, rock placement, fronded mattress, etc., as described in Section 3, Description of Proposed Activities) will be used at cable crossings and for additional cable protection along the export cable corridors if needed. However, cable routing has been designed to minimize cable crossings, cable length, and overlap with known fishing areas, while also maximizing the portion of the cable that can be buried and maintained at target burial depth, in order to mitigate potential impacts to fishing activity. Based on preliminary understanding of site conditions from geophysical and geotechnical surveys, Mayflower Wind estimates that up to 10 percent of the length of the offshore export cables may require additional cable protection. The total estimated cable protection area represents approximately 0.1 percent of the entirety of the Falmouth export cable corridor. Such areas will be marked appropriately on nautical charts, which will limit the likelihood of interaction with fixed or mobile gear, as discussed in Section 11.2.3.

Presence of in-water structures associated with the WTGs, OSPs, scour protection, and other Project components may result in a change in the species assemblage due to reef effects and the creation of intertidal habitats surrounding the vertical structure of monopile foundations. The conversion of softbottom to hardbottom surrounding each foundation as described above will reduce the amount of softbottom habitat in the Lease Area. However, softbottom habitat is not a limiting factor in terms of benthic habitat availability in the Offshore Project Area. Once substructures and scour protection are installed at each position, the foundations will quickly become colonized by algae and invertebrates, creating artificial reefs in the water column (van Hal et al., 2017) and intertidal habitats created within pelagic waters resulting from the vertical structure at the water surface. However, this modification of habitat will be localized to each of the 149 WTG/OSP positions, with the vast majority of habitat within the Lease Area remaining unmodified.

The effects of entrainment mortality from the Mayflower OSP are not expected to cause detectable changes to adult fish populations in any of the susceptible fish species, as described in Section 6.7.4. Eggs and larvae of commercially and recreationally important species prevalent in the Offshore Project Area experience naturally high mortality and low survival rates. While removals attributed to entrainment will occur, they would be minimal (and likely undetectable) relative to sources of natural mortality, and therefore negligible to existing populations. The relatively low volume of cooling water usage flow proposed for the Mayflower Wind OSP facility is orders of magnitude lower compared to most coastal power plant facilities. This, coupled with its location in open ocean waters, can lead to the reasonable assumption that impacts on fish populations will be negligible to commercial and recreational fishing.

The spatially limited area around WTG substructures and scour protection can provide shelter for (Reubens et al., 2014) and attract certain fish species (Reubens et al., 2011). The lack of natural structured habitats in the Lease Area may be a limiting factor in the current distribution and abundance of benthic species that use hardbottom and structure, such as cod and black sea bass (Guida et al., 2017), offshore pelagic species such as tunas and sharks, and schooling forage fish (Itano et al., 2000; NMFS, 2017b).

Once WTG substructures and scour protection are installed, these areas will quickly become colonized by algae and invertebrates, creating artificial reefs in the water column (van Hal et al., 2017) and intertidal habitats created by the vertical structure, followed by dispersal of species associated with structure into the Lease Area. Lobster, crabs, and other invertebrate species may also seek shelter within scour protection. Structures in the Lease Area associated with the WTGs, OSPs, and other Project components may result in indirect changes in species assemblages, concentrations, and species types due to reef effects and creation of new hard substrate. However, this alteration of target species composition will be localized to each of the WTG/OSP positions and areas of cable protection.

In a similar disturbance scenario, post-construction monitoring at the Block Island Wind Farm has shown that there are no substantial differences in benthic macrofaunal communities or ecological function within turbine areas two years after installation (HDR, 2019). Cable protection at crossings will also introduce hard structure to the seafloor, which may also have similar reef effects and attract structure-associated species. However, this modification will be localized to the crossings (up to 25 locations between both export cable corridors). Additionally, Mayflower Wind will work with municipal shellfish constables to coordinate shellfish seeding with planned activities prior to construction activities. See Section 6.6, Benthic and Shellfish; Appendix M, Benthic and Shellfish Resources Characterization Report; and Appendix N, Essential Fish Habitat Assessment, for more information on impacts to benthic habitats.

The inter-array cables will be buried at a target depth of 3.2 to 8.2 feet (1.0 to 2.5 m), and the offshore export cables will be buried at a target depth of 3.2 to 13.1 feet (1.0 to 4.0 m). Cable protection at crossings will introduce hard structure to the seafloor, which may alter the soft-bottom fish community by attracting structure-associated species and displacing soft bottom-associated species. However, this modification will be localized to the crossings (up to 25 locations between both export cable corridors) and as discussed above, have been minimized through the cable routing process. EMF exposure of target species along the export cable corridors and inter-array cables will be limited to those species that are sensitive to EMF, such as sharks, skates, and rays (Gill and Desender, 2020).

However, as discussed in Section 6.7, Finfish and Invertebrates, Appendix P1, EMF Assessment for the Proposed Mayflower Wind Project, and Appendix P2, High Voltage Direct Current Electric and Magnetic Field (EMF) Assessment, EMF is not expected to be a physical barrier to movement of commercially or recreationally targeted EMF-sensitive fish or invertebrate species (BOEM, 2020b; Hutchison et al., 2018).

While the concentration of structure-associated species may change as a result of the proposed Project, the abundance of other species, such as flatfishes, may not change due to the presence of structures because sandy bottom habitat is ubiquitous in the Lease Area and will remain as such. At some wind farms in the North and Baltic Seas, no measurable differences in community abundances within and outside of wind farms were observed (Degraer et al., 2016). In the U.S., neither the distribution, abundance, nor condition of individual fishes was altered by installation of WTGs at Block Island Wind Farm, despite predicted impacts to demersal fishes and American lobster communities (Wilber et al., 2018).

At the Block Island Wind Farm, the distribution, abundance, and condition of seven flatfish species showed no changes from pre-construction conditions (Carey, 2017). See Sections 6.6, Benthic and Shellfish and Section 6.7, Finfish and Invertebrates, for more information on species composition and interactions.

Overall, adverse effects to commercially and recreationally targeted species are expected to be negligible within the context and scale of the southern New England region (CRMC, 2010). Effects of the introduction of structure in the Lease Area may be adverse, beneficial, or mixed, depending on the species and location (van der Stap & Coolen, 2016; Wilhelmsson et al., 2006) as well as the perception of various stakeholders. Furthermore, with structure-associated fish and invertebrate species becoming concentrated near the foundations and scour protection, recreational fishing opportunities in particular may be enhanced, as has been well-documented previously near oil and gas foundations (van der Stap & Coolen., 2016), and for recently installed offshore wind projects in the U.S. (Moore, 2020).

Mayflower Wind will avoid locating onshore facilities or landfall sites in or near important fish habitats to the extent practicable.

11.2.2.3 Decommissioning

Impacts resulting from decommissioning of the proposed Project are expected to be similar to or less than those already described in Section 11.2.2.1 for construction. The WTGs and their foundation components will be removed in adherence to regulatory requirements (see Section 3, Description of Proposed Activities). Project activities are expected to affect the benthic finfish and invertebrate communities that were established during the operations phase of the proposed Project, particularly to attached epifauna that colonize the WTG foundations. The loss of hardbottom substrates will likely cause the benthic communities in the Lease Area to return to pre-construction conditions. Furthermore, decommissioning techniques are expected to advance during the lifetime of the proposed Project. Prior to the decommissioning phase, a full decommissioning plan will be provided to the appropriate regulatory agencies for approval, along with a re-evaluation of potential impacts within the context of the best available science to be considered at that time.

11.2.3 Gear Interactions

11.2.3.1 Construction

Commercial or recreational fishing vessels potentially impacted by gear interactions in the construction phase of the proposed Project include bottom trawling, midwater trawling, gillnetting, and pots and traps. Recreational fishermen typically utilize hook and line gear and are known to fish at shoals and areas around the Offshore Project Area. They are unlikely to leave gear out overnight, which is anticipated to result in a low incidence of gear interactions for recreational fishermen. The Falmouth export cable corridor crosses an area where commercial fishing occurs as shown in **Figure 11-14**. However, the area has historically had relatively low levels of recreational fishing effort, except near the proposed landfall locations and within the recreational fishing locations shown in **Figure 11-22**. There may be higher recreational fishing activity within the Sakonnet River portion of the Brayton Point export cable corridor compared to the offshore portion. Overlap with such areas are expanded on in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report.

Cooperation between offshore wind developers and the USCG is expected to help limit gear interactions that may occur (Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC, 2019). As described in Appendix W, Fisheries Communication Plan, Mayflower Wind is currently working with commercial and recreational fishermen as well as FRs to determine construction timing and locations with fishing vessels to anticipate and avoid/minimize/mitigate gear interactions that may occur during construction.

During construction, the presence of partially installed Project components may increase the risk of gear entanglement and snagging with mobile and fixed fishing gear. Temporary safety zone restrictions associated with construction activities will limit direct access to areas with construction activity for the safety of mariners and Project employees, but these areas will be limited spatially and temporally. To promote the safety of the public and work crews during construction, Mayflower Wind will implement construction safety zones around active construction areas in consultation with USCG. This proposed nature of these zones is based on USCG regulations (33 CFR Part 147), as well as precedents set by other recent offshore wind projects constructed in the U.S. With a safety zone of this scale, gear entanglements, snags, or other interactions with Project components will be unlikely to occur unless surface buoys/lines became separated from deployed gear and drift into partially installed Project components. Mayflower Wind will notify mariners via LNMs of the presence and location of partially installed structures. Mayflower Wind will consider the use of fixed mooring buoys at various strategic locations in the Project Area to avoid the need for anchoring. More information on safety zones markings and LNMs can be found in Section 13, Navigation and Vessel Traffic.

Appendix W, Fisheries Communications Plan, combined with the direct outreach activities anticipated during construction, will provide the fishing community with advance notice, prior to formal LNMs being issued, describing the extent and duration of construction activities and locations of fixed structures within the Offshore Project Area, including partially installed structures within the safety zones. Should fixed gear become separated from marker buoys, set adrift inadvertently, or mobile gear becoming snagged on, or entangled in, the WTG/OSP substructures, cables, or other Project components, Mayflower Wind will work with fishermen through a lost gear claims form process to determine if reimbursement is warranted (see Appendix W, Fisheries Communication Plan). A process to compensate fishermen for entanglements of fishing gear by geophysical and geotechnical survey gear has already been developed jointly with other offshore wind developers and with input from the fishing industry via FRs. This joint developer gear loss compensation application form has been made publicly accessible and is available on Mayflower Wind's website. Additionally, the Mayflower Wind FLO proactively contacts fishermen if their gear is entangled by geophysical and geotechnical survey operations and will continue to do so in later phases of the proposed Project, including during construction.

11.2.3.2 Operations and Maintenance

Fishing vessels potentially impacted by gear interactions in the operational phase of the proposed Project primarily include bottom trawls, midwater trawls, gillnets, and pots and traps, since those types of gear are most commonly used in the Offshore Project Area.

The three major types of bottom contacting mobile fishing gear utilized within the Offshore Project Area are hydraulic clam dredging, scallop dredging, and otter trawling. To mitigate the risk or potential impacts for each of these requires an understanding of both the initial impacts and of the cumulative impacts of successive tows. Hydraulic clam dredging poses the largest risk to the offshore export cables because of the nature in which it is conducted and its depth of impact (e.g., penetration depth). Bottom otter trawling and scallop dredging pose much lower risks of interactions with cables because of the penetration depths of those gear types. However, the target cable burial depths that have been established will mitigate the risk of potential impact for all three of these gear types, regardless of penetration depth. In addition, the three most commonly landed species caught in the export cable corridors (longfin squid, Atlantic herring, and scup) are not caught by these higher-risk gear types (**Table 11-11**).

Fixed gear (e.g., pots and traps, gillnets) is also utilized in the Offshore Project Area. However, while pot and trap fishing gear does contact the bottom, the way in which it is designed, deployed, and hauled along with its depth of impact pose lower risks of interactions with cables. This gear may become entangled on foundations or scour protection if they are set within the diameter footprint of the scour protection surrounding each foundation.

This is a potential risk for the Jonah crab fishery which is within the five most commonly landed species in both the Lease Area, and also the lobster and Atlantic deep-sea red crab fisheries which occur at lower levels (**Table 11-16**). Safety zones surrounding each foundation will partially include the scour protection on the seabed within that zone, and it is unlikely that fixed or mobile gear will be set or towed close enough to interact with the scour protection surrounding each foundation, in the interest of vessel safety procedures. These fishermen may be asked to keep surface marker buoys at a reasonable distance from the foundations to allow for safe approach by both Project service and fishing vessels. However, this gear could still be set near the foundations in a way that does not limit access (if the vessel follows USCG regulations).

Mayflower Wind is considering four substructure concepts: monopile, piled jacket, suction-bucket jacket, and GBS. Fixed gear may become entangled with these substructures if set too close and/or water currents causes the fishing gear to drift along the bottom of the seafloor. However, studies in Europe have observed consistent catch rates of common fixed-gear target species (lobsters) within the perimeter of wind farms (Orsted, 2020).

This suggests that the risk of fixed gear entanglements is low, and areas where this type of interaction may occur are very localized and directly adjacent to each of the WTGs or OSPs. Should fixed gear become separated from marker buoys/anchors resulting in an entanglement or snag on the WTG foundation, cable protection, or other Project components, Mayflower Wind will work with fishermen through a gear loss claim application form to determine if reimbursement is warranted in a process similar to the compensation application process already in place for potential gear loss due to geophysical and geotechnical survey activity (see Appendix W, Fisheries Communication Plan).

Another gear entanglement scenario is mobile gear (bottom trawls, midwater trawls, hydraulic dredges) snagging on an exposed cable that might become unburied within the Offshore Project Area. Mayflower Wind has conducted a Cable Burial Risk Assessment to calculate the target cable lowering depth to minimize risks to the offshore export cables from damage, and to mitigate potential conflicts between commercial or recreational fishermen and the new structure. This also includes potential risks to the cable from trawling activity along the export cable corridors. To minimize conflicts between fishing gear and the proposed Project's inter-array and offshore export cables, the inter-array cables will be buried at a target depth of 3.2 to 8.2 feet (1.0 to 2.5 m), and the offshore export cables will be buried at a target depth of 3.2 to 13.1 feet (1.0 to 4.0 m). A cable burial depth targeted at 5 to 6 feet (1.5 to 1.8 m) has resulted in cable interactions approaching zero incidents, based on observations in the U.S. telecommunications industry since 2000 (NASCA, 2019). The cooperation between developers and the USCG will help to further limit gear interactions that may occur (Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC, 2019).

Mayflower Wind is considering the following methods to install and bury the offshore export cable: vertical injector, jetting sled, jetting ROV, pre-cut plow, mechanical plow, and mechanical cutting ROV system. Secondary cable protection methods may include the creation of a rock berm, concrete mattress placement, rock placement, or fronded mattresses. Half shells may be used as well, which are typically used to protect cables ends at pull-in areas and where trenching is not possible. More information on cable installation and burial activities can be found in Sections 3, Description of Proposed Activities.

To minimize interference with fishing activities, Mayflower Wind has sited the export cable corridors to minimize overlap with known areas of high fishing activity. Outreach activities by the FLO and FRs have gained a better understanding of future areas of potential activity, and to promote a strong awareness campaign to have seabed assets on charts, liaise with individual fishermen, and provide clear understandings of the risks associated with cable interactions (Appendix W, Fisheries Communication Plan). Certain areas of surficial hardbottom or a subsea asset crossing will necessitate the installation of external protection of the cables (i.e., rock berms, mattress, etc.), which may result in that area of bottom being a snag concern for trawling or dredging (i.e., due to the potential for gear hangs). In some cases, areas of hardbottom may have already been known seabed obstructions (snags) prior to construction, as they often represent pre-existing surficial obstructions.

Some loss of fishing grounds may occur due to cable protection methods in soft bottom habitats, but the overall area associated with introduced cable protection represents a very small portion of the Falmouth export cable corridor (approximately 0.1 percent). Although up to 25 crossings are possible in the export cable corridors under the maximum design scenario (inclusive of current and planned cables), some of these potential crossings may involve yet to be built offshore export cables currently proposed by other offshore wind developers. These yet to be built cables remain subject to further change and approvals prior to construction, and as a result, these crossings may not be necessary. Where applicable, Mayflower Wind will record required cable protection on electronic charts to be distributed to fishermen. Furthermore, crossings of existing utilities along the export cable corridors will likely only occur nearshore where lower levels of bottom contacting mobile gear fisheries (and no hydraulic clam dredging) occur.

The proposed depth of lowering will mitigate the risks of interaction with bottom-contacting, mobile fishing gear dredging over the life of the cable. While it is possible that portions of cables buried within highly mobile sediments could become unburied or achieve depths less than the target depth during extreme storm events or natural seabed mobility processes, burial to the proposed target depth will minimize the risk of exposure and potential damage. Additionally, long term monitoring of cable burial depth and condition will serve as another mitigation strategy, ensuring appropriate burial depth is maintained during the O&M phase. See Appendix F2, Scour Potential Impacts from Operational Phase and Post-Construction Infrastructure, for an analysis of scour potential.

Supporting information on gear entanglement/snags is included in Appendix V, Commercial and Recreational Fisheries and Fishing Activity Technical Report; Appendix X, Navigation Safety Risk

Assessment; and in Section 13, Navigation and Vessel Traffic. Should fixed gear become separated from marker buoys, set adrift inadvertently, or mobile gear become snagged on, or entangled in, the foundations, cables, or other Project components, Mayflower Wind will work with fishermen through a process including a gear loss claim application form to determine if reimbursement is warranted (see Appendix W, Fisheries Communication Plan).

11.2.3.3 Decommissioning

Impacts resulting from decommissioning of the proposed Project are expected to be similar to or less than those already described in Section 11.2.3.1 for construction. Under the assumption that the fisheries patterns, fishing grounds, and steaming patterns remain consistent, it is not anticipated that the effects of the decommissioning phase will be materially different for gear interaction from those assessed during the construction phase. Furthermore, decommissioning techniques are expected to advance during the lifetime of the proposed Project. Prior to the decommissioning phase, a full decommissioning plan will be provided to the appropriate regulatory agencies for approval, along with a re-evaluation of potential impacts within the context of the best available science to be considered at that time.

12 ZONING AND LAND USE

Zoning and land use revolve around the development, occupation, and use of a land area for human-related activities such as, but not limited to, housing, commerce, manufacturing, utilities, agriculture, recreation, conservation of natural resources, etc. This section describes the zoning and land use in areas that may be affected by the proposed Project. It includes an evaluation of potential Project-related effects, as well as proposed avoidance, minimization, and mitigation measures. The following sections will also describe zoning regulations and the existing land use, including coastal infrastructure as related to the Onshore Project Areas.

12.1 AFFECTED ENVIRONMENT

The proposed Project can potentially directly affect the zoning of land parcels hosting the Project's physical footprint, infrastructure, and related uses. Land use can also be directly and indirectly affected during the construction and decommissioning of the onshore infrastructure located in Barnstable and Bristol counties, Massachusetts and Newport County, Rhode Island: the landfall sites, the onshore substation, the converter station, the onshore export cable routes, and underground transmission line to the POIs in Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island. The proposed Project may also affect zoning and land use near the staging areas, such as, but not limited to, the New Bedford MCT and other ports.

Once the proposed Project is constructed, onshore and nearshore Project activities will have no substantive effect on zoning and land use. During operations, the presence of the offshore infrastructure in the Lease Area may indirectly affect land use in areas of Martha's Vineyard and Nantucket, in Massachusetts, which may have a view on the Project WTGs and OSPs. See Section 8 for detailed discussion on visual effects.

The zoning and land use information provided in this section is based on current (as of July 2021) zoning bylaws and maps for Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island (Town of Falmouth, 2020, 2021; Town of Portsmouth, 2002, 2012; Town of Somerset, 2020, 2021).

12.1.1 Regulatory Setting for Zoning and Land Use

Massachusetts General Law c. 40A, B and R authorizes cities and towns to regulate local land use. Towns and cities in Massachusetts may jointly plan development projects. There is an emphasis on "smart growth" which aims to increase affordable housing while preserving open space (Mass.Gov, 2020). Similarly, Rhode Island local planning is governed by a series of state laws which enable communities to plan and regulate the built environment (State of Rhode Island Statewide Planning Program, 2014).

The proposed Project will be developed under a mix of zoning jurisdictions. Most lands that would be directly and indirectly affected by proposed Project infrastructure are under municipal jurisdiction, i.e., the Towns of Falmouth, Somerset and New Bedford in Massachusetts and Portsmouth in Rhode Island.[14]

[14] Town of Falmouth, Town Code, Division 3, Chapter 240, Zoning; Town of New Bedford, Massachusetts Code of Ordinances, Chapter 9, Comprehensive Zoning; Town of Somerset, Massachusetts Zoning By-Law; Town of Portsmouth, RI Zoning Ordinance

Figure 12-1, **Figure 12-2**, and **Figure 12-3** illustrate the applicable zoning jurisdictions within the Falmouth and the Brayton Point Onshore Project Areas, including the onshore export cable route over Aquidneck Island.

Other agencies may regulate, or opine on, zoning and land use matters related to the proposed Project. The MA EFSB, charged with ensuring a reliable energy supply with a minimum effect on the environment at the lowest possible cost, makes the final state-approval of proposed large energy facilities such as wind projects in Massachusetts. The RI EFSB serves as the licensing and permitting authority required for the siting, construction, or alteration of major energy facilities in the State of Rhode Island.

The proposed Project is also subject to review by the Cape Cod Commission (CCC) and the Martha's Vineyard Commission (MVC). The CCC and MVC are regional planning agencies created with authority to regulate large-scale developments, known as Development of Regional Impacts. The CCC and MVC are authorized to implement regional land use policies, recommend specific areas for special protection, and review development for any regional impacts. CCC and MVC approvals supplement local authority and establish mitigation measures to address impacts on regional issues such as water quality, traffic, community character, natural resources, and economic development.

The CZM, within the EEA, is in charge of policy, planning, and technical assistance for coastal and ocean issues (CZM, 2020). Massachusetts's coast is lined with commercial development (including piers, wharves, and warehouses) and residential developments, many of which were constructed before coastal management policies and regulations were implemented. The CZM aims to protect public and private development, and conservation and recreation areas, by addressing issues concerning population growth and aging infrastructure (CZM, 2020).

Rhode Island also has jurisdiction under Section 309 of the Coastal Zone Management Act because of the portion of the Brayton Point export cable corridor that enters Rhode Island waters in the Sakonnet River and makes an intermediate landfall on Aquidneck Island, in Portsmouth, Rhode Island. The CRMC has the responsibility to preserve, protect, develop, and restore the coastal areas of the state, via the implementation of integrated and comprehensive coastal management plans (CRMC, n.d.).

Section 1, Introduction provides a detailed description of the proposed Project's regulatory framework.

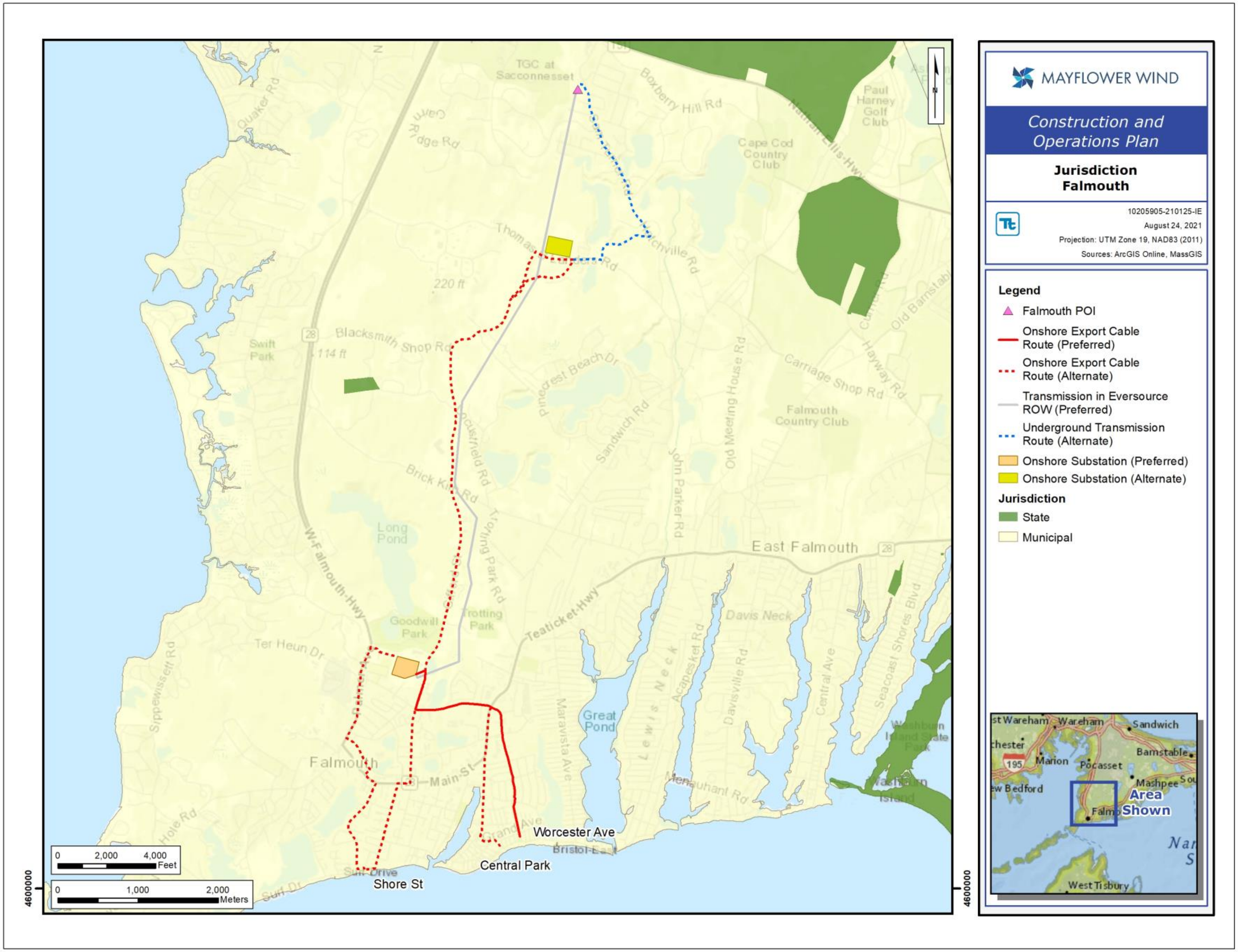


FIGURE 12-1. FALMOUTH ONSHORE PROJECT AREA JURISDICTIONS

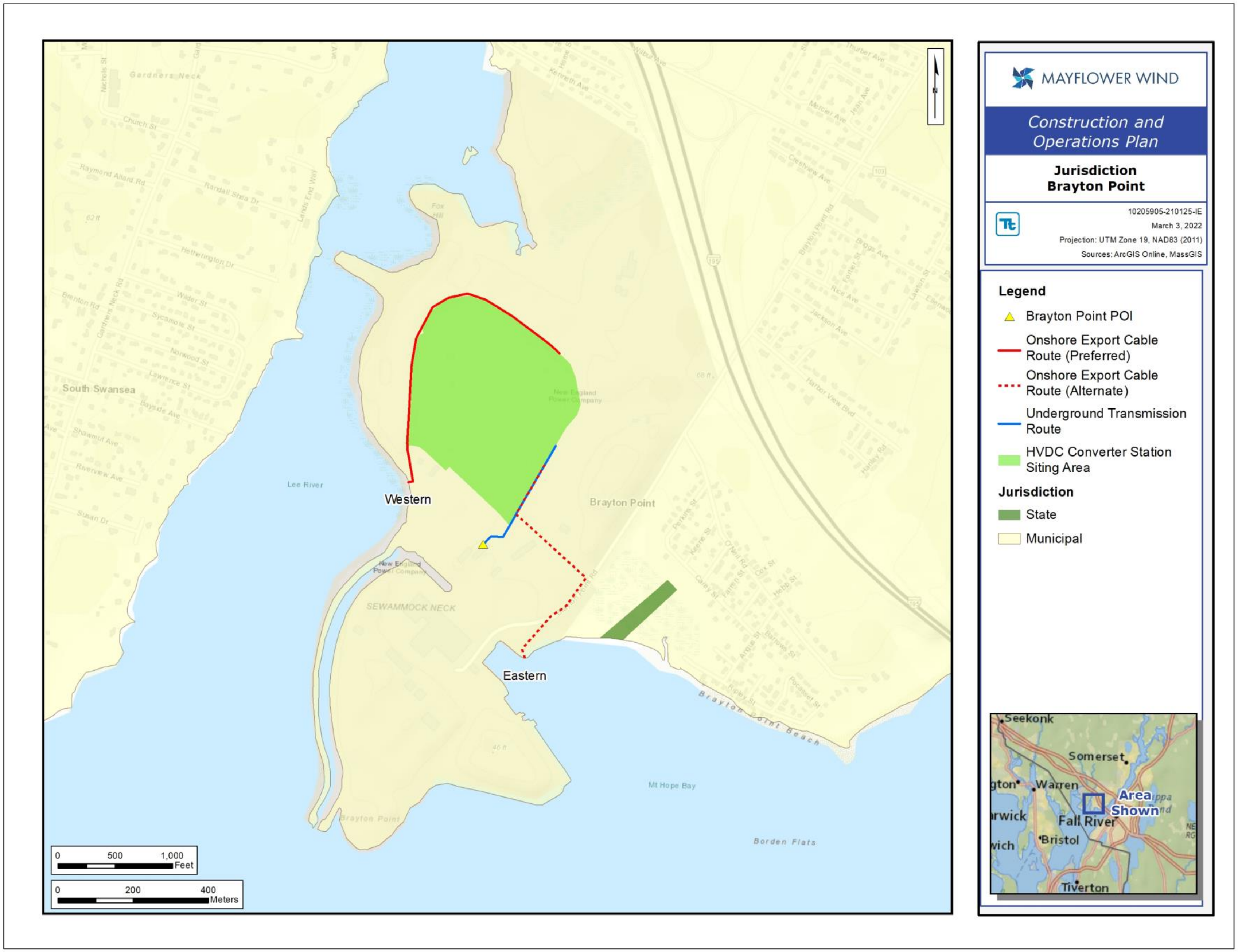


FIGURE 12-2. BRAYTON POINT ONSHORE PROJECT AREA JURISDICTIONS

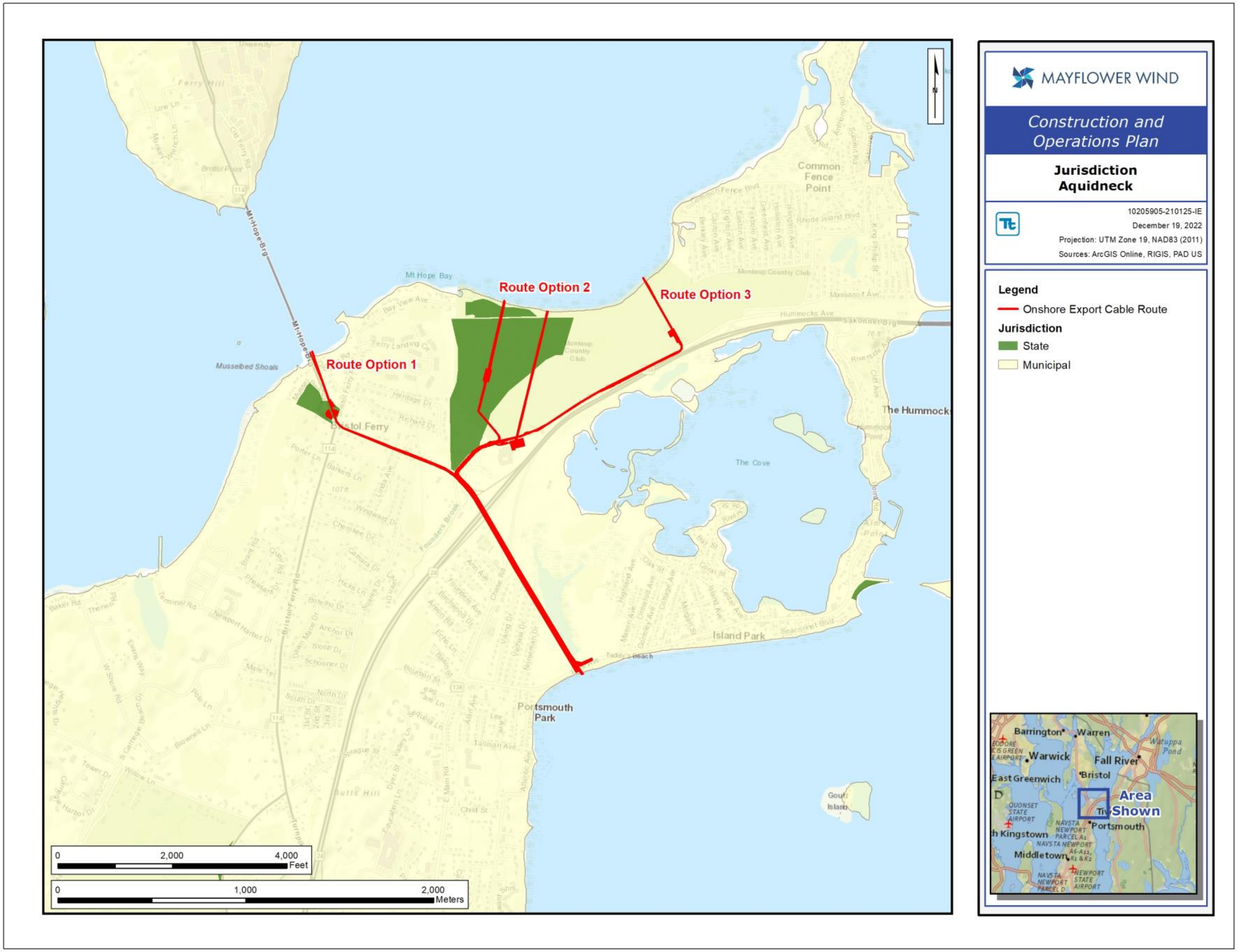


FIGURE 12-3. AQUIDNECK ISLAND ONSHORE CABLE ROUTE JURISDICTIONS

12.1.2 Landfall Locations and HDD Sites

There are three potential landfall locations identified in Falmouth and two potential landfall locations in Somerset, as presented in **Figure 12-4, Figure 12-5, Figure 12-6, Figure 12-7,** and **Figure 12-8**. Additionally, four HDD locations are under consideration for the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island.

12.1.2.1 Falmouth Landfall Location Option 1: Falmouth Heights Beach – Worcester Avenue

The first potential sea-to-shore transition is located at the Falmouth Heights Beach, just south of Worcester Avenue. The landfall locations and HDD sites are located within Worcester Park. The beach and park are zoned "Public Use" (Zoning code: PU) and classified as "Vacant, Selectmen or City Council." **Figure 12-4** overlays the proposed location on aerial imagery.

The beach and park are the property of and are managed by Falmouth, Massachusetts. The beach is bordered by Grand Avenue, which separates it from the 4.8-ac (1.94-ha) park. Worcester Park divides the north and south lanes of Worcester Avenue for several blocks. The beach and Worcester Park are surrounded by a low-density residential district zoned "Residential, Single family" (Zoning code: RC).

The landfall location is located approximately 20 feet (16 m) north from public parking areas. There is a 100-foot (30-m)-long beach barrier south of the landfall location.

Source: Adapted from Google Earth

FIGURE 12-4. LANDFALL LOCATION OPTION 1 WITH REPRESENTATIVE HDD ENTRY POINTS: FALMOUTH HEIGHTS BEACH - WORCESTER AVENUE

12.1.2.2 Falmouth Landfall Location Option 2: Surf Drive Beach – Shore Street

A second potential sea-to-shore transition is located at the Surf Drive Beach south of Shore Street. The landfall locations and HDD entry points are located within a public parking area. The beach and public parking area are the property of the Town of Falmouth, are zoned "Public Use" (Zoning code: PU) and classified as "Vacant, Tax title/Treasurer." **Figure 12-5** overlays the proposed location on aerial imagery.

The beach and landfall location are bordered by Surf Drive, which separates it from a low-density area to the north which is zoned as "Residential, Single family" (Zoning code: RC). The Falmouth Beach Department operational facility (the Ellen T. Mitchell Bath House) is located approximately 492 ft (150 m) to the west (Falmouth, Massachusetts Beach Department, 2020). There are two beach barriers south of the parking area forming a 1-ac (0.4-ha) protected area.

Source: Adapted from Google Earth

FIGURE 12-5. LANDFALL LOCATION OPTION 2 WITH REPRESENTATIVE HDD ENTRY POINTS: SURF DRIVE BEACH - SHORE STREET

12.1.2.3 Falmouth Landfall Location Option 3: Central Park

A third potential sea-to-shore transition is located at Central Park on Falmouth Heights Beach, north of Grand Avenue. The landfall location and HDD entry points are located within the Central Park, which is zoned “Public Use” (Zoning code: PU) and is directly adjacent to a property, which is zoned “Business 3” (Zoning code: B3) and properties zoned “Residential, Single family” (Zoning code: RC). There are also restaurants and parking facilities in proximity to this landfall location. HDD entry points for the Central Park landfall location have yet to be identified. **Figure 12-6** overlays the proposed location on aerial imagery.

Source: Adapted from Google Earth

FIGURE 12-6. LANDFALL LOCATION OPTION 3: CENTRAL PARK

12.1.2.4 Somerset Landfall Location Option 1: Western Landfall (Somerset, MA)

The preferred landfall (Western) for the Brayton Point landfall is located in the western portion of the former Brayton Point Power Station, adjacent to where two cooling towers were formerly located. The entire parcel of the former Brayton Point Power Station is zoned "Industrial District" (Zoning code: ID). The landfall site is not adjacent to any public roads or private lands that are not owned by the facility. **Figure 12-7** overlays the proposed location on aerial imagery.

FIGURE 12-7. BRAYTON POINT LANDFALL LOCATION OPTION 1: WESTERN LANDFALL

12.1.2.5 Somerset Landfall Location Option 2: Eastern Landfall (Somerset, MA)

The alternate location (Eastern) for the Brayton Point landfall is located in the eastern portion of the former Brayton Point Power Station, southeast of Brayton Point Road. This landfall is adjacent to a parking lot on Brayton Point and south of the three storage ponds on the property. This landfall location is on the former Brayton Point Power Station site and is zoned "Industrial District" (Zoning code: ID). However, the eastern side of the property sits adjacent to a residential district. **Figure 12-8** overlays the proposed location on aerial imagery.

FIGURE 12-8. BRAYTON POINT LANDFALL LOCATION OPTION 2: EASTERN LANDFALL

12.1.2.6 Brayton Point Export Cable Corridor Intermediate Landfall

The Brayton Point onshore export cable intermediate landfall on Aquidneck Island, in Portsmouth, Rhode Island, will consist of two HDD sites, one entry site onto Aquidneck Island, and one exit site into Mount Hope Bay. One location is under consideration for the entry landfall, and three locations are under consideration for the exit site.

12.1.2.6.1 Aquidneck Island Entry Landfall

One landfall option is under consideration for the entry HDD of the intermediate landfall on Aquidneck Island in Portsmouth, Rhode Island. The landfall under consideration is at the southern terminus of Boyds Lane. The area is zoned "Residential" (Zoning code: R-20) and is next to Commercially zoned property. **Figure 12-9** overlays the proposed location on aerial imagery.

FIGURE 12-9. INTERMEDIATE LANDFALL ENTRY HDD – AQUIDNECK ISLAND

12.1.2.6.2 Aquidneck Island Route 1

The first exit site under consideration for HDD into Mount Hope Bay occurs at the Mount Hope Bridge and is zoned "Residential" (Zoning code: R-20) (Town of Portsmouth, 2002). **Figure 12-10** overlays the proposed exit location (HDD Option 4) for Aquidneck Route 1 on aerial imagery.

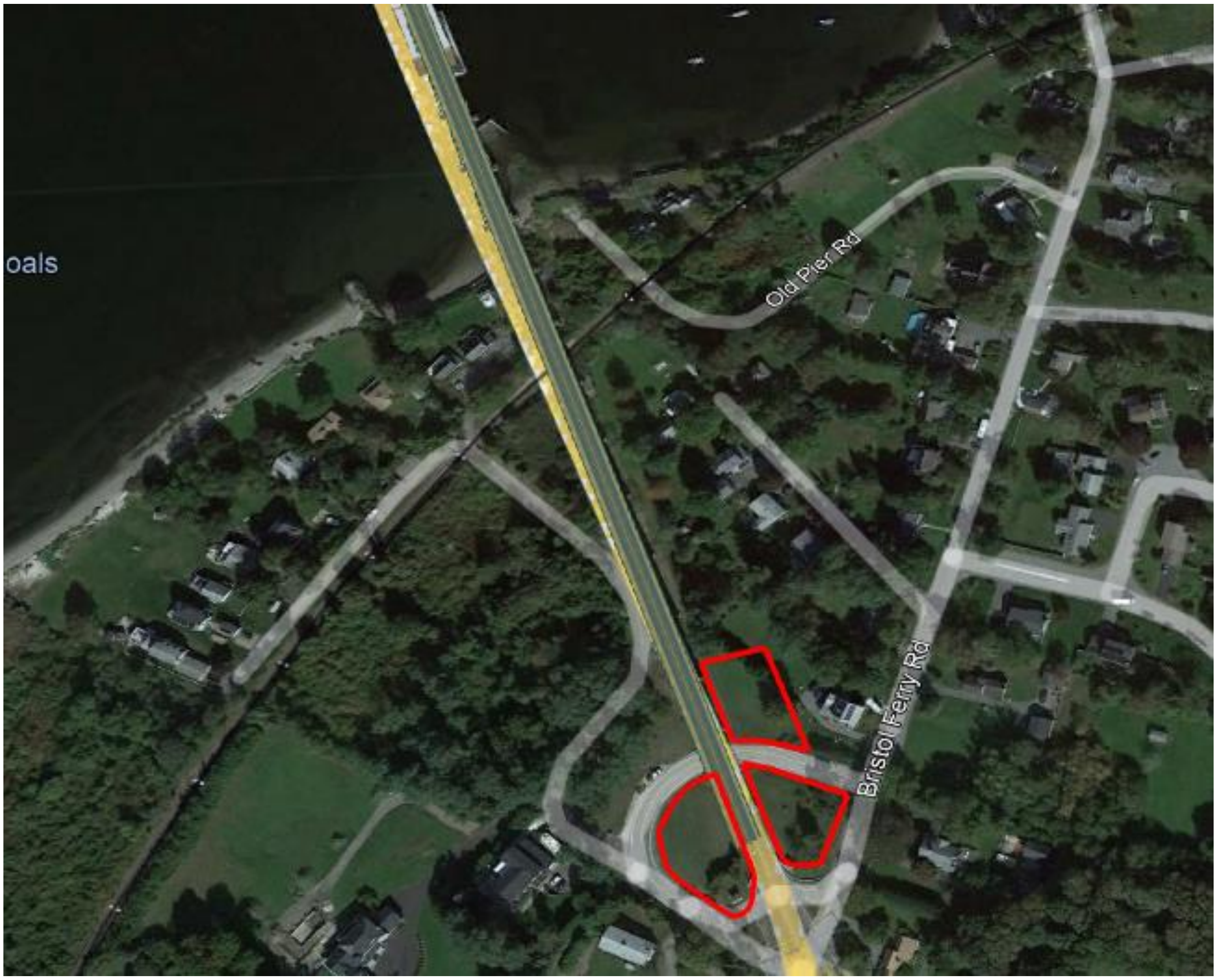


FIGURE 12-10. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 1, AQUIDNECK ISLAND; HDD OPTION 4

12.1.2.6.3 Aquidneck Island Route 2

The second exit site under consideration for HDD has two exit HDD options. The first option occurs at an existing utility ROW, north of Anthony Road and west of the Montaup Country Club golf course. The area is zoned "Residential" (Zoning code: R-10), and the HDD will run beneath the Bertha K. Russel Preserve, which is zoned Open Space. **Figure 12-11** overlays the proposed location (HDD Option 2) for the northern HDD option of Aquidneck Route 2 on aerial imagery. The southern exit HDD option along Aquidneck Route 2 is located in the parking lot of the Roger Williams University Baypoint Residence Hall along Anthony Road. **Figure 12-12** overlays the southern proposed exit HDD option (HDD Option 1) of Aquidneck Route 2 on aerial imagery.

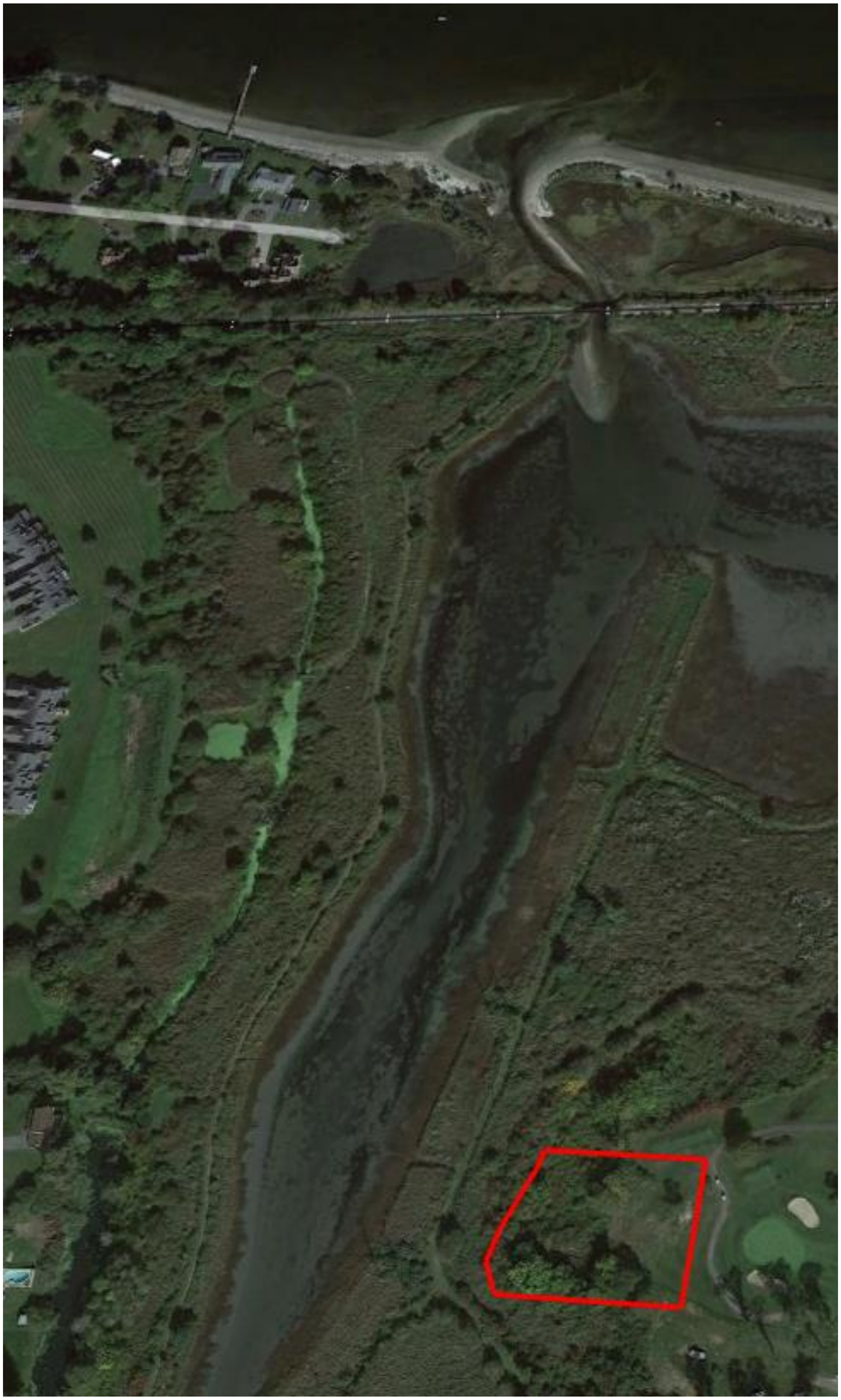


FIGURE 12-11. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 2, AQUIDNECK ISLAND; HDD OPTION 2

FIGURE 12-12. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 2, AQUIDNECK ISLAND; HDD OPTION 1

12.1.2.6.4 Aquidneck Island Exit Option 3

The third exit site under consideration for HDD into Mount Hope Bay occurs at Montaup Country Club golf course. The area is "Residential" (Zoning code: R-10) and is adjacent to "Residential" (Zoning code: R-20) (Town of Portsmouth, 2002). **Figure 12-13** overlays the proposed exit location (HDD Option 3) for Aquidneck Route 3 on aerial imagery.

FIGURE 12-13. INTERMEDIATE LANDFALL EXIT HDD – ROUTE 3, AQUIDNECK ISLAND; HDD OPTION 3

12.1.3 Onshore Substation and HVDC Converter Station Sites

Preliminary onshore substation footprint designs assume that an area of up to 31 ac (12.5 ha) will be required to accommodate the switching, transformers, and construction equipment. There are currently two potential substation locations identified in Falmouth, presented in **Figure 12-14** and **Figure 12-15**. There is currently one onshore HVDC converter station site identified in Somerset, for which footprint designs assume that an area of up to 7.5 ac (3 ha) will be required.

12.1.3.1 Onshore Substation Option 1: Lawrence Lynch (396 Gifford Street, Falmouth, MA)

This proposed onshore substation would be located on a private 27.3-ac (11.01-ha) parcel used as a sand and gravel quarry. The parcel is zoned "Light Industrial A" (Zoning code: LIA) and is highly affected by current mining activities**. Figure 12-14** overlays the proposed location on aerial imagery.

The area is bordered to the north by the Falmouth Department of Public Works facility and a public park, both parcels are zoned "Public Use" (Zoning code: PU). There is low-density residential housing on land zoned RC to the northwest, and a place of worship on land zoned "Public Use" (Zoning code: PU) to the west. The land across Gifford Street to the southeast is zoned "Agricultural B" (Zoning code: AGB) and hosts the Atria Woodbriar senior home.

Source: Adapted from Google Earth

FIGURE 12-14. ONSHORE SUBSTATION OPTION 1: LAWRENCE LYNCH

12.1.3.2 Onshore Substation Option 2: Cape Cod Aggregates (469 Thomas B. Landers Road, Falmouth, MA)

This proposed onshore substation would be located on the eastern half of three private parcels zoned PU. The parcels are currently exploited as a single sand and gravel quarry. **Figure 12-15** overlays the proposed location on aerial imagery.

The parcels are bordered to the north and east by wooded land zoned "Agricultural AA" (Zoning code: AGAA) and marked for low-density residential development. Thomas B. Landers Road borders the parcels to the south from east to west. Most of the land across the road also belong to Cape Cod Aggregates. The wooded parcel directly south of the proposed substation is zoned "Agricultural A" (Zoning code: AGA). Parcels south of Thomas B. Landers Road and east of Blacksmith Shop Road are zoned "Agricultural A" (Zoning code: AGA) and are used for low-density residential housing. The parcel to the west is zoned "Light Industrial A" (Zoning code: LIA, classified as developable vacant land and used for commercial purposes. Finally, the wooded parcel to the northwest is zoned "Agricultural AA" (Zoning code: AGAA) and classified as municipal vacant/conservation land.

Source: Adapted from Google Earth

FIGURE 12-15. ONSHORE SUBSTATION OPTION 2: CAPE COD AGGREGATES

12.1.3.3 Brayton Point HVDC Converter Station

This proposed HVDC converter station would be located on a 235 acre (95 ha) property located in Somerset, off Mount Hope Bay on the South Coast of Massachusetts. Brayton Point formerly housed a 1,500-megawatt power plant that was decommissioned in 2017 (**Figure 12-16**). The entirety of the converter station sits land zoned "Industrial District" (Zoning code: ID).

Source: Adapted from Google Earth

FIGURE 12-16. HVDC CONVERTER STATION AREA

12.1.4 Potential Onshore Export Cable Routes

As the final landfall location(s) and onshore substation location have not yet been determined, all potential onshore export cable route and transmission line options are considered here.

The zoning of land that may be affected by the onshore export cable routes in the Falmouth and Brayton Onshore Project Areas, including the Aquidneck Island onshore export cable route are illustrated in **Figure 12-17**, **Figure 12-18**, and **Figure 12-19**. The majority of the transmission route options are located within existing ROWs (state and town roads, and utility ROW), and are not anticipated to present any zoning issues. Zoning laws do not apply to state or local ROWs and, as such, proposed underground cables in these ROWs will not require zoning approvals.

12.1.4.1 Falmouth Onshore Export Cable

Generally, zoning in proximity to the onshore export cable route options in Falmouth is predominantly "Residential" (Zoning codes: RB and RC), "Commercial" (Zoning codes: B1, B2, B3, and GR), and "Public Use" (Zoning code: PU; **Figure 12-20**). Zoning in proximity to the Falmouth transmission line options is predominantly "Public Use" (Zoning code: PU) and "Agricultural" (Zoning codes: AGA, AGAA and AGB), with some "Residential" zones (Zoning codes: RB and R40).

Some parcels zoned "Public Use" (Zoning code: PU) and classified as forests, conservation, or recreational are located in proximity to the onshore export cable routes, including Falmouth Heights Beach, Surf Drive Beach, Worcester Avenue Park, Central Park, and Crescent Park as well as some isolated parcels in proximity to proposed Project infrastructure locations.

12.1.4.2 Brayton Point Onshore Export Cable

The land uses along the onshore export cable route options in Somerset are zoned "Industrial District" (Zoning code: ID; **Figure 12-21**). Prior to cable landfall, the Brayton Point offshore export cable will have an onshore underground component on Aquidneck Island in the Town of Portsmouth, Rhode Island. Mayflower Wind is currently considering three routes through Aquidneck Island, each landfall at the southern terminus of Boyds Lane on the beach and transiting through Aquidneck Island to Mount Hope Bay to the north. The land uses along the underground onshore export cable route through Aquidneck Island are for urban development, conservation/limited uses, prime farmland, major parks and open space, and water bodies (**Figure 12-22**).

12.1.4.3 Brayton Point Export Cable Corridor Intermediate Landfall

12.1.4.3.1 Aquidneck Island Route 1

The onshore underground Aquidneck Island Route 1 makes landfall at the southern terminus of Boyds Lane and exits Aquidneck Island into Mount Hope Bay via Route 114 at the Mount Hope Bridge. The area is zoned "Residential" (Zoning code: R-20) and "Residential" (Zoning code: R-10) and borders Commercially zoned property (Town of Portsmouth, 2002).

12.1.4.3.2 Aquidneck Island Route 2

The onshore underground Aquidneck Island Route 2 makes landfall at the southern terminus of Boyds Lane and exits Aquidneck Island into Mount Hope Bay via either an existing utility ROW or an existing parking lot. The area is zoned "Residential" (Zoning code: R-10) and is adjacent to "Residential" (Zoning code: R-20) land (Town of Portsmouth, 2002).

12.1.4.3.3 Aquidneck Island Route 3

The onshore underground Aquidneck Island Route 3 makes landfall at the southern terminus of Boyds Lane and exits Aquidneck Island into Mount Hope Bay via Montaup Country Club. The area is zoned "Residential" (Zoning code: R-10) and is adjacent to "Residential" (Zoning code: R-20) land (Town of Portsmouth, 2002).

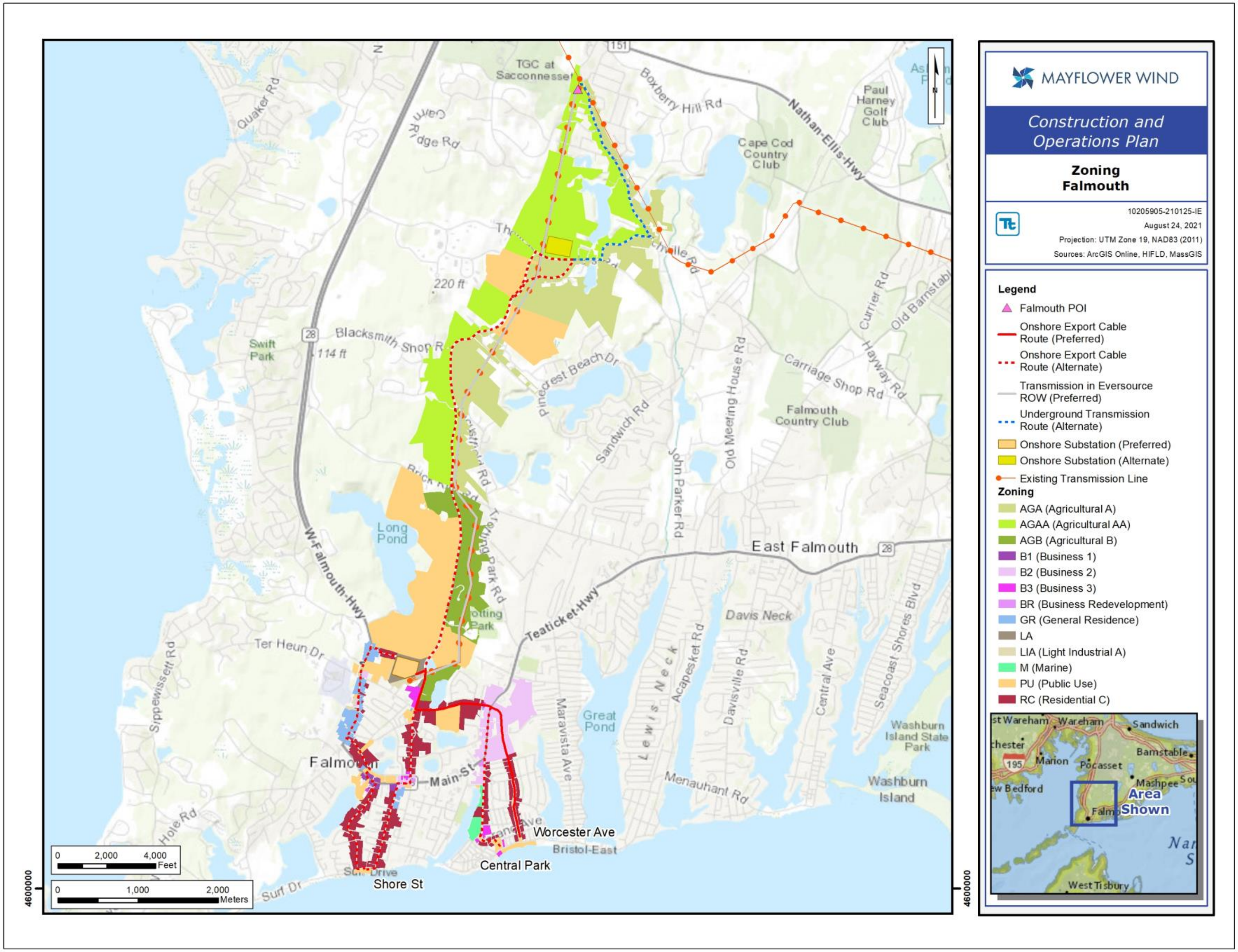


FIGURE 12-17. ZONING OF LAND ALONG THE FALMOUTH ONSHORE EXPORT CABLE ROUTES

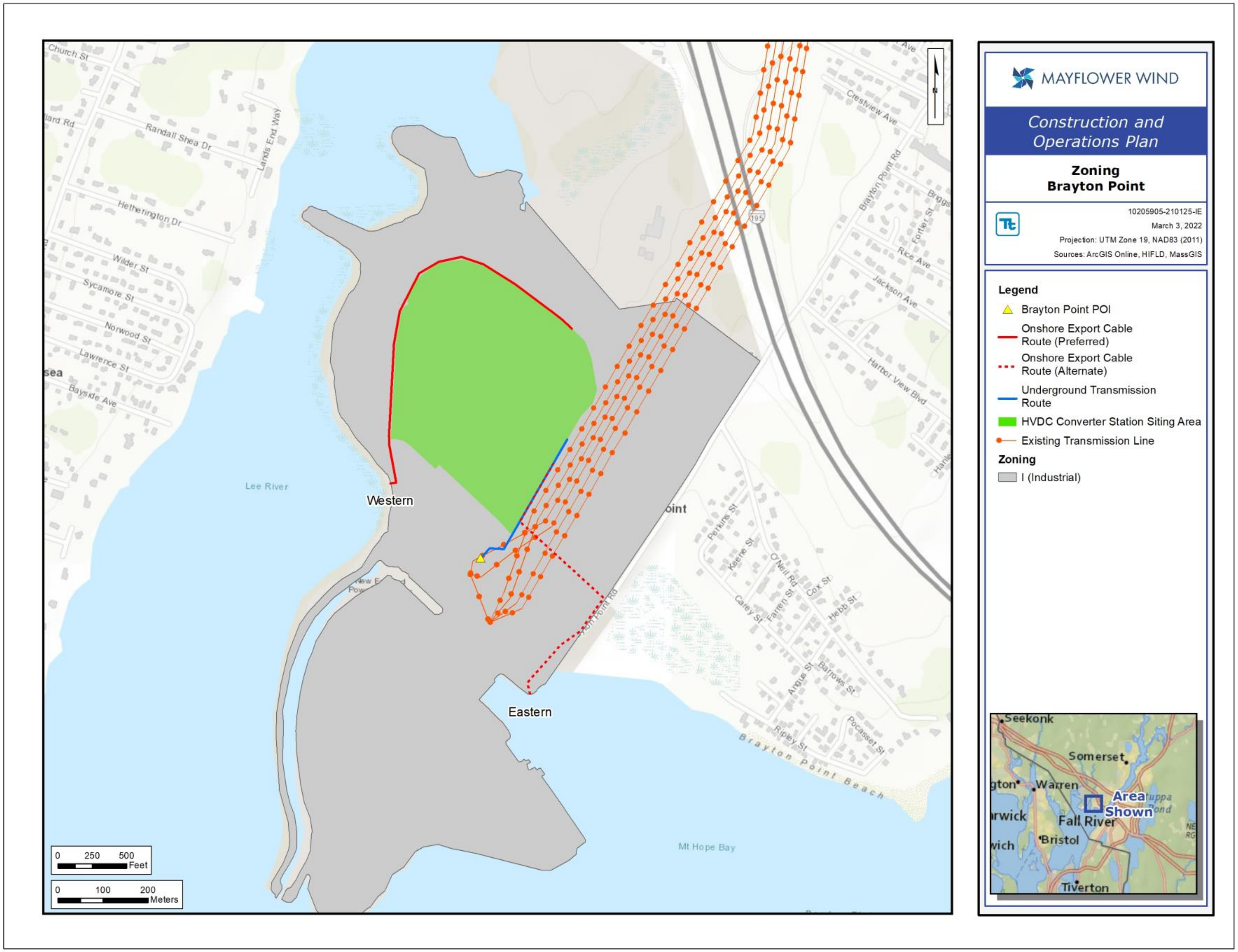


FIGURE 12-18. ZONING OF LAND WITIN THE BRAYTON POINT ONSHORE PROJECT AREA

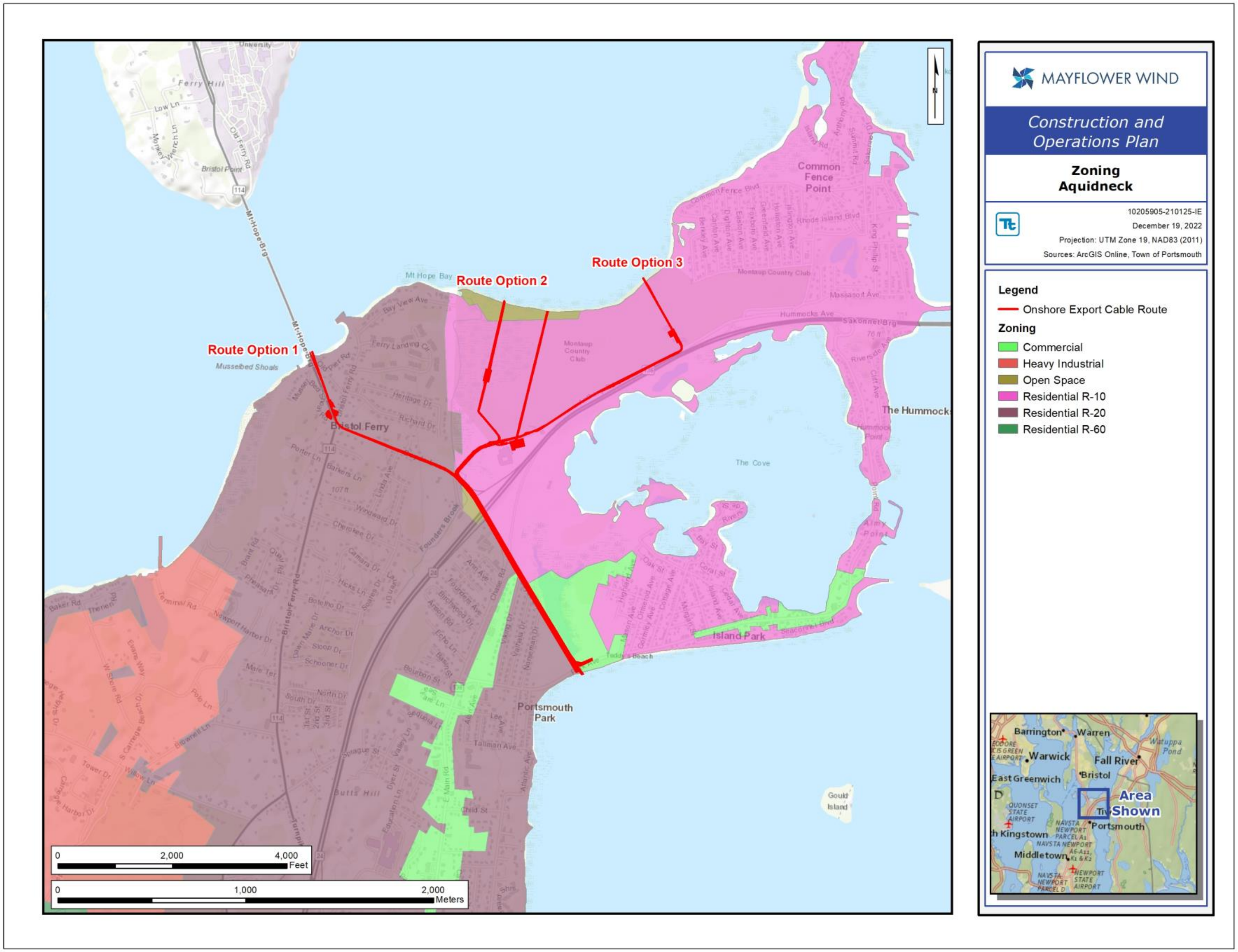


FIGURE 12-19. ZONING OF LAND ALONG THE ONSHORE EXPORT CABLE ROUTE – AQUIDNECK ISLAND

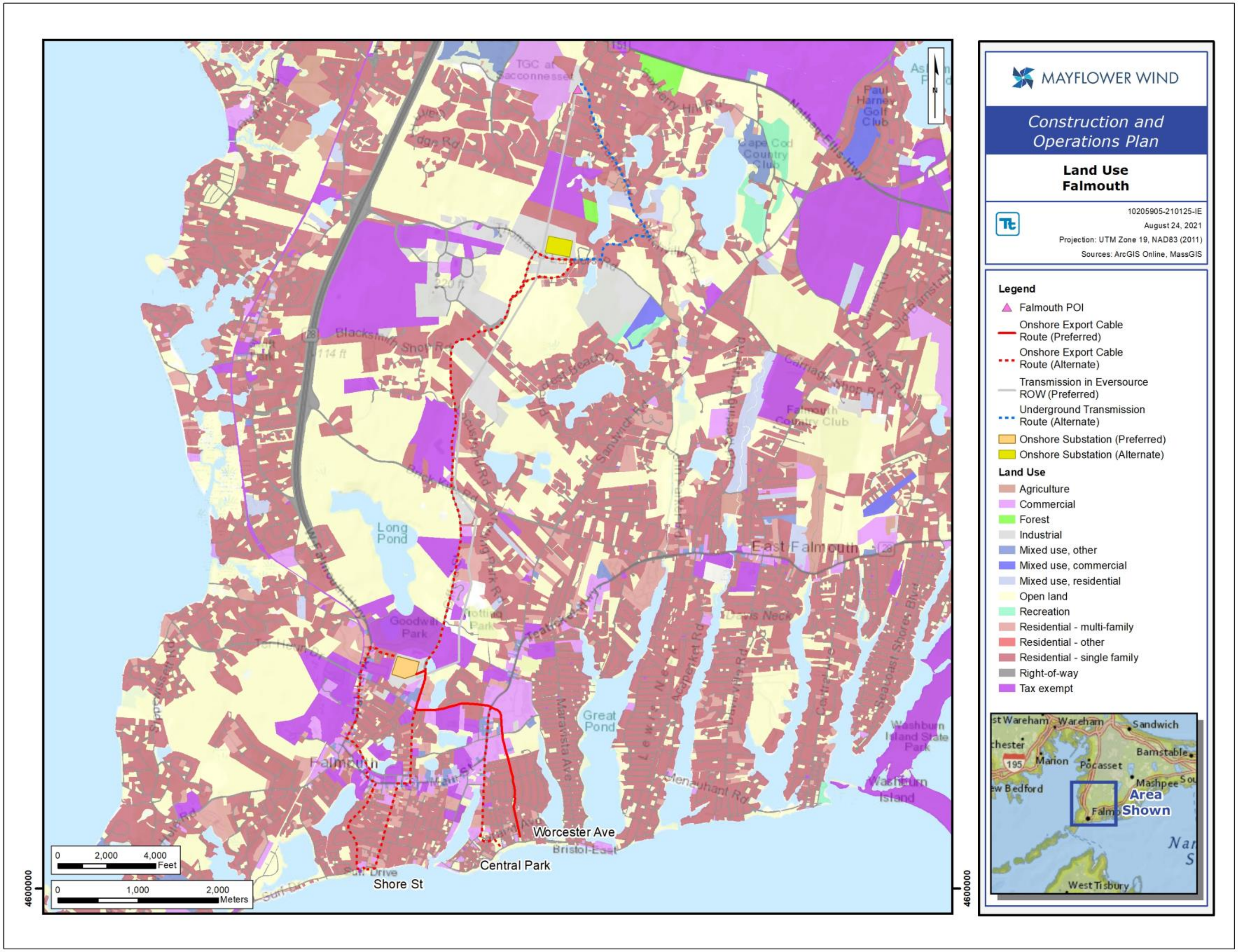


FIGURE 12-20. LAND USES WITHIN 500 FT (152 M) OF THE ONSHORE PROJECT COMPONENTS - FALMOUTH

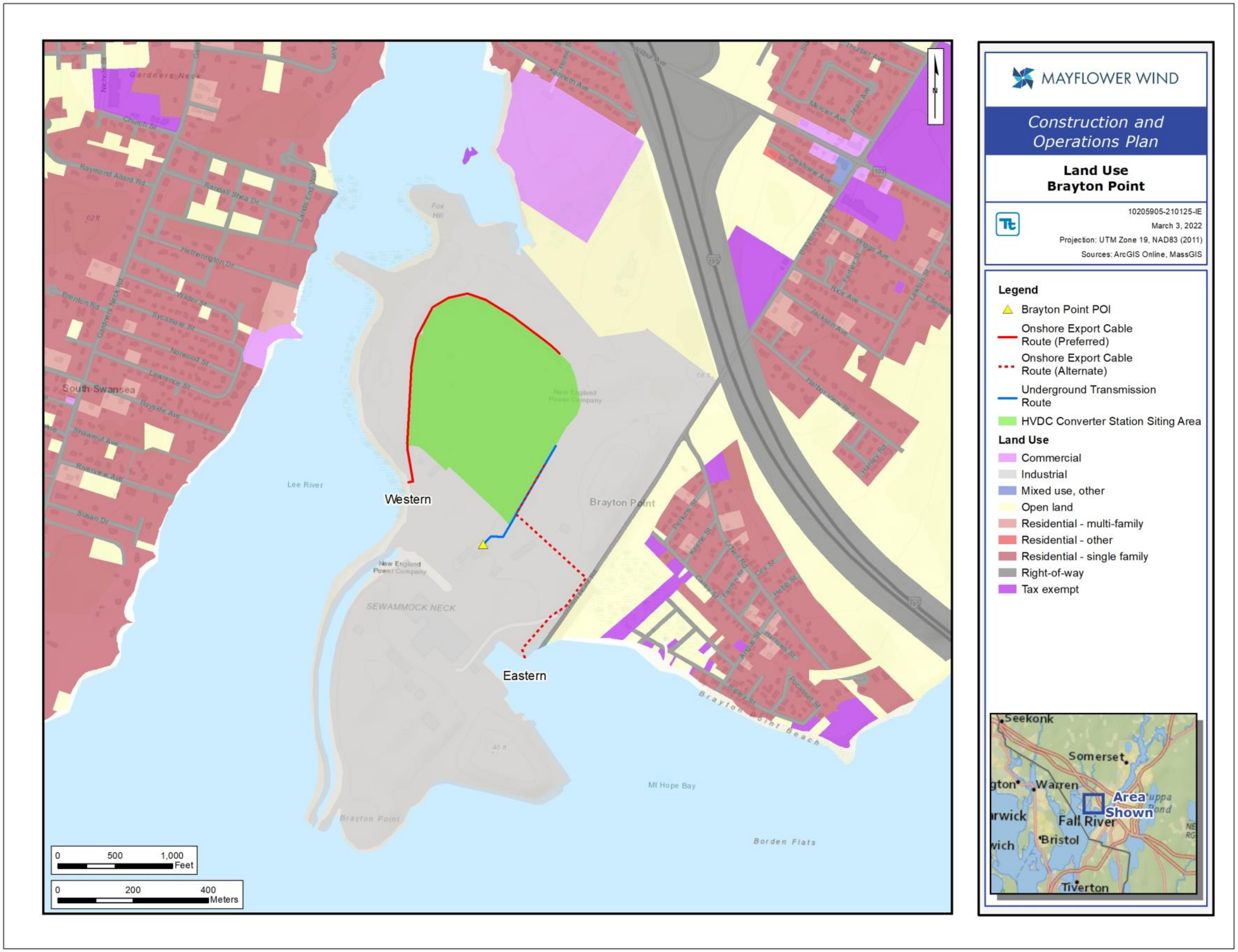


FIGURE 12-21. LAND USES WITHIN 500 FT (152 M) OF ONSHORE PROJECT COMPONENTS – BRAYTON POINT

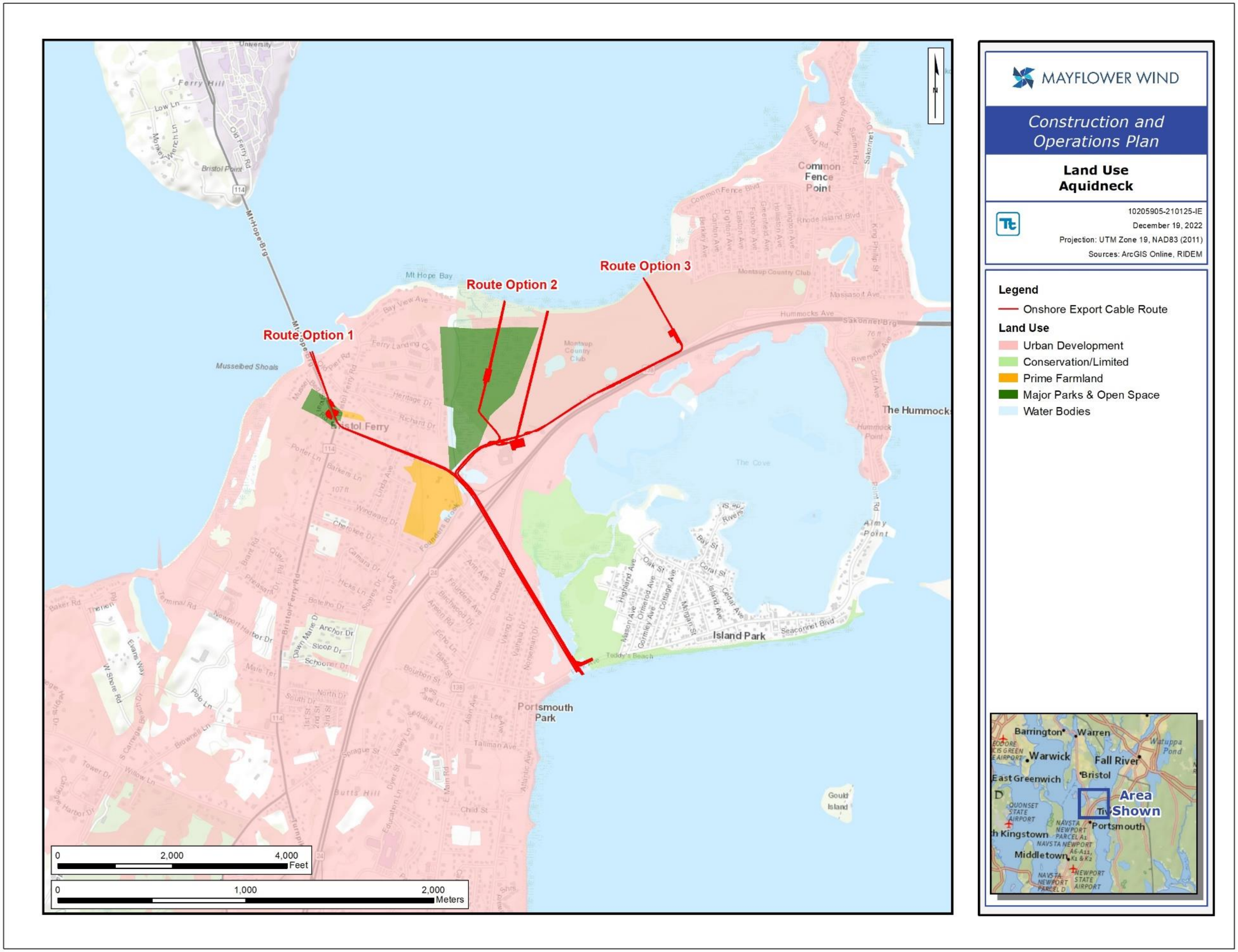


FIGURE 12-22. LAND USES WITHIN 500 FT (152 M) OF THE ONSHORE PROJECT COMPONENTS – AQUIDNECK ISLAND

12.1.5 Ports

The proposed Project will likely use the New Bedford MCT in Bristol County. This facility is part of New Bedford's extensive industrial waterfront, adjacent to the Acushnet River estuary, which empties into Buzzards Bay. The New Bedford MCT is a completed facility developed by the Commonwealth of Massachusetts specifically to support the construction of offshore wind facilities, and the port is surrounded by marine-related industrial uses. As such, zoning and existing land uses are appropriate for Project activities.

12.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan* (COP). The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3.3 is considered for the analysis of potential effects.

The majority of IPFs will occur in local communities where onshore Project components are sited, specifically in Falmouth in Barnstable County, Massachusetts, Somerset in Bristol County, Massachusetts and Portsmouth in Newport County, Rhode Island. The effects will largely be associated with the installation and construction of the onshore components. These areas include the landfall location, the onshore substation, the converter station, and the new utility duct bank beneath and along public ROWs from the landfall locations to the onshore substation and converter station, as well as underground transmission lines from the onshore substation and converter station to the POIs. Project activities at the New Bedford MCT may also affect surrounding land use.

Similarly, periodic maintenance and repairs of onshore components could affect neighboring land uses. Furthermore, proposed Project WTGs in the Lease Area could be visible from the elevated areas on Martha's Vineyard and Nantucket and their respective coastlines, depending on vegetation, topography, and atmospheric conditions. Disturbance of the seascape could theoretically affect shore-side property value and tourism-based land uses. However, the closest proposed Project WTGs would be approximately 20 nm (37 km) from the coast and would not dominate the view, even in the best atmospheric conditions. Visual effects are discussed in Section 8 and Appendix T, Visual Impact Assessment.

It is envisioned that the majority of the onshore components will be left in place for possible future reuse. If necessary, decommissioning of the onshore components would be coordinated closely with the host town and aim to have the fewest environmental impacts. Refer to Section 3.3 for detailed information regarding decommissioning.

Table 12-1 provides a summary of the potential effects from the proposed Project on zoning and land use, and full discussions for these effects are presented below. Proposed avoidance, minimization, and mitigation measures to reduce potential effects to zoning and land use including resources are summarized in Section 16.

TABLE 12-1. IPFS AND POTENTIAL EFFECTS ON ZONING AND LAND USE IN THE PROJECT AREA

IPF	Potential Effects		Period of Effect		
	Project Component		Project Phase		
	Landfall Location, Onshore Export Cables and Transmission Line	Onshore Substation and Converter Station	Construction	O&M	Decomm.
Land Use	-	Zoning exception or relief	X	-	-
Traffic	Disruption in accessibility	Disruption in accessibility	X	X	-
Noise and Vibration	Reduced enjoyment	Reduced enjoyment	X	-	-
Planned Discharges - Air emissions	Reduced enjoyment	Reduced enjoyment	X	X	X
Accidental Events	Disruption of use	Disruption of use	X	X	X

12.2.1 Land Use

The proposed Project may affect zoning and land use where onshore infrastructure is installed, namely within the Towns of Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island. No direct installation activities will occur at the New Bedford MCT, on Martha's Vineyard, or on Nantucket.

12.2.1.1 Construction

The potential landfall location options in Falmouth, Massachusetts are zoned PU by the Town of Falmouth; this zoning designation does not allow the installation of electrical transmission infrastructure. Consequently, any landfall location option would likely require obtaining an easement from the Town of Falmouth and a zoning exemption from the Commonwealth of Massachusetts, but could also potentially require zoning relief. Mayflower Wind will consult and work with the local authorities and MA EFSB to facilitate the authorization of the required land use in the parcel.

The preferred onshore substation location, at Lawrence Lynch, is zoned LIA, which allows electricity regulating substations as a land use. This zoning is appropriate for the installation of a substation. The location for the alternate substation location, Cape Cod Aggregates, is zoned PU, which does not allow the installation of electrical transmission infrastructure. Consequently, Option 2 would require either zoning relief or obtaining a zoning exemption from the Commonwealth of Massachusetts. Mayflower Wind will consult and work with the municipal authority and MA EFSB to facilitate the authorization of the required land use in the parcel.

In Falmouth, Massachusetts, the underground duct bank will be installed beneath existing roads and possibly some green spaces (Worcester Park or Central Park), while the transmission line will be installed either within the ROW of existing roads or within the utility-owned ROW already used for electrical lines. Local zoning laws do not apply to state or local ROWs and, as such, proposed transmission line routes in these ROWs will not require zoning relief. Mayflower Wind will consult and work with the municipal authority and MA EFSB to facilitate the authorization of the underground duct bank installation in any parcel where this activity is typically not permitted.

The intermediate landfall, which will occur on land zoned R-10 Residential and R-20 Residential along existing roads and/or across privately owned land (the Montaup Country Club). Local zoning laws do not apply to state or local ROWs and, as such, proposed transmission line routes in these ROWs will not require zoning relief. Mayflower Wind will consult and work with the municipal authority and RI EFSB to facilitate the authorization of the underground duct bank installation in any parcel where this activity is typically not permitted.

Since all proposed Project components in Somerset are sited within an area intended for industrial uses (including the development of substations), it is not expected that construction related activities will impact other land uses within the parcel.

12.2.2 Construction Areas/Traffic

The proposed Project may disrupt accessibility during installation activities of onshore infrastructure, namely within Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island. No direct installation activities will occur around the New Bedford MCT, on Martha's Vineyard, or on Nantucket.

12.2.2.1 Construction

Installation of the underground export cables at the landfall location could temporarily disrupt accessibility to neighboring land uses. Construction staging in parking lots adjacent to or near the landfall locations would reduce available parking for the Falmouth Heights Beach and Surf Drive Beach. The Project landfall activities in Falmouth would be limited to gated areas affecting only small portions of the beach.

Road construction along the underground export cable route or alternate underground transmission route in Falmouth could disrupt accessibility by causing traffic and requiring detours. Installation of the transmission line in Falmouth will occur in the off road utility-owned ROW, which is largely absent of human presence, and in the vicinity of residential and commercial areas along the ROW. Installation of a transmission line is a relatively low-impact activity.

Construction of the onshore substation in Falmouth may disrupt accessibility in the immediate vicinity of the activities, due to traffic from construction vehicles. As construction vehicles already circulate in these areas due to the current land uses, there would be little change in accessibility.

Installation of the underground export cable and onshore converter station in Somerset is limited to the location of the former Brayton Point Power Station; these roads are limited to restricted traffic. Therefore, immediate impacts to traffic will be minimal. There may be short-term disruption to local traffic on roads leading into the Brayton Point property during construction activities.

The onshore component of the offshore export cable on Aquidneck Island in Portsmouth will pass through residential zoned areas, and construction will impact traffic in those neighborhoods. However, impacts will be temporary and localized during the construction phase of the Project.

As detailed in Section 3, Description of Proposed Activities, installation and construction activities at the landfall locations, onshore substation, converter station, and along the onshore export cable route and underground transmission lines are planned to occur intermittently for up to two years (see Section 3, Description of Proposed Activities). However, access disruptions will occur for a short period at any given location as installation of the equipment progresses along the onshore export cable route and transmission line. At the landfall location and the onshore substation area in Falmouth, installation activities (which are planned to occur intermittently for up to two years) may cause temporary restrictions to limited areas. Given the existing use at Brayton Point, landfall and converter station construction activities in Somerset are not expected to result in restrictions beyond the already restricted-access nature of the site.

Mayflower Wind will develop and implement a Construction Management Plan, which will include an onshore construction schedule to minimize effects to recreational uses and tourism-related activities to the extent feasible, such as scheduling nearshore construction activities to avoid the height of the summer tourist season. Mayflower Wind will work with and coordinate with stakeholders/visitors' bureaus to schedule outside of major events taking place onshore. For example, Mayflower Wind does not anticipate HDD installation activities at the Falmouth landfall location between Memorial and Labor Day.

Mayflower Wind will work with Falmouth and Somerset, Massachusetts and Portsmouth, Rhode Island, to develop a Traffic Management Plan that minimizes the disruptions to residences and commercial establishments in the vicinity of construction and installation activities. Construction monitoring would be implemented to ensure compliance with the Traffic Management Plan. Furthermore, a Construction Management Plan, which will include onshore construction schedule will be developed and implemented to minimize effects to neighboring land uses to the extent feasible. Mayflower Wind will coordinate with stakeholders to schedule work activities outside of major events taking place onshore. To the extent allowed, onshore construction activities will comply with local regulatory authority requirements.

All areas temporarily affected by installation and construction activities, including roads, beaches, parking areas, green spaces, etc., will be restored to an equal or better condition, as appropriate for the existing land use.

12.2.2.2 Operations and Maintenance

Once installed, the landfall location, onshore substation, converter station, onshore export cables, and transmission line would not affect adjacent land uses. Existing activities on nearby affected parcels will be able to resume and continue as before.

Periodic maintenance and repairs could have temporary effects on access to adjacent land uses, similar to work on any other utility infrastructure, including effects on accessibility due to construction and traffic. These effects will be addressed as described above in Section 12.2.2.1. Additionally, in the event that unscheduled repairs are needed, an authorization will be obtained from the local authorities as required.

Some O&M activities of offshore Project infrastructure will be staged from the New Bedford MCT, resulting in normal vehicular traffic consistent with existing and designated uses for this type of facility.

12.2.3 Noise and Vibration

Noise and vibration from installation activities may reduce enjoyment around the onshore infrastructure, namely within the Towns of Falmouth and Somerset. Some noise and vibration would also be generated at the New Bedford MCT. No direct installation activities will occur on Martha's Vineyard or on Nantucket.

12.2.3.1 Construction

Installation of the onshore export cables at the landfall location in Falmouth, Massachusetts and the export cable route through Portsmouth, Rhode Island could temporarily affect neighboring land uses, including beaches and residential and commercial areas along the onshore export cable route. This is mainly due to disturbance through construction noise and vibration.

Construction of Onshore Substation Option 1 may affect neighboring land uses, including some residential areas and places of worship with a cemetery, mainly due to disturbance through construction noise and vibration. Noise and vibration from the construction of Onshore Substation Option 2 in Falmouth or the converter station and onshore cables in Somerset would have few effects on enjoyment as the neighboring areas are mostly unoccupied. The existing zoning of the converter station is intended for industrial use and has been historically used as an energy facility.

The proposed Project will implement best practices to minimize potential effects. Also, an onshore construction schedule will be developed to minimize effects to neighboring land uses to the extent feasible. Finally, onshore construction activities will comply with local regulatory authority requirements.

Project activities will generate some noise and vibration at the New Bedford MCT and, to a lesser extent, any of the other ports used for Project activities. These effects are typical for industrial ports. The proposed Project would not increase these effects above the levels typically experienced or expected at these facilities and would not hinder other nearby land use or use of coastal infrastructure. See Section 9, Acoustic Resources, for additional information regarding acoustic resources.

12.2.3.2 Operations and Maintenance

Periodic maintenance and repair activities may have temporary effects on enjoyment of adjacent land uses, mainly due to noise, vibration, and fugitive dust. These short-term effects will be addressed as described in Section 12.2.3.1.

12.2.4 Planned Discharges - Air Emissions

Air emissions from installation activities may reduce enjoyment around the onshore infrastructure, namely within the Towns of Falmouth and Portsmouth. Some air emissions would also be generated at the New Bedford MCT. No direct installation activities will occur on Martha's Vineyard or on Nantucket.

12.2.4.1 Construction

Construction related air emissions may affect the land uses in the immediate vicinity of the construction activities. Air emissions will mostly be created by vehicles and construction equipment, and will include carbon monoxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x), sulfuric acid mist (H_2SO_4), and particulate matter. Earth moving activities will also create some airborne particulate matter (construction dust). Air quality effects are discussed in more detail in Sections 5.1 and Appendix G, Air Emissions Report.

Installation of the Falmouth onshore export cables, and the preferred onshore substation could temporarily affect neighboring land uses, including beaches and residential and commercial areas along the export cable routes. Air emissions from the construction of alternate onshore substation, the converter station, Brayton Point onshore export cables, and the underground transmission routes would have few effects on air quality as the neighboring areas are mostly unoccupied or located along high-traffic roads.

The proposed Project will implement BMPs to minimize potential effects on air quality. Also, an onshore construction schedule will be developed to minimize effects to neighboring communities, to the extent feasible. Onshore construction activities will comply with local regulatory authority requirements. Further avoidance, minimization and mitigation measures related to air emissions are described in Section 5.1, Air Quality.

Project activities will generate air emissions at the New Bedford MCT and, to a lesser extent, any of the other ports used for Project activities. These effects are typical for industrial ports. The proposed Project would not increase these effects above the levels typically experienced or expected in the vicinity of these facilities.

12.2.4.2 Operations and Maintenance

Air emissions during periodic maintenance and repair activities may have temporary effects on communities, similar to work on any other utility infrastructure. These short-term effects will be addressed as described in Section 10, Socioeconomics.

12.2.4.3 Decommissioning

Decommissioning activities will be similar to the construction phase but less intensive. Therefore, fewer air emissions would be generated than during the construction phase. These short-term effects will be addressed as described in Section 10, Socioeconomics .

12.2.5 Accidental Events

Accidental releases from onshore construction activities could affect adjacent land uses in Falmouth and Somerset in Massachusetts. See Appendix AA, Oil Spill Response Plan for details on how accidental releases will be handled.

12.2.5.1 Construction and Decommissioning

Accidental releases of fuel, oil or other hazardous materials from construction activities may affect neighboring onshore land uses, including some developed areas, forests, and wetlands, as well as nearshore land uses such as beaches and other coastal services.

Installation activities of offshore Project infrastructure will likely be staged from the New Bedford MCT, consistent with existing and designated uses for this type of facility and not anticipated to result in an increased risk of accidental events.

The proposed Project will implement BMPs and implement a safety and environmental plan as well as an emergency response procedure to avoid, minimize, and mitigate any accidental releases during all Project activities.

12.2.5.2 Operations and Maintenance

Accidental releases of fuel, oil, or other hazardous materials from periodic maintenance and repair activities may affect neighboring onshore land uses. As discussed above, the proposed Project will implement best practices and implement a safety and environmental plan, as well as an emergency response procedure to avoid, minimize, and mitigate any accidental releases during all Project activities.

O&M activities of the offshore Project infrastructure would be staged from the New Bedford MCT, consistent with existing and designated uses for this type of facility and not anticipated to result in an increased risk of accidental events.

13 NAVIGATION AND VESSEL TRAFFIC

This section describes Project activities that may affect navigation and vessel traffic within the Offshore Project Area, which includes the Lease Area and the offshore export cable corridors. A detailed Navigation Safety Risk Assessment (NSRA), included as Appendix X, has also been conducted for the proposed Project. The NSRA conforms to the USCG *Guidance for Offshore Renewable Energy Installations* contained in *Navigation Vessel Inspection Circular 01-19* (NVIC 01-19) and incorporates information gained through consultation with the USCG and maritime transportation stakeholders.

Technical appendices related to navigation and vessel traffic include:

- Appendix X, Navigation Safety Risk Assessment
- Appendix V, Commercial and Recreational Fisheries Technical Report

13.1 AFFECTED ENVIRONMENT

For the purpose of the NSRA, the Offshore Project Area is defined as the largest possible footprint of the offshore Project structures. The boundaries of the evaluated NSRA Study Area are at least 20 nm (37 km) from the Lease Area and extend to the north to cover the Falmouth export cable corridor and northwest to cover the Brayton Point export cable corridor. The NSRA Study Area was discussed at the NSRA kickoff meeting and the USCG had no objections to the proposed Study Area.[15] Appendix X, Navigation Safety Risk Assessment, includes an assessment of the navigation risks in the Lease Area and along the Falmouth export cable corridor. The Brayton Point export cable corridor assessment is included in an addendum to Appendix X, Navigation Safety Risk Assessment.

The evaluated Project Area and the NSRA Study Area are shown in **Figure 13-1**.

13.1.1 Vessel Traffic

Vessel traffic in the NSRA Study Area includes a wide range of vessel types, from passenger cruise ships to small pleasure craft. The sources employed to identify vessel traffic patterns include AIS data from 2019 (MarineTraffic, 2020), Nationwide Automatic Identification System data for 2019, 2016 VMS data from NMFS, VTR data from 2011 to 2015, the 2020 MARIPARS (USCG, 2020a), and interactions with recreational boating, fishing, and towing industry organizations, agencies, and other stakeholders. **Figure 13-2** presents density of vessel tracks based on 2019 AIS data.

The NSRA Study Area experiences a wide range of vessel traffic density, vessel types, and vessel sizes. Vessel traffic in the northern portions of the NSRA Study Area (within Nantucket Sound, the Sakonnet River, Mount Hope Bay) consists mostly of smaller vessels with a high seasonal influence on the level of traffic. Relatively few vessels transit between the northern portion of the NSRA Study Area and the southern portion. Vessel traffic in the southern portion of the NSRA Study Area is more complex due to the mixture of deep draft vessels and commercial fishing vessels engaged in fishing or transiting to fishing locations.

[15] The PDE has been since updated to include the Brayton Point export cable corridor; however, a similar approach was applied to identify an appropriate study area for the corridor.

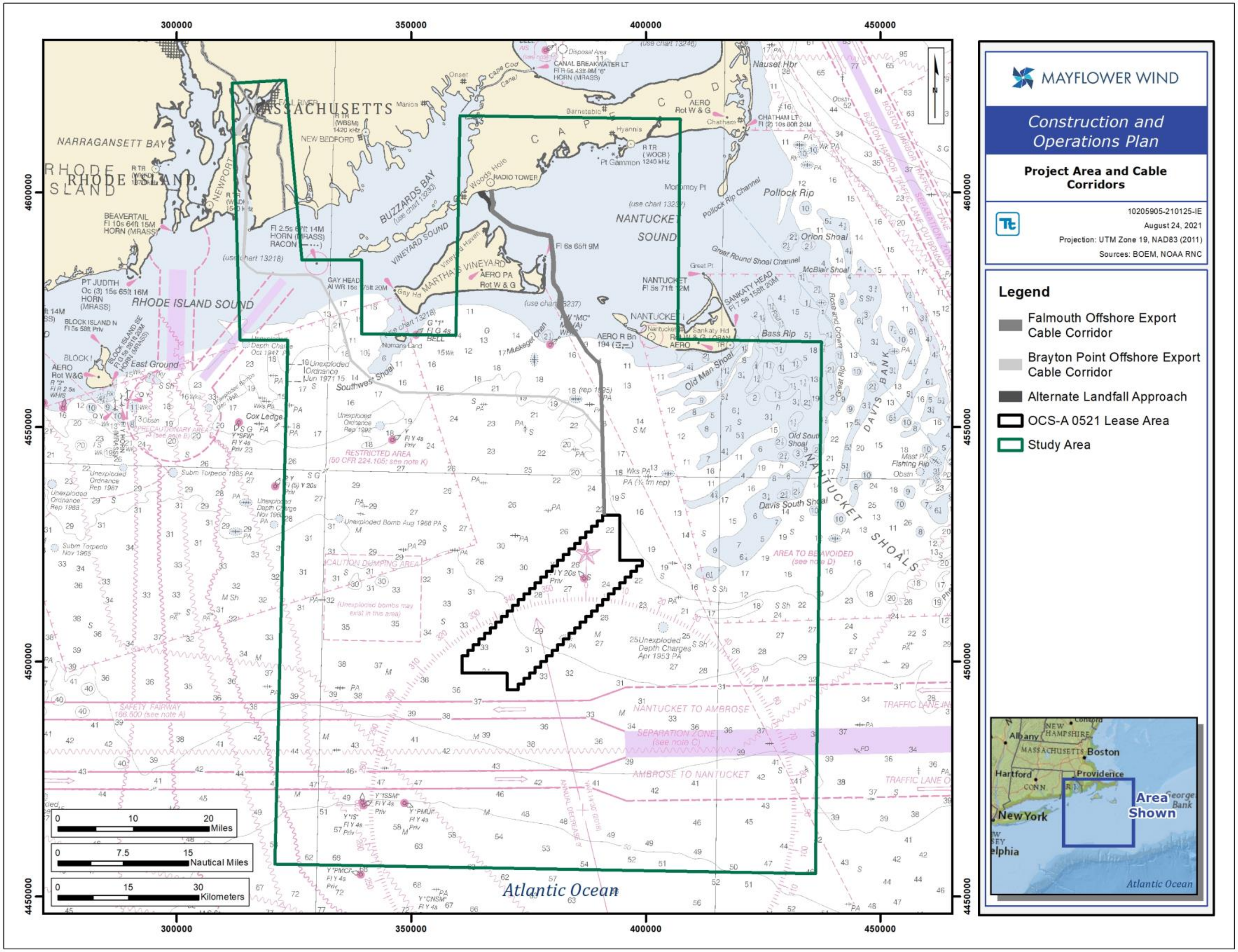


FIGURE 13-1. NSRA STUDY AREA

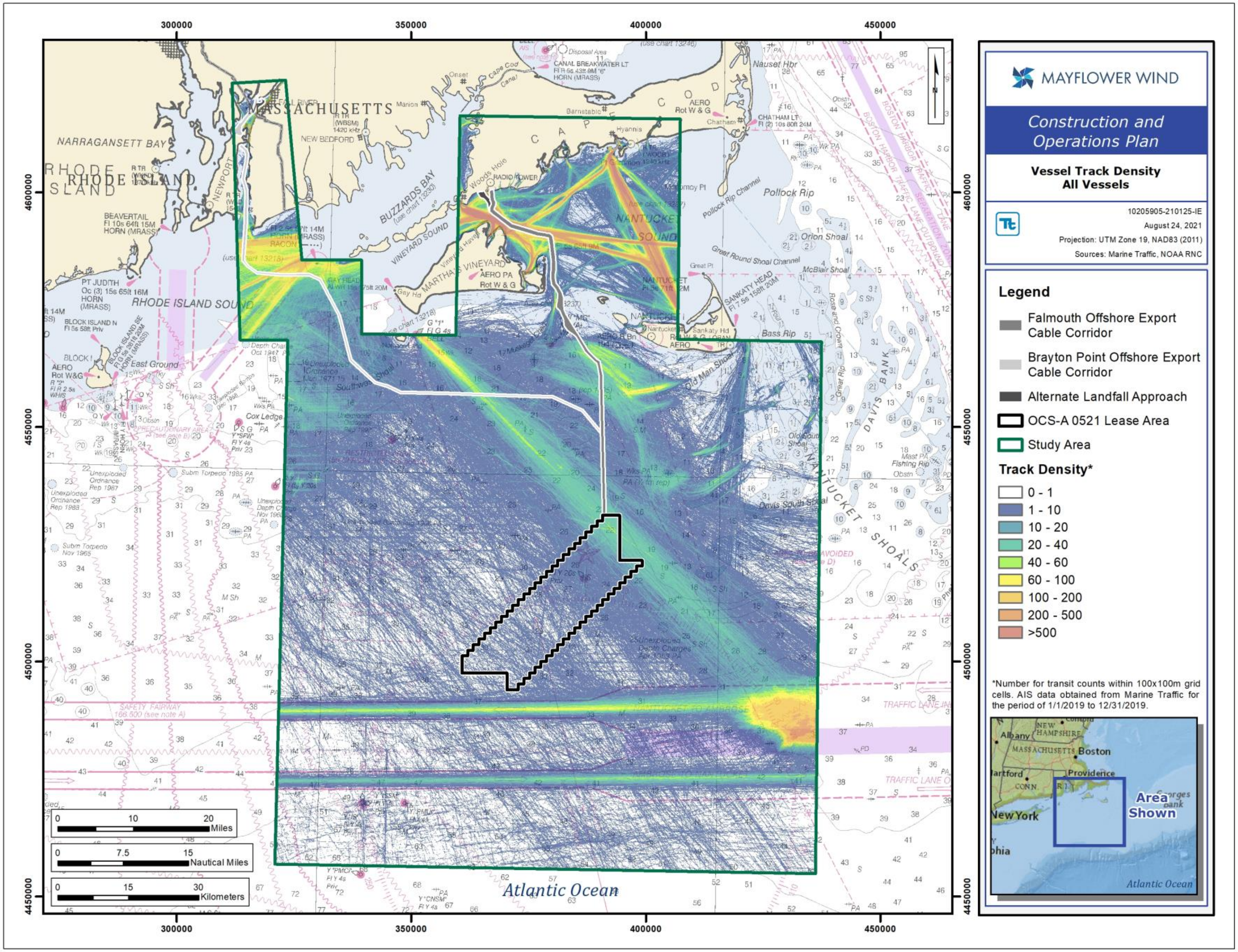


FIGURE 13-2. AIS TRAFFIC DENSITY IN THE NSRA STUDY AREA

Cargo, carrier, and tanker vessel traffic patterns obtained through AIS data show that deep draft vessels utilize two TSSs in proximity to the NSRA Study Area to approach and depart from ports. A TSS is an internationally recognized measure that minimizes the risk of collision by separating vessels into opposing streams of traffic through the establishment of traffic lanes (IMO, 2019). The densest vessel tracks are within the Off New York TSS, located between the approaches to New York and waters south of Nantucket. Outside of the Off New York TSS, cargo, carrier, and tanker vessels transit to and from the Off Narragansett Bay TSS. Minimal cargo and tanker activity exists within the Sakonnet River and Rhode Island Sound with slightly higher activity within Mount Hope Bay.

Commercial fishing vessels are subject to different regulatory navigational requirements, including differences in AIS carriage and trip reporting requirements (NOAA, 2020). The NSRA evaluated patterns using Nationwide Automatic Identification System data, fishing activity by catch (VTR data), fishing activity by gear, and the MARIPARS report. Within the area evaluated in the NSRA, the densest commercial fishing vessel transit route is in a northwest-southeast corridor from Martha's Vineyard and along Nantucket Shoals intersecting the Falmouth export cable corridor. In the vicinity of the Brayton Point export cable corridor, the densest commercial fishing activity occurs in Rhode Island Sound with limited activity within Mount Hope Bay and the Sakonnet River, with the exception of high levels of monkfish fishing and limited gillnet fishing in the south. More details regarding commercial and recreational fishing in proximity to the NSRA Study Area can be found in Section 11, Commercial and Recreational Fisheries and Fishing Activity, and in Appendix V, Commercial and Recreational Fisheries Technical Report.

NMFS provided commercial fisheries landings data specific to each lease area in the Atlantic OCS by combining VTRs and dealer reports into modeled fishing intensity raster datasets (NOAA, 2020). For the years 2008 through 2018, data for the Mayflower Wind Lease Area indicate that the gear types of bottom and midwater trawls, pots, traps, and gillnets represent more than 95 percent of the commercial fishing activity in the Lease Area. Additional discussion on this dataset and its limitations is provided in Section 11, Commercial and Recreational Fisheries and Fishing Activity, and Appendix V, Commercial and Recreational Fisheries Technical Report.

Passenger vessels present in proximity to the NSRA Study Area include roll-on/roll-off vessels transiting between Cape Cod, Martha's Vineyard, and Nantucket. These smaller passenger vessels are mostly transiting throughout Nantucket Sound and Rhode Island Sound, north and northwest of the Lease Area. Within the vicinity of the NSRA Study Area, most of the passenger transits are from cruise ships in the Off New York TSS. Similar to passenger vessels, the majority of pleasure vessel transits occur within Nantucket Sound and Rhode Island Sound, the Sakonnet River, and Mount Hope Bay.

13.1.2 Navigation

Two TSSs in the region influence deep draft vessel routes. The Off New York TSS is located south of the Lease Area and the TSS Off Narragansett Bay in Rhode Island Sound is located northwest of the Lease Area.

The Off New York TSS resembles a divided highway with westbound traffic transiting in the northern lane and eastbound traffic transiting in the southern lane. The width of each lane is 5 nm (9.3 km) at its eastern terminus outside of the Lease Area, where westbound traffic enters and eastbound traffic exits. The lanes narrow to 3 nm (5.6 km) immediately south of the Lease Area. A 3 to 6 nm (5.6 to 11.1 km)-

wide Separation Zone lies between the inbound and outbound lanes; it is wider where the traffic lanes are narrower.

Outside of the Lease Area, cargo vessels, carriers, and tankers also transit to and from Narragansett Bay via the TSS Off Narragansett Bay. Some of these vessel tracks cross the Lease Area when transiting between the Off New York TSS and the TSS Off Narragansett Bay. Nantucket Shoals, located to the northeast and east of the Lease Area, pose a significant hazard to deep draft vessels. As such, the western edge of the shoals has been designated by the International Maritime Organization as an Area to be Avoided (NOAA, 2020).

An Aid to Navigation (ATON) is a device, system, or service external to vessels designed and operated to enhance safe and efficient navigation of individual vessels or vessel traffic (IALA, 2017). A Private Aid to Navigation (PATON) is any marine aid to navigation operated in the navigable waters of the United States other than those operated by the federal government (68 CFR Part 152). ATON and PATON located throughout the vicinity of the NSRA Study Area may assist vessels in more accurately determining their positioning in relation to the Lease Area and Project components as well as identifying potential hazards. Mayflower Wind will submit requests for up to 149 PATONs from the USCG, one for each of the WTG or OSP positions.

13.2 Potential Effects

Impact Producing Factors are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

The potential effects of the proposed Project to navigation and vessel traffic during construction, operation, and decommissioning are listed in **Table 13-1**. Potential effects directly relating to commercial and recreational fishing are discussed in Section 11, Commercial and Recreational Fisheries and Fishing Activity; and specific potential effects directly relating to pleasure vessels and tourism vessels are discussed in Section 10.3, Recreation and Tourism. Avoidance, minimization, and mitigation measures Mayflower Wind will implement regarding the effects of the proposed Project on navigation and vessel traffic are included in Section 16, Summary of Avoidance, Minimization, and Mitigation Measures.

TABLE 13-1. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON NAVIGATION AND VESSEL TRAFFIC

IPF	Potential Effects		Period of Effect		
	Project Component		Project Phase		
	Lease Area	ECCs	Construction	O&M	Decomm.
Actions that may displace human uses	Project vessel operations; presence of structures	Project vessel operations	X	X	X
Activities that may displace or impact fishing, recreation, and tourism	Transit times for passing vessels; presence of structures; vessel activity	Transit times for passing vessels	X	X	X
Accidental Events	Project vessel operations; presence of structures	Project vessel operations	X	X	X
Altered Visual conditions	Presence of offshore structures; WTG and OSP installation and decommissioning equipment	Export cables installation and decommissioning equipment	X	X	X
Change in Ambient Lighting	WTG and OSP lighting; construction lighting; decommissioning equipment lighting	Construction equipment lighting; decommissioning equipment lighting	X	X	X

13.2.1 Actions that may Displace Human Uses

13.2.1.1 Construction

During the construction phase of the proposed Project, vessel transits required for Project construction will increase in number within the Offshore Project Area and to and from port. Beginning during the construction phase, deep draft and tug vessels that presently transit through the Offshore Project Area may begin to modify their routes further west to avoid construction activity, vessels, and any structures already in place. Mayflower Wind will implement construction safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing construction activities. This will not unreasonably increase transit times and distances transited for those vessels that modify their routes around the Offshore Project Area (see Appendix X, Navigation Safety Risk Assessment for further details).

13.2.1.2 Operations and Maintenance

Once the proposed Project has transitioned into the operational phase, the presence of offshore structures including the WTGs and OSPs may displace deep draft and tug traffic to the west. Displaced vessels generally join similar traffic in nearby routes. The operational phase of the proposed Project will require less Project-related vessel traffic than the construction and decommissioning phases, as Project vessels will mostly be transiting to and from the Offshore Project Area for scheduled and unscheduled maintenance. Minimal displacement of human uses will occur due to Project maintenance vessels.

13.2.1.3 Decommissioning

The decommissioning phase of the proposed Project will see effects to navigation and vessel traffic similar to those experienced during the construction phase. Project vessel traffic within the Offshore Project Area and transiting to and from port will increase as a direct result of decommissioning activities. Vessels that transited through the Offshore Project Area during the operations phase may alter their routes to avoid temporary decommissioning activities. Deep draft and tug traffic may decide to follow routes through the Offshore Project Area as they did pre-construction, as Project structures are removed. Mayflower Wind will implement decommissioning safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing decommissioning activities. Beyond the safety zones, navigation around decommissioning activities will not be prohibited by any offshore wind-related requirements. However, mariners are required to adhere to the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS) (IMO, 1972), to be aware of the prevailing environment, and to avoid unsafe situations.

13.2.2 Activities that may Displace or Impact Fishing and Recreation and Tourism

Commercial fishing traffic that presently transits through the Offshore Project Area may instead take routes to the east or west of the Offshore Project Area. Changes to commercial and recreational fishing vessel transit patterns will occur but the specifics of these changes and how they are ultimately manifested are not fully determinable at this time. These changes are not dependent solely on the presence of WTGs and other Project components but are also dependent on the distributions of fish populations, market forces, and more, all of which will change throughout the life of the proposed Project due to a wide range of dynamic, interconnected factors. More information regarding Project effects on commercial and recreational fishing can be found in Section 11, Commercial and Recreational Fisheries and Fishing Activity, and the effects on recreation and tourism can be found in Section 10.3, Recreation and Tourism.

13.2.2.1 Construction

There will be an increase in vessel traffic density as a direct result of the construction phase of the proposed Project. Vessels utilized will include construction vessels, support vessels, and crew transfer vessels. The indicative construction schedule is located in Section 3.2, Proposed Project Schedule, and a detailed discussion of vessels expected to be utilized during all phases of the proposed Project and their anticipated durations of use is included in Section 3.3.14, Vessels, Vehicles, and Aircrafts. Vessel transit routes are likely to navigate around construction activity and vessels. This effect to normal vessel transit routes will occur between ports and the construction activity. Mayflower Wind will implement construction safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing construction activities.

Port approaches for fishing and recreational vessels transiting within the vicinity of the export cable corridors could also be affected by the construction phase of the proposed Project. Port approaches in proximity to the export cable corridors are detailed in the NSRA. Pleasure and local passenger vessels transiting within Nantucket Sound and Mount Hope Bay may experience changes to port access from a higher volume of vessels, increased transit times due to offshore construction areas, including the export cable corridors, and changes in vessel traffic during the construction phase of the proposed Project. Alternate routes based on construction activity location may be required. See Section 3.3.13, Port Facilities, for more information on potential ports to be used by the proposed Project.

13.2.2.2 Operations and Maintenance

The operational phase of the proposed Project will require less Project-related vessel traffic than the construction and decommissioning phases, as Project vessels will mostly be transiting to and from the Offshore Project Area for scheduled and unscheduled maintenance. Those fishing vessels that transit around the Lease Area are anticipated to experience no or small changes to transit times, on the order of 30 minutes at most, by avoiding the Lease Area. More detailed information on the effects to commercial and recreational fishing during operation is provided in Section 11, Commercial and Recreational Fisheries and Fishing Activity.

13.2.2.3 Decommissioning

There may be an increase in Project-related vessel traffic from ports to and from the Offshore Project Area as a direct result of the decommissioning phase of the proposed Project. Pleasure and local passenger vessels transiting within Nantucket Sound may experience changes to port access from a higher volume of vessels, increased transit times due to offshore decommissioning areas, and changes in vessel traffic during the decommissioning phase of the proposed Project. Mayflower Wind will implement construction safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing decommissioning activities. Beyond the safety zones, navigation around decommissioning activities will not be prohibited by any offshore wind-related requirements. However, mariners are required to adhere to the COLREGS (IMO, 1972), to be aware of the prevailing environment, and to avoid unsafe situations.

13.2.3 Accidental Events

13.2.3.1 Construction

Unplanned accidental events can occur during any phase of the proposed Project. Offshore construction activities could be a hazard to passing vessels and fishing activities. Vessels involved in Project construction could also experience accidental events, including collision or allision, from passing vessels. An increase in vessel traffic during Project construction can lead to an increased risk of accidental events. Mayflower Wind will implement construction safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing construction activities.

13.2.3.2 Operations and Maintenance

The potential exists for new accidents involving a vessel allision with a structure, or changes to vessel routes that result in alteration of the accident risk profile in or nearby the Offshore Project Area. The NSRA developed estimates of the frequency or likelihood of marine accidents as a result of the proposed Project and a "what if" consequence analysis. As discussed in the NSRA, the increase in frequency of collision, allision, and grounding events as a result of the proposed Project is statistically expected to increase by 0.4 incidents per year. This number includes accidents with cargo/carrier, fishing, other/undefined, passenger, pleasure, tanker, oil tanker, and tugs or service vessels. The consequence analysis within Appendix X, Navigation Safety Risk Assessment, discusses the ranges of severity for reasonably foreseeable accidents or events. Navigation within the Offshore Project Area will not be prohibited by any offshore wind-related requirements. However, mariners are required to adhere to the COLREGS (IMO, 1972), to be aware of the prevailing environment, and to avoid unsafe situations.

13.2.3.3 Decommissioning

Much like construction, the decommissioning phase of the proposed Project will experience a higher number of Project-related vessel transits to, within, and from the Offshore Project Area. Offshore decommissioning activities could be a hazard to passing vessels and fishing activities. Decommissioning vessels could experience accidental events or hazards from passing vessels. The likelihood of accidental events involving vessel operations occurring during the decommissioning phase of the proposed Project will change in proportion to the number of vessels in a given area. The change will be due to the presence of Project vessels in the vicinity of the decommissioning activities and additional transits to and from port. Mayflower Wind will implement decommissioning safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing decommissioning activities. Beyond the anticipated safety zones, navigation around decommissioning activities will not be prohibited by any offshore wind-related requirements. However, mariners are required to adhere to the COLREGS (IMO, 1972), to be aware of the prevailing environment, and to avoid unsafe situations.

13.2.4 Altered Visual Conditions

13.2.4.1 Construction

The presence of offshore equipment during the construction phase of the proposed Project could alter visual conditions within the Offshore Project Area. Altered visual conditions as a result of construction equipment and activities can influence navigation and vessel traffic within the Offshore Project Area and some vessels may opt to divert away from the Offshore Project Area during transit.

13.2.4.2 Operations and Maintenance

Once the proposed Project is operational, the offshore structures present may make Search and Rescue (SAR) efforts more challenging in bad visibility or high seas over the Lease Area. The USCG confirmed that it would be able to execute its SAR mission with sea and air assets if the Project WTG/OSP layout was in a 1 nm x 1 nm (1.9 km x 1.9 km) uniform grid pattern (USCG, 2020a). The presence of offshore structures can influence navigation and vessel traffic within the Lease Area. Vessels can opt to navigate around the structures or use them as a PATON.

As discussed in Appendix X, Navigation Safety Risk Assessment, WTG substructures may block the view of vessels passing by them. The NSRA conservatively estimates that the maximum monopile substructure within the PDE could potentially limit a vessel's visibility of a second vessel for up to 11 seconds, assuming the second vessel was equidistant on the opposite side of the structure and was not moving. A hazardous situation could exist if two vessels were transiting at speed on intersecting courses while close to the same monopile substructure. Both vessels would be aware that their line of sight was limited by the structure, and in line with COLREGS, should reduce speed and keep vigilant watch.

13.2.4.3 Decommissioning

The presence of offshore equipment during the decommissioning phase of the proposed Project could alter visual conditions within the Offshore Project Area. Altered visual conditions as a result of the presence of decommissioning equipment and commencement of decommissioning activities can influence visibility within the Offshore Project Area and prompt vessels to divert away from the Offshore Project Area during transit.

13.2.5 Change in Ambient Lighting

13.2.5.1 Construction

Some construction practices may require 24-hour operation, which will change the ambient lighting at night within the Offshore Project Area. This lighting may affect visibility for vessels transiting through the Offshore Project Area.

13.2.5.2 Operations and Maintenance

The operational phase of the proposed Project will see new additional lighting within the Lease Area on the offshore structures. The WTGs and OSPs will be lit and marked according to FAA, BOEM, and USCG requirements and may affect structure visibility for vessels transiting around the Lease Area. Marking of offshore Project structures is specified in international standards and USCG guidance. The most relevant standards include: First Coast Guard District Local Notice to Mariners 44/20, "ME, NH, MA, RI, CT, NY, NJ-Atlantic Ocean-Offshore Structure PATON Marking Guidance – Revised" (USCG, 2020b); International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 on the Marking of Man-Made Offshore Structures (IALA, 2013); The Convention on International Civil Aviation Annex 14 (ICAO, 2013), released by the International Civil Aviation Organization for marking of wind turbines with regard to safety of aviation; and *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development* (BOEM, 2021). See Section 3.3.12, Marking and Lighting, for more information on marking and lighting of Project components.

13.2.5.3 Decommissioning

Some decommissioning practices may require 24-hour operation, which will change the ambient lighting at night. This lighting may affect visibility for vessels transiting through the Offshore Project Area.

14 Other Marine Uses (Military Uses, Aviation, Offshore Energy, and Cables and Pipelines)

This section describes other human activities in the Offshore Project Area that may be affected by the proposed Project and includes an evaluation of potential Project-related effects, as well as proposed avoidance, minimization, and mitigation measures.

The location of the Lease Area was selected by BOEM following extensive pre-screening and stakeholder outreach which included a review of other marine uses in order to minimize conflicts (BOEM, 2013). BOEM did not evaluate potential Project-specific effects for specific uses. The following sections describe military uses, aviation, offshore energy, and cable and pipeline uses, as these uses have not been discussed in other sections of the COP.

14.1 Affected Environment

The Project can potentially affect marine uses within the Offshore Project Area (Lease Area and offshore export cable corridors) due to the presence of additional vessels during construction, O&M, and decommissioning activities, and the presence of the offshore infrastructure (WTGs, OSPs, and offshore export cables) during the O&M. Therefore, the area of interest for the evaluation of Project effects on other marine uses includes the Offshore Project Area and an area encompassing the various military uses and aviation-related activities in the region, including the Massachusetts Counties of Barnstable, Bristol, Dukes, Nantucket, and the Rhode Island Counties of Bristol and Newport. **Figure 14-1** illustrates the areas of interest for other marines uses.

14.1.1 National Security

National security uses in the vicinity of the Offshore Project Area include any activities by military and national security entities, such as the Navy, the USCG, the Air Force, North American Aerospace Defense Command (NORAD), the Department of Homeland Security (DHS), and the FAA.

Military uses in the region mainly revolve around the presence of several naval bases (BOEM, 2013; CRMC, 2010), including Naval Station Newport in Rhode Island, which hosts various Marine Corps, USCG, and U.S. Army Reserve commands and activities, including research, development, test and evaluation, engineering, and fleet support center for submarines, autonomous underwater systems, and offensive and defensive weapons systems associated with undersea warfare. Other bases include Naval Submarine Base New London (Connecticut), the Portsmouth Naval Shipyard (Maine/New Hampshire), Naval Weapons Station Earle (New Jersey), Joint Base Cape Cod (Massachusetts), Joint Base McGuire-Dix-Lakehurst (New Jersey), and the Newport Naval Undersea Warfare Center (Rhode Island), from where the U.S. Atlantic Fleet conducts training and testing exercises in the Northeast Range Complex for the Navy. The Northeast Range Complex for the Navy includes the Boston, Atlantic City, and Narraganset Bay Operating Areas (OPAREAs). **Figure 14-2** presents military uses in the area.

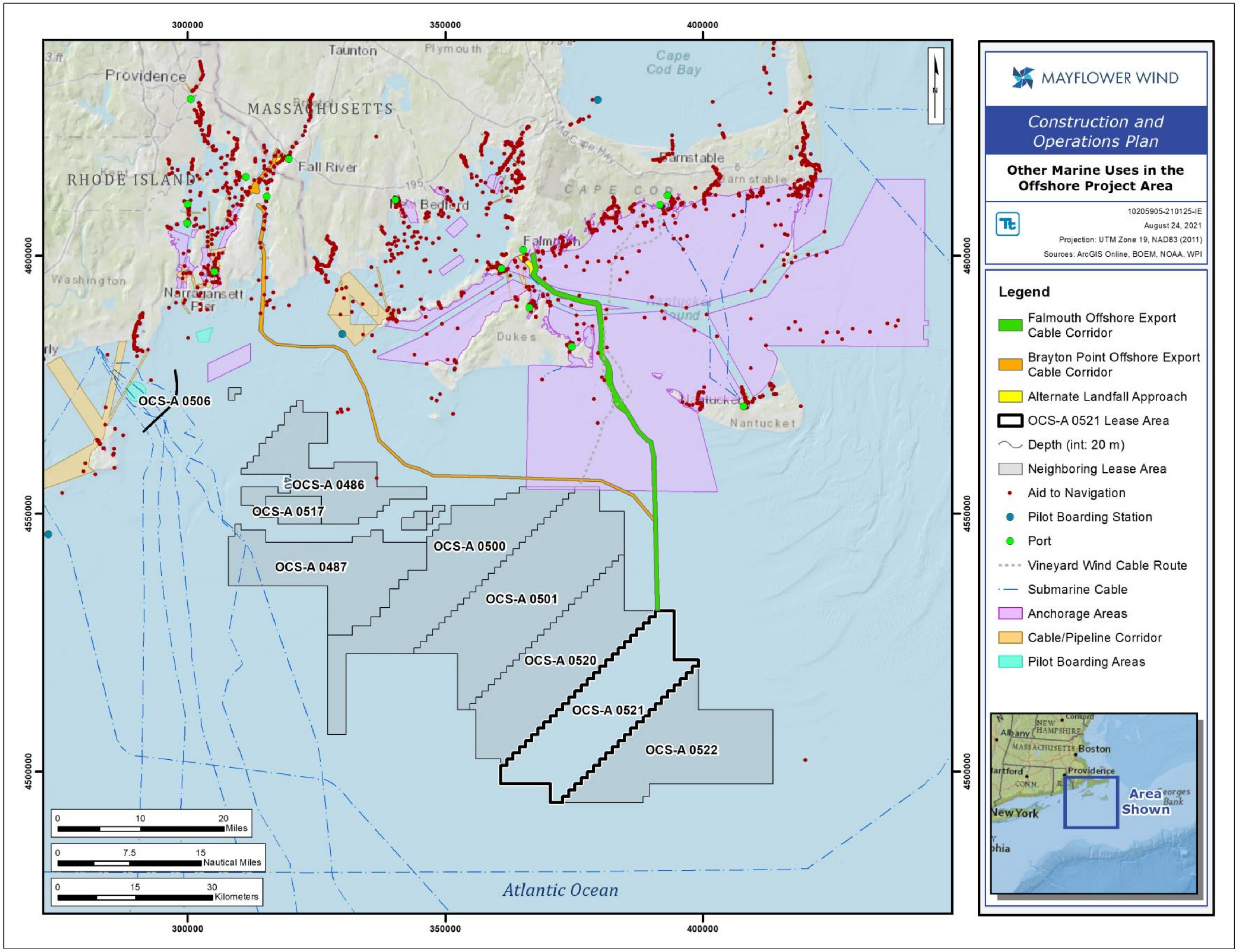


FIGURE 14-1. AREA OF INTEREST FOR OTHER MARINE USES

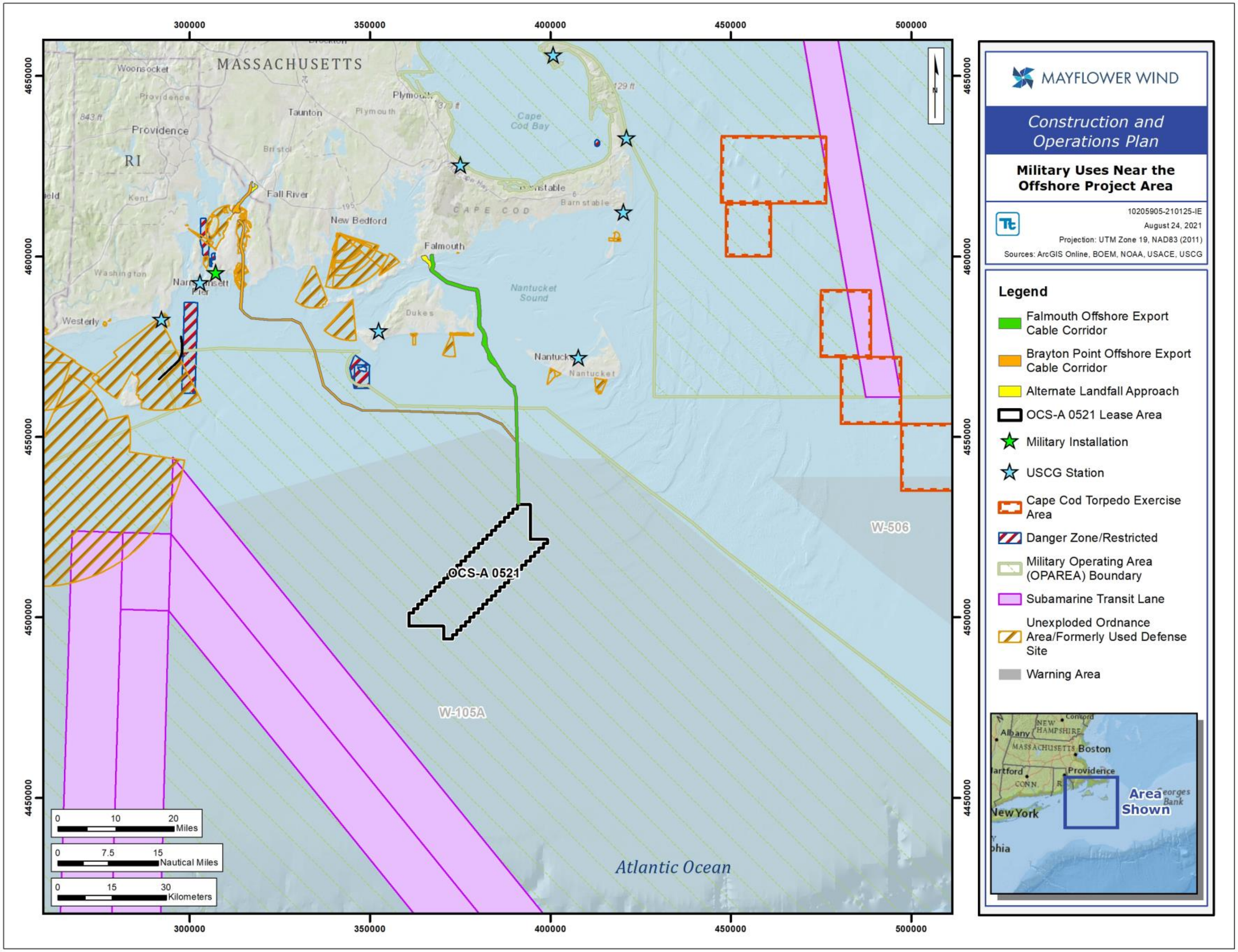


FIGURE 14-2. MILITARY USES NEAR THE OFFSHORE PROJECT AREA

The Lease Area and a section of the offshore export cable corridors overlap with the Narraganset Bay OPAREA, which extends approximately 180 nm (333 km) from the coasts of Massachusetts, Rhode Island, and New York.

The Offshore Project Area also overlaps the Navy Undersea Warfare Center Testing Range (**Figure 14-2**). The area is used for research, development, testing, and evaluation of undersea warfare systems, including acoustic testing, and, as necessary, to support other Navy and Department of Defense (DoD) operations. Current restricted areas are located south and east of the Offshore Project Area. While naval vessels occasionally transit in the vicinity of the Offshore Project Area, they are not involved in any type of range activity in proximity to the Offshore Project Area (AECOM, 2020).

The Offshore Project Area does not overlap any submarine transit lanes, torpedo exercise areas, danger zones or restricted areas, or safety, security, and regulated zones (AECOM, 2020). The Brayton Point export cable corridor does overlap with the recommended Traffic Route for Buzzards Bay and the outbound lane of the Traffic Separation Scheme for Buzzards Bay, as discussed in Section 13, Navigation and Vessel Traffic. The closest submarine transit lane is located approximately 12 miles (19.2 km) southeast of the Lease Area, travelling to and from Naval Submarine Base New London in Groton, Connecticut. The closest of the Cape Cod Torpedo Exercise Areas, which are used for countermeasure and torpedo testing and training, is at least 37 nm (69 km) east of the Offshore Project Area. The only danger zones (areas used for target practice, bombing, rocket firing and/or other especially hazardous operations) and restricted areas (government property with prohibited or limited access) near the Offshore Project Area are the waters surrounding Noman's Land Island, approximately 4.2 nm (7.8 km) southeast of the Brayton Point export cable corridor to Danger Zone 334.80(a) and approximately 3.3 nm (6.11 km) east of the Brayton Point export cable corridor to Danger Zone 167.103. None of the activities in these areas have any regular interaction with the Offshore Project Area.

The Falmouth export cable corridor does not overlap any unexploded ordnance (UXO) areas or Formerly Used Defense Sites (FUDS) (AECOM, 2020). The Brayton Point export cable corridor intersects one land-based FUDS which extends into the Sakonnet River. The status for the intersected FUDS site is listed as complete and closed out (USACE, 2019). UXO areas may contain explosive weapons (bombs, bullets, shells, grenades, mines, etc.) that did not explode when used and still pose a risk of detonation. FUDS are sites used for military training, production, installation and testing of weapon systems, which may contain UXO. BOEM's pre-screening process for the selection of the MA/RI WEAs included the avoidance of UXO areas and FUDS (BOEM, 2013). The nearest UXO site is located at least 10 miles (16 km) west of the MA/RI WEA.

Airborne military activity may occur in regulated airspace areas, such as special use airspace. These are areas within the National Airspace System wherein limitations may be imposed upon aircraft operations (AECOM, 2020). These may include warning areas, restricted areas, prohibited areas, military operations areas, air traffic control (ATC) assigned airspace, and any other designated airspace areas. There is special use airspace (W-105A) that overlies the Offshore Project Area.

The DHS is responsible for public security and includes several components, including the USCG. The USCG 1st District is responsible for USCG activities in Northern New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine. Services include maritime safety, homeland security, national defense, and environmental protection. The 1st Coast Guard District maintains two units covering over 3,000 mi^2 (7,770 km^2) of offshore waters and 1,200 miles (1,930 km) of coastline in Rhode Island and southeastern Massachusetts, including Cape Cod, Martha's Vineyard, and Nantucket. The units are identified as; Sector Southeastern New England, located in Woods Hole, Massachusetts, Providence, Rhode Island; and its affiliate Air Station Cape Cod, located at Joint Base Cape Cod, which provides SAR, maritime law enforcement, international ice patrol, aids to navigation support, and marine environmental protection. The Lease Area and export cable corridors fall within the USCG Sector Southeastern New England area of responsibility.

The FAA conducts aeronautical studies for structures proposed within any state, territory, or possession of the United States, within the District of Columbia, or within territorial waters surrounding the United States out to 12 nm (22 km) from the coast. The FAA regulates commercial aviation transportation over the U.S. and air navigation facilities. While the Lease Area is not located within FAA jurisdiction for aeronautical studies due to its location beyond 12 nm (22.2 km), the FAA maintains and operates air traffic control and navigation systems and airspace for both civil and military aircraft that overlies the Lease Area. It is an essential stakeholder for aviation safety in relation to the proposed Project.

14.1.2 Aviation

There are several public and private-use airports in the region, with the closest public airports to the Offshore Project Area being Nantucket Memorial Airport on Nantucket, Katama Airfield and Martha's Vineyard Airport on Martha's Vineyard, Newport State Airport on Aquidneck Island, Rhode Island and New Bedford Regional Airport in New Bedford, Massachusetts (**Figure 14-3**). The closest private airports or airstrips to the Falmouth export cable corridor are located on Tuckernuck Island and Martha's Vineyard (Trade Wind Airport). Only Nantucket Memorial Airport and Martha's Vineyard Airport provide commercial services to and from local and regional destinations (NMA, 2020; MVY, 2019). There are other public and private airports and heliports on the mainland. The private airport in the closest vicinity to the Brayton Point export cable corridor and Onshore Project Area is Canapitsit Airport in Gosnold, Massachusetts.

The Obstruction Evaluation and Airspace Analysis (CAG, 2020a) indicated there are no Visual Flight Rules traffic pattern airspace, expected Visual Flight Rules routes, instrument departure procedure obstacle clearance surfaces, or low altitude enroute airway obstacle clearance surfaces overlying the Lease Area. Mayflower Wind WTGs will not intrude into these types of aviation airspaces. The lowest obstacle clearance surfaces overlying the Lease Area range from 1,049 to 4,549 feet (319 to 1,387 m) above mean sea level (AMSL) (**Figure 14-4**) and are associated with:

- Boston Consolidated (A90) Terminal Radar Approach Control (TRACON) minimum vectoring altitude (MVA) sectors;
- Boston (ZBW) Air Route Traffic Control Center (ARTCC) minimum instrument flight rules altitude sectors; and
- New York (ZNY) ARTCC minimum instrument flight rules altitude sectors.

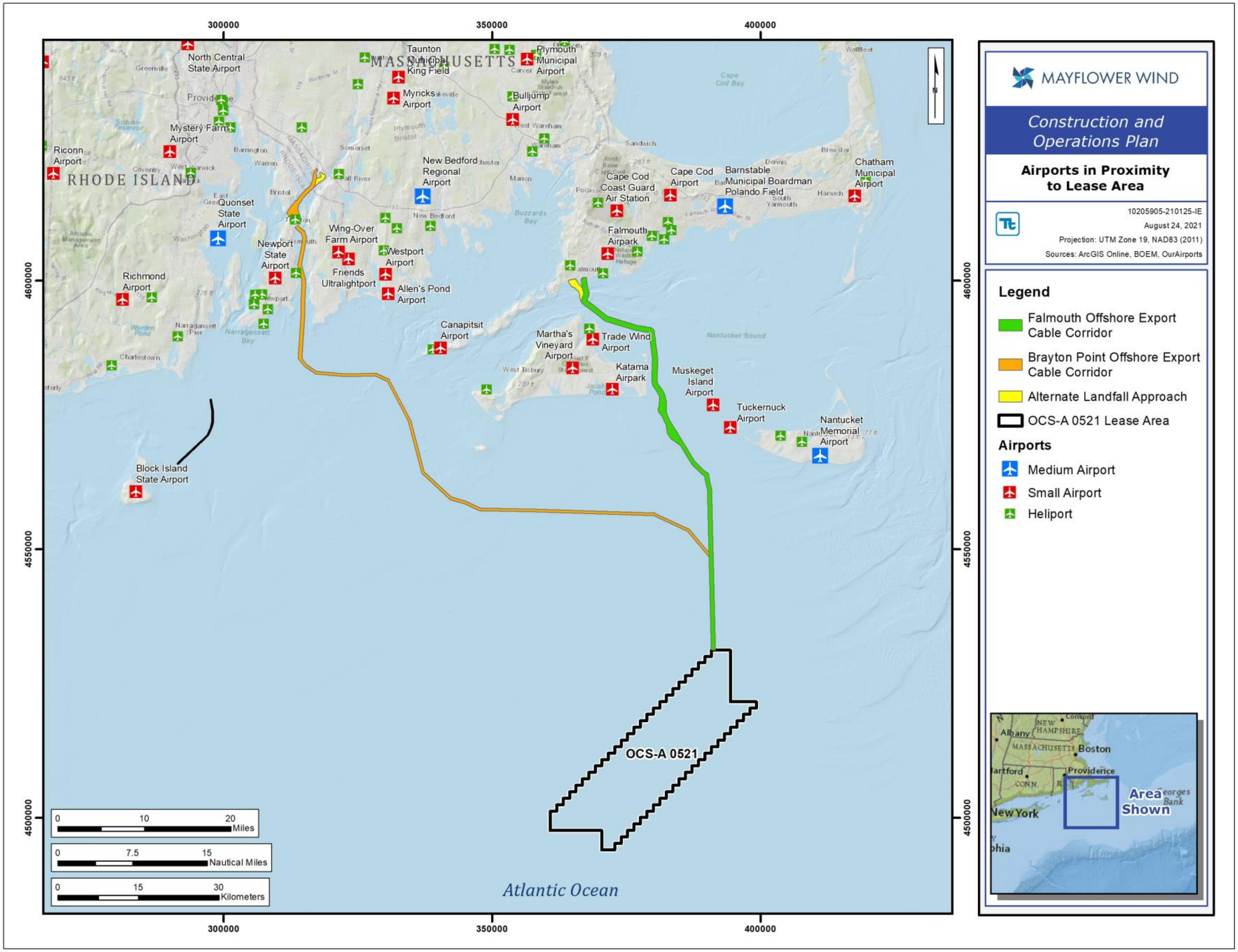
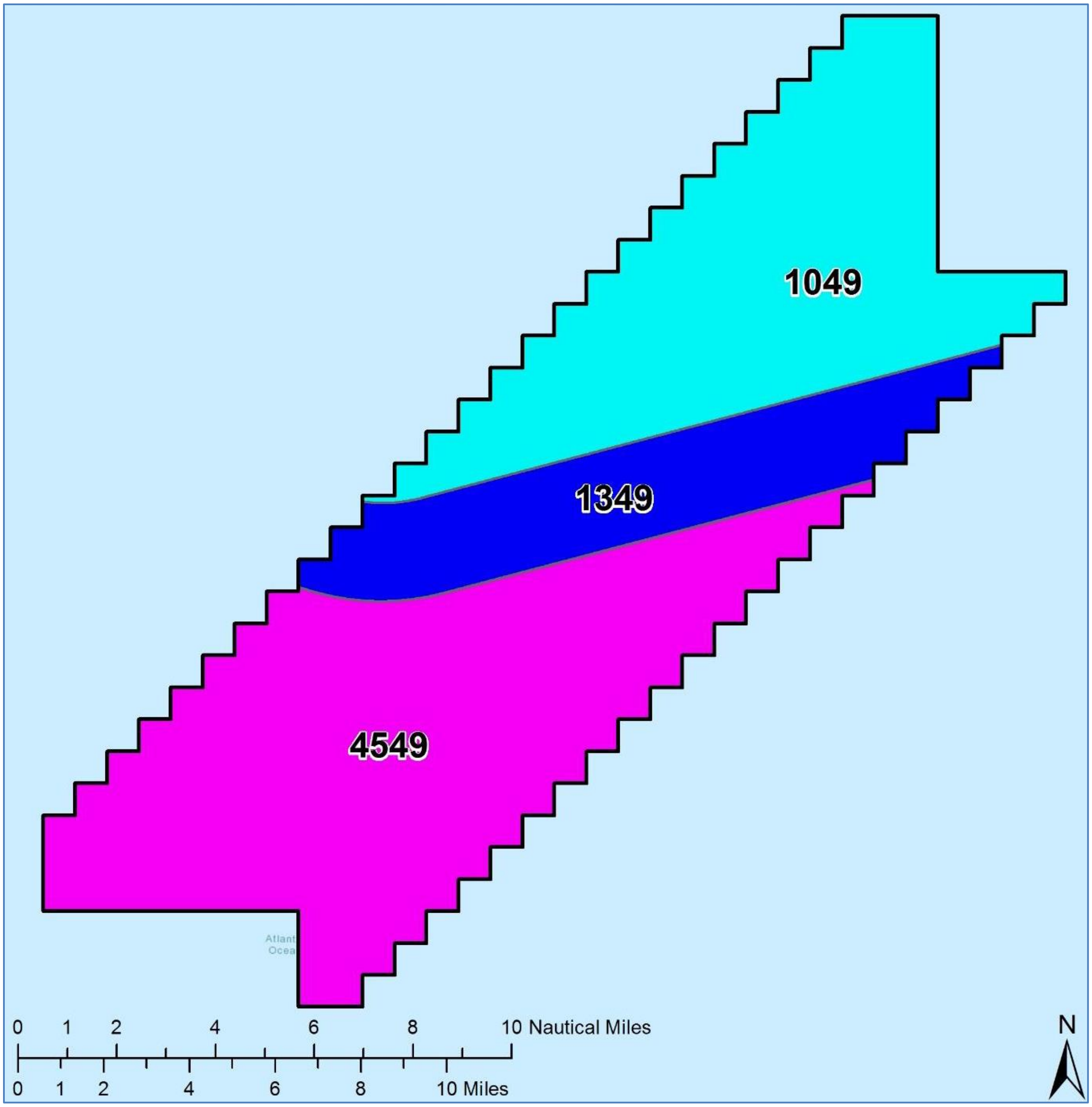


FIGURE 14-3. PUBLIC- AND PRIVATE-USE AIRPORTS IN PROXIMITY TO THE OFFSHORE PROJECT AREA



Source: Adapted from CAG, 2020a. (Appendix Y1, Obstruction Evaluation & Airspace Analysis).

FIGURE 14-4. OBSTACLE CLEARANCE SURFACE (FT AMSL) OVERLYING THE LEASE AREA

Appendix Y4, Radar and Navigational Aid Screening Study, was prepared to identify radar sites and navigational aids (NAVAIDS) that may be affected by the proposed Project, using the DoD Preliminary Screening Tool and other publicly available sources. This review provides a preliminary indication of whether Project WTGs may be within line-of-sight of one or more radar sites. However, it does not account for all ground-based radar sites, including Relocatable Over-the-Horizon Radar sites, tethered aerostat radar sites, or FAA Terminal Doppler Weather Radar sites. Refer to Appendix Y4, Radar and Navigational Aid Screening Study, for additional information on the methodology. Additionally, engagement has occurred with DoD and other relevant agencies, starting with an Informal Review

Request to DoD in May 2020. Details on coordination with these agencies can be found in Appendix A, Agency Correspondence.

Table 14-1 describes the radar systems and NAVAIDS identified in the study and **Figure 14-5** presents the locations of the systems. The three closest radar sites are the Falmouth Airport Surveillance Radar model-8 (ASR-8), Nantucket ASR-9, and the Providence Airport ASR-9. These radar sites are used for air defense and homeland security, as well as for air traffic control at multiple facilities by the FAA, including the Boston TRACON, Nantucket Air Traffic Control Tower, and the Providence TRACON. Most of the Lease Area is within the line of sight of long-range radar systems used by the DoD and DHS for air defense and homeland security.

TABLE 14-1. RADAR SYSTEMS AND AVIATION NAVAIDS IDENTIFIED NEAR THE LEASE AREA

System type	ID	Owner/Operator	Use
Air Route Surveillance Radars (ARSRs) and ASRs	Boston ASR-9 Falmouth ASR-8 Nantucket ASR-9 North Truro ARSR-4 Providence ASR-9 Riverhead ARSR-4	DoD and DHS	Air defense and homeland security
		FAA	Air traffic control at multiple facilities, including the Boston TRACON, Boston ARTCC, and the New York ARTCC
Early Warning Radars	Cape Cod Air Force Station	DoD	Ballistic missile defense and space surveillance
High Frequency Radars	Amagansett High Frequency radar Block Island High Frequency radar Martha's Vineyard High Frequency radar Nantucket High Frequency radar Nauset High Frequency radar	NOAA and other agencies	Integrated Ocean Observing System
Next Generation Radar	Boston WSR-88D Brookhaven WSR-88D	NOAA and other agencies	Weather Radar
Secondary Surveillance Radar	ATC Beacon Interrogator model-5 ATC Beacon Interrogator model-6 Mode S	FAA	Secondary Surveillance Radar
Terminal Doppler Weather Radars	Boston Control (ATC) Beacon Interrogator model-5 ATC Beacon Interrogator model-6 Mode S	FAA	Air traffic control at the Boston TRACON
VHF Omnidirectional Range (VOR) NAVAIDS, and co-located Distance Measuring Equipment (DME)	Martha's Vineyard VOR/DME Nantucket VOR/DME	FAA	Conventional VORs

Source: Adapted from Westslope Consulting, LLC., 2020 (Appendix Y4, Radar and Navigational Aid Screening Study).

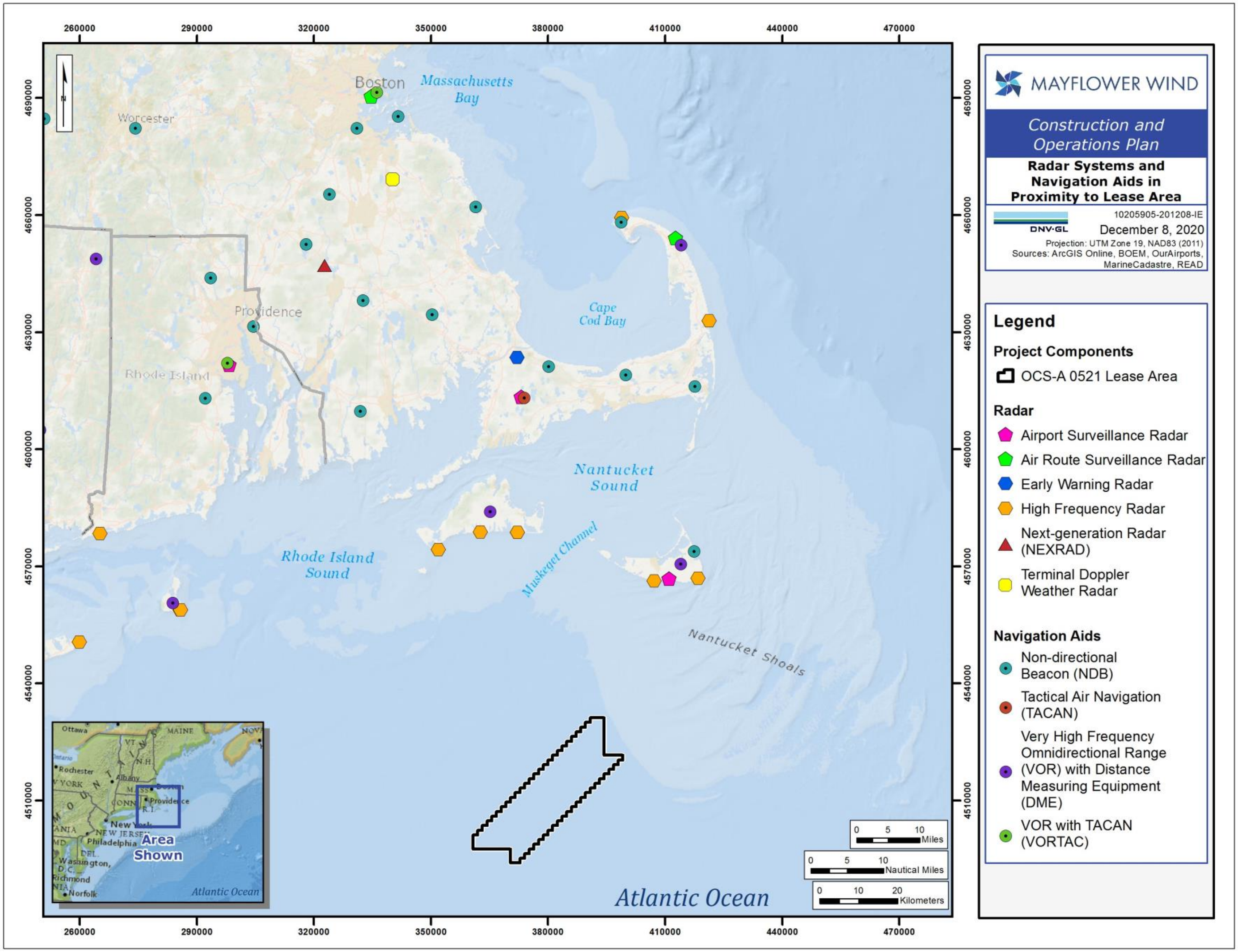


FIGURE 14-5. RADAR SYSTEMS AND NAVIGATIONAL AIDS IN PROXIMITY TO THE LEASE AREA

14.1.3 Federal Offshore Energy

The Lease Area is within one of six WEAs scoped by BOEM through its Intergovernmental Task Force Process for commercial wind energy leasing on the OCS off the Atlantic Coast (BOEM, 2020a). The lease areas were selected after a lengthy process, with a goal of minimizing conflicts among existing uses and the environment.

In conformance with Section 7(a) of the Project's Commercial Lease of Submerged Lands for Renewable Energy Development on the OCS, the proposed Project does not propose activities 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.

14.1.4 Cables and Pipelines

The Project export cable corridors are planned to intersect multiple areas containing existing or planned submarine cables. Additionally, two charted pipeline areas have been identified along the Brayton Point export cable corridor. See Section 3.3.5 for additional information on the location of the submarine cables and pipelines intersected by the Project export cable corridors, as shown in **Table 14-2** and **Figure 14-6**. Mayflower Wind will coordinate with cable and pipeline owners to agree on detailed crossing design, installation, and maintenance requirements.

TABLE 14-2. SUBMARINE CABLES/PIPELINES INTERSECTING THE EXPORT CABLE CORRIDORS

Cable Description	Number of Cables/Pipelines to be Crossed	Location	Offshore Project Area
Potential Crossing Area A	Up to 2 existing cables	Between Martha's Vineyard and Falmouth, Massachusetts (cables make landfall at Shore Street in Falmouth)	Falmouth ECC
Potential Crossing Area B	Up to 7 planned cables a/	South of Muskeget Channel	Falmouth ECC
Potential Crossing Area C	Up to 7 planned cables a/	South of Muskeget Channel	Brayton Point ECC
Potential Crossing Area D	Up to 4 planned cables	South of Nomans Land	Brayton Point ECC
Potential Crossing Area E	Up to 2 planned cables b/	South of Sakonnet River	Brayton Point ECC
Potential Crossing Area F	1 existing pipeline	Sakonnet River (charted Pipeline Area)	Brayton Point ECC
Potential Crossing Area G	2 existing pipelines	Sakonnet River (charted Pipeline Area)	Brayton Point ECC

Notes:
a/ Vineyard Wind
b/ Bay State Wind (up to 2 planned)

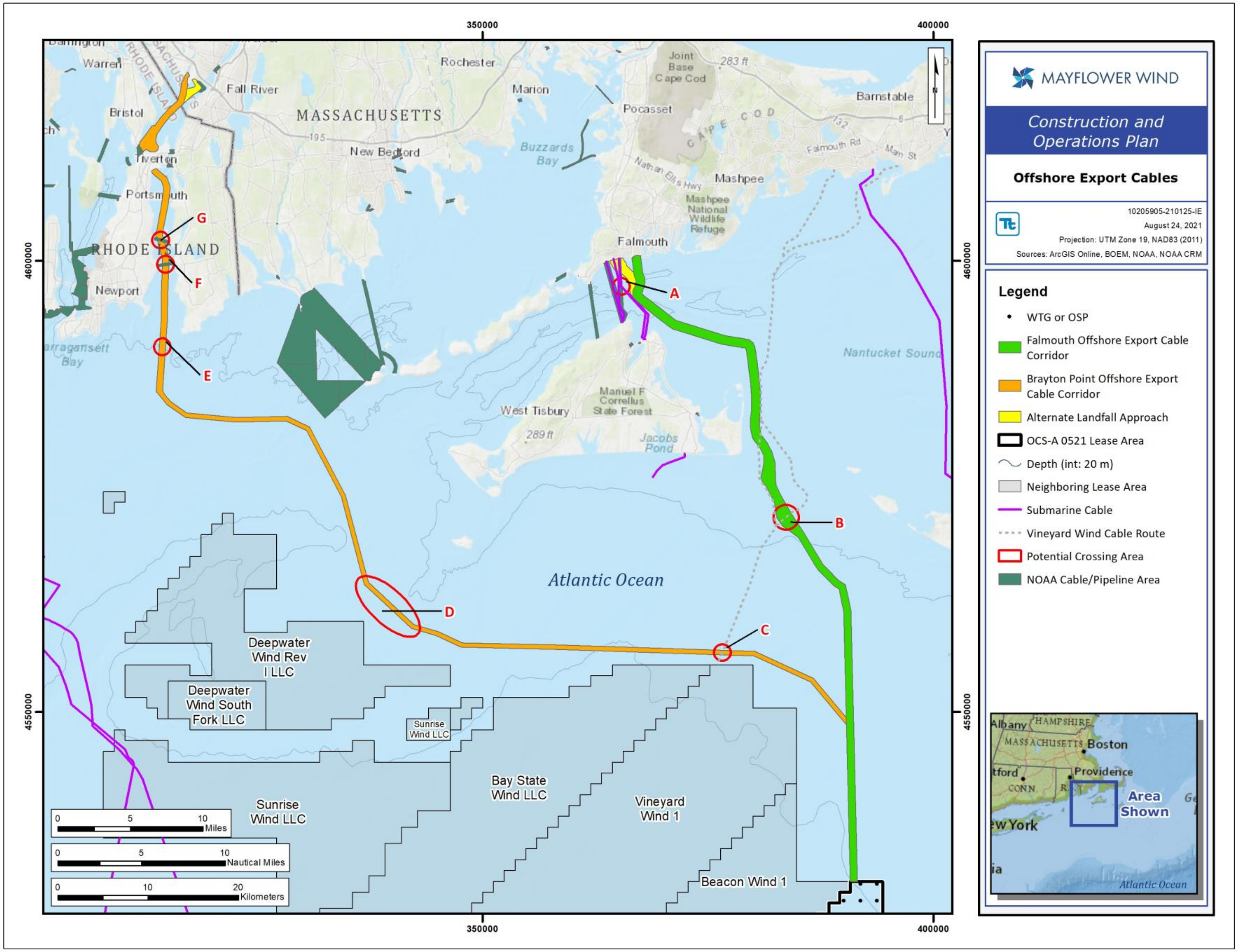


FIGURE 14-6. POTENTIAL CABLE AND PIPELINE CROSSINGS

14.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020b). IPFs were adapted from BOEM's (2020) *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build-out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of Proposed Activities, is considered for the analysis of potential effects.

The majority of IPFs will occur in the Lease Area. The effects will largely be associated with the presence of offshore components, as described in Section 3.3, Project Components and Project Stages, and therefore have the potential to occur throughout the life of the proposed Project. Temporary activity along the export cable corridors also has the potential to disrupt other marine uses (military uses, aviation, offshore energy, and cables and pipelines). However, Mayflower Wind has sited the export cable corridors to minimize these impacts.

The presence of Project infrastructure in the Lease Area and export cable corridors could affect other development projects and commercial activities, such as energy infrastructure and military operations. Affects to recreation and tourism, commercial and recreational fishing, and navigation and vessel traffic have been discussed in Sections 10.3, Recreation and Tourism, 11, Commercial and Recreational Fisheries and Fishing Activity, and 13, Navigation and Vessel Traffic, respectively. Proposed avoidance, minimization, and mitigation measures to reduce potential effects on other marine uses are summarized in Section 16, Summary of Avoidance, Minimization, and Mitigation Measures.

TABLE 14-3. IPFS AND POTENTIAL EFFECTS ON OTHER MARINE USES (MILITARY, AVIATION, OFFSHORE ENERGY AND CABLES/PIPELINES) IN THE AREA OF INTEREST

IPF	Potential Effect		Period of Potential Effect		
	Project Component		Construction	O&M	Decomm.
	Lease Area Infrastructure	Offshore Export Cables			
Changes in Ambient Lighting	Introduced lighting	-	X	X	X
Installation and Maintenance of Infrastructure	Increased marine traffic Use Conflict - Military	Damage to existing cables/pipelines	X	X	X
Presence of Infrastructure	Obstruction to air navigation Interference with radar systems Use Conflict - Military	-	X	X	X

14.2.1 Changes in Ambient Lighting

14.2.1.1 Construction, Operations and Maintenance, and Decommissioning

Vessels use navigation lighting during construction, operation and maintenance, and decommissioning activities. WTGs and OSPs will have navigation and aviation lighting during the operation and maintenance phase. Furthermore, PATON will be issued for the offshore Project structures in the Lease Area during all phases of the proposed Project.

Vessel lighting will be aligned with USCG and BOEM's *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development* (BOEM, 2021). PATON will be installed in accordance with IALA guidance for the marking of man-made offshore structures (IALA, 2013) and with USCG approval. WTG lighting will comply with BOEM guidelines, which align with FAA Advisory Circular AC 70/7460-1M (FAA, 2020). The proposed Project will use ADLS to reduce visual effects while maintaining air navigation safety. The ADLS will be set up to activate Project obstruction lighting when aircraft enter a pre-defined activation volume. Based on historical air traffic data for flights passing through the ADLS activation volume, the ADLS-controlled obstruction lights will be activated for approximately 4 minutes and 46 seconds per year (CAG, 2020a) (Appendix Y3, Aircraft Detection Lighting System Efficacy Analysis). Use of ADLS by the Project will be subject to technical feasibility, commercial availability, and agency review and approval.

14.2.2 Installation and Maintenance of Infrastructure

14.2.2.1 Construction, Operations and Maintenance, and Decommissioning

14.2.2.1.1 Increased Marine Traffic

The presence of additional vessels during the construction and decommissioning phases, and the presence of WTGs and OSPs in the Lease Area may increase the risk of collisions and allisions. Mayflower Wind will provide 1.0 nm (1.9 km) of space between structures, allowing room for anticipated vessels to safely transit through and maneuver within the Lease Area. Mayflower Wind will establish mariner diligence and offshore standard work safety practices for all Project-related vessel. Section 13, Navigation and Vessel Traffic, and Appendix X, Navigation Safety Risk Assessment discuss navigation hazards in detail and provide relevant mitigation measures, such as aligning with USCG and BOEM marking and lighting guidelines, and IALA guidance for the marking of man-made offshore structures (BOEM 2021; IALA, 2013).

Mayflower Wind will continue to coordinate with the USCG, Air Force, Navy, NORAD, and other military and national security stakeholders to implement operational curtailment of WTGs during SAR operations, or other national security emergencies, near the Lease Area. Marking of structures will be aligned with letter and number marking of all offshore structures within the MA/RI WEA, improving SAR operations and general navigation.

Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of construction/decommissioning activity, as necessary.

14.2.2.1.2 Damage to Existing Cables/Pipelines

Mayflower Wind will use well established standard techniques for adequately avoiding, minimizing, or mitigating the existing cables and the newly installed Project offshore export cables. Mayflower Wind will coordinate with the owners of the existing and planned cables and pipelines intersected by the export cable corridors, and any other unanticipated cable crossings not identified in Section 14.1.4, to agree on detailed crossing design, installation, and maintenance requirements. See Section 3.3.5, Offshore Export Cables, for further details on cable/pipeline crossings, installation, and maintenance requirements.

14.2.3 Presence of Infrastructure

14.2.3.1 Construction, Operations and Maintenance, and Decommissioning

14.2.3.1.1 Obstruction to Air Navigation

The Air Force and Navy Fleet Area Control and Surveillance Facility, Virginia Capes or other units may object to the presence of WTGs in the W-105A warning area (Appendix Y1, Obstruction Evaluation & Airspace Analysis). The Military Aviation and Installation Assurance Siting Clearinghouse (Clearinghouse) may issue a Notice of Presumed Risk to National Security letter to initiate mitigation discussions. If this occurs, Mayflower Wind will work with the Clearinghouse to ensure that all appropriate mitigation measures for DoD units are identified and implemented. Mayflower Wind submitted an Informal Review Request to the DoD in May 2020 and will continue to engage with the DoD and relevant agencies as the Project progresses. Details on coordination with these agencies can be found in Appendix A, Agency Correspondence.

The maximum WTG height in the PDE is 1,066.3 feet (325 m) (see Section 3.3.2, Wind Turbine Generator, for more details on the WTG PDE). WTGs over 1,049 feet (319.7 m) in the northern portion in the Lease Area would be identified as obstructions to air navigation to the Boston Consolidated (A90) TRACON MVA Sector U (CAG, 2020a) (Appendix Y1, Obstruction Evaluation & Airspace Analysis). This would not necessarily be considered a hazard by the FAA. Proposed structures must have airspace impacts that constitute a substantial adverse effect in order to warrant the issuance of determinations of hazard. It is more likely that an increase to the MVA from 2,000 feet to 2,100 feet AMSL would be an acceptable mitigation measure. Historical air traffic data indicates that the required changes to the MVA Sector U should not affect a significant volume of radar vectoring operations (Appendix Y2, Air Traffic Flow Analysis). The proposed Project is not located within the territorial airspace surrounding the U.S. (FAA, 2019) and, as such, is not under the jurisdiction of the FAA. However, Mayflower Wind will continue to work with the FAA and the owner/operator of the affected system(s) to ensure that appropriate mitigation measures are identified and implemented.

14.2.3.1.2 Interference with Radar Systems

Project infrastructure may have a physical and/or electromagnetic effect on some types of radars and aviation NAVAIDs. Of the radar systems and NAVAIDS identified in the Appendix Y4, Radar and Navigational Aid Screening Study, only a few may be affected by the presence of WTGs in the Lease Area. Specifically, Project WTGs will be within the line of sight of four Air Route Surveillance Radars (ARSRs) and Airport Surveillance Radar (ASRs); Falmouth (ASR-8), Nantucket (ASR-9), North Truro (ARSR-4), and Riverhead (ARSR-4). Radar effects to Falmouth ASR-8 and Nantucket ASR-9 may include unwanted radar returns (clutter) resulting in a partial loss of primary target detection and a number of false primary targets over and in the immediate vicinity of WTGs within line of sight. Other possible radar effects may include a partial loss of weather detection and false weather indications over and in the immediate vicinity of WTGs within line of sight. Project WTGs are not in the line of sight of the North Truro ARSR-4 and Riverhead ARSR-4; no radar effects are expected. The DoD and FAA may have concerns with the WTGs in the line of sight of the Falmouth ASR-8 and the Nantucket ASR-9 sites. The FAA's aeronautical study process and the DoD Siting Clearinghouse process will provide an official decision as to whether impacts are acceptable to operations and if there are any required mitigations. See Appendix Y4, Radar and Navigational Aid Screening Study, for further information.

WTGs in the northern half of the Lease Area will be within the line of sight of the Air Force Station Early Warning Radar. This could have an effect on this early warning radar. Mayflower Wind will work with the DoD Siting Clearinghouse to identify and implement appropriate mitigation measures, as appropriate.

The WTGs will be in the line of sight of Martha's Vineyard High Frequency Radar and Nantucket High Frequency Radar. WTGs with a maximum tip height of 1,066.3 feet (325 m) will be within the line of sight of Block Island High Frequency radar. Radar effects may include clutter in the vicinity of the WTGs located in the study area within line of sight, and possibly in the vicinity of WTGs located in the study area beyond line of sight, due to the propagation of High Frequency electromagnetic waves over the ocean surface. While the WTGs are not within the line of sight of the other High Frequency radars, radar effects are still possible beyond line of sight due to the propagation of High Frequency electromagnetic waves over the ocean surface.

Although radar effects do not always translate into operational impacts, Mayflower Wind will continue to coordinate with the DoD Siting Clearinghouse, FAA, and NORAD to determine the potential effects on radars and NAVAIDs and identify appropriate mitigation measures. Mayflower Wind will coordinate with NOAA and the Northeastern Regional Association of Coastal Ocean Observing Systems to determine potential effects on high frequency radars and identify appropriate mitigation measures, as necessary.

14.2.3.1.3 Use Conflict - Military

The presence of WTGs and OSPs in the Lease Area may cause temporal and seasonal space use conflicts with military and national security vessels operating around the Lease Area. The Lease Area occupies a portion of the W-105A warning area within the Narraganset Bay OPAREA (**Figure 14-2**), and military traffic within the MA WEA is relatively low (four vessels recorded within the MA WEA between 2016 and 2017, BOEM, 2020c). As stated above, a space of 1.0 nm (1.9 km) will be provided between structures for anticipated vessels to safely transit through and maneuver within the Lease Area.

Marking of structures will be aligned with letter and number marking of all offshore structures within the MA/RI WEA, improving SAR operations and general navigation. Mayflower Wind will liaise with the military and national security stakeholders to reduce potential conflicts, as necessary.

Mayflower Wind will continue to coordinate with the USCG, Air Force, Navy, NORAD, and other military and national security stakeholders to implement operational curtailment of WTGs during SAR operations, or other national security emergencies, near the Lease Area, as necessary. Refer to Section 11, Commercial and Recreational Fisheries and Fishing Activity, and Section 13 for additional information on potential effects to commercial vessels and recreational vessels, Navigation and Vessel Traffic.

15 Public Health and Safety

15.1 Affected Environment

Public health and safety is the science of anticipating, recognizing, evaluating, and controlling workplace risks that could harm the public's health and well-being. "Public" may be defined as the workforce population and also immediately adjacent communities of the workplace that could be affected by workplace activities. This section describes and evaluates potential Project-related effects to public health and safety.

In this section, the Offshore Project Area is defined as the area encompassing the Lease Area and the offshore export cable corridor, including the Project components in this area (WTG, OSPs, inter-array cables, and offshore export cables). The Onshore Project Areas are defined as the area immediately surrounding the onshore Project components (the sea-to-shore transition vault, onshore export cables, onshore substation, onshore converter station and transmission lines) and the area surrounding onshore support facilities (marshalling port[s], service operations vessel and crew transfer vessel port[s], and O&M facilities). The Project Area includes both Onshore and Offshore Project Areas.

Technical appendices related to public health and safety include:

- Appendix Z, Safety Management System
- Appendix AA, OSRP

15.1.1 Health and Safety Regulations Related to the Proposed Project

Various agencies promulgate public health and safety regulations, standards, and guidelines depending upon 1) location of workforce (offshore versus onshore, state versus federal, etc.) and 2) the factors affecting public health and safety (such as unplanned releases versus allisions). The following section describes relevant public health and safety regulations, standards, and guidelines pertaining to the proposed Project.

According to the Department of the Interior Policy Statement on Regulating Workplace Safety and Health Conditions on Renewable Energy Facilities on the Outer Continental Shelf (BSEE, 2019), the BSEE, in collaboration with BOEM, is responsible for regulating worker health and safety on offshore wind farms on the OCS, pursuant to Section 388 of the Energy Policy Act of 2005. Mayflower Wind will submit a Safety Management System (Appendix Z) to BSEE. The proposed Project's Safety Management System (SMS) will preempt Occupational Safety and Health Administration (OSHA) enforcement of its regulations on the OCS, as stated in Section 4(b)(1) of the OSHA of 1970, and in accordance with the foregoing Department of the Interior policy statement.

The following relevant and applicable Department of the Interior regulations provide requirements and guidance pertaining to the SMS:

- 30 CFR § 585.810 – gives BOEM the authority to regulate all renewable energy development activities on the OCS
- 30 CFR § 585.627(d) – requires SMS description in the COP

- 30 CFR § 585.811 – requires that the SMS be fully functional when Mayflower Wind begins activities described in the approved COP

The following OSHA regulations are applicable to the proposed Project:

- 29 CFR Part 1926 – applicable to construction activities on land and up to 3 nm offshore
- 29 CFR Part 1910 – applicable to general industry activities such as O&M on land and up to 3 nm offshore
- 29 CFR Parts 1915, 1916, and 1917 – applicable for shipyard, marine terminals, and longshoring activities

The following USCG regulations, under 33 CFR Subchapter N and Chapter 46 CFR, are applicable to the proposed Project:

- 33 CFR Part 142 – Workplace Safety and Health
- 33 CFR Part 143 – Design and Equipment
- 33 CFR § 144.10 – Lifesaving Appliances
- 33 CFR Part 145 – Firefighting Equipment
- 33 CFR Part 146 – Operations

The following EPA regulations are applicable to the proposed Project:

- 40 CFR Part 112 – SPCC Plan
- Emergency Planning and Community Right-to-Know Act – State Emergency Response Commission

15.1.2 Communities Health and Safety

As stated above, in addition to workplace health and safety, immediately adjacent communities of the Onshore Project Areas could be affected by workplace activities. Project components near communities include the onshore substation, onshore converter station, construction, and marshalling ports; logistics ports, and O&M facilities. The Project SMS and OSRP describe how the proposed Project will anticipate and prevent public health and safety events and emergencies. In the event of an emergency, the SMS describes how the proposed Project will prepare for and execute an incident response.

Once the final locations of onshore facilities are determined, Mayflower Wind will update the spill response and emergency response plans for any site-specific considerations. Mayflower Wind will coordinate with the appropriate local response agencies in developing these plans and provide copies to the local response agencies.

Chemicals stored in these facilities will be inventoried and contained in primary storage containment with secondary containment measures where required and where practicable. Stored chemicals will be managed and subject to a periodic containment integrity inspection program (as established in a SPCC Plan, to be developed). Secondary containment will be sized to house the volume of chemical or oil plus an additional safety margin to compensate for rainwater, where applicable. As an offshore wind farm with associated onshore facilities, the proposed Project will not be processing chemicals or hydrocarbons. The Project chemicals are not expected to be airborne carcinogens or pose a hazard to community health, and as such do not require a community evacuation plan.

15.2 Potential Effects

IPFs are stressors typically created by anthropogenic forces (e.g., WTGs, offshore export cable, and onshore export cable), which result in specific changes to the environment during each development phase (BOEM, 2019, 2020). IPFs were adapted from BOEM's 2020 *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. The full build out scenario of the proposed Project (e.g., maximum WTGs) as described in Section 3, Description of the Proposed Activities, is considered for the analysis of potential effects.

The majority of IPFs will occur within the Project Area and in adjacent communities to the Onshore Project Areas. Effects to public health and safety will largely be associated with the use of vessels, vehicles, cranes, helicopters, drones, and Project components. The potential effects of the proposed Project to occur during construction, operation, and decommissioning are listed in **Table 15-1**.

Measures to avoid, minimize, and mitigate potential impacts to public health and safety were considered and will be implemented, when necessary. Such measures may fall into several categories described below and are also listed in Section 16, Summary of Avoidance, Minimization, and Mitigation Measures.

TABLE 15-1. IPFS AND POTENTIAL EFFECTS OF THE PROPOSED PROJECT ON PUBLIC HEALTH AND SAFETY

IPF	Potential Effects		Period of Effect		
	Project Component		Project Phase		
	Offshore Project Area	Onshore Project Area	Construction	O&M	Decomm.
Unplanned Events	Allisions/Collisions; Unplanned releases; Occupational hazards	Allisions/Collisions; Unplanned releases; Occupational hazards	X	X	X

15.2.1 Unplanned Events

An unplanned event is an unintended or unexpected incident that may or may not result in harm to persons, property, and/or the environment. Mayflower Wind has identified the following three unplanned events that may potentially affect public health and safety: allisions and collisions, unplanned releases, and occupational hazards.

15.2.1.1 Allisions and Collisions

In the context of offshore wind projects, collisions typically involve marine vessels either colliding with other vessels or marine life, and allisions typically refer to marine vessels colliding with stationary fixtures, such as WTGs or OSPs. Similarly, onshore collisions refer to one moving object striking another moving object, and allisions refer to one moving object striking a stationary object.

Allisions and collisions may directly affect public health and safety by causing injury to persons involved, and causing damage to equipment and property. Indirect effects of allisions and collisions to public health and safety may include unplanned releases (see Section 15.2.1.2) and stressing healthcare resources.

15.2.1.1.1 Construction and Decommissioning

During construction and decommissioning of the proposed Project, there will be a slight increase to maritime traffic, see Section 13, Navigation and Vessel Traffic, for traffic measurement parameters. Section 33.14, Vessels, Vehicles, and Aircrafts, and Appendix G, Air Emissions Report, lists the proposed types, number, and estimated use duration of vehicles, vessels, aircrafts, and drones planned for the construction and decommissioning phases.

With any vessel navigation, traffic poses a risk of collisions in the Offshore Project Area. However, vessel traffic associated with installation activities is relatively short-lived, as detailed in Section 3.2, Proposed Project Schedule, and Appendix X, Navigation Safety Risk Assessment. The presence of above-surface Project components in the Lease Area creates risk of allisions, see Section 13, Navigation and Vessel Traffic, and Appendix X, Navigation Safety Risk Assessment, for measures to reduce offshore allisions and collisions during construction.

Onshore construction and installation activities may slightly increase the number of vehicles on the road (see Section 3.3.14, Vessels, Vehicles, and Aircrafts, for types of vehicles to be used during onshore construction), but traffic congestion is anticipated to result from some Project construction activities. Disruption of road accessibility will temporarily affect public health and safety by potentially increasing the risk of vehicle allision and collisions. Section 12, Zoning and Land Use further discusses potential onshore traffic changes. Measures to reduce onshore allisions and collisions during construction and decommissioning are listed in Section 12, Zoning and Land Use.

15.2.1.1.2 Operations and Maintenance

Section 33.14, Vessels, Vehicles, and Aircrafts, and Appendix G, Air Emissions Report, lists the proposed types, number, and estimated use duration of vehicles, vessels, and potential aircrafts and/or drones planned for the O&M phase of the proposed Project. Measures to reduce offshore allisions and collisions during O&M activities are listed in Section 13, Navigation and Vessel Traffic, and in Appendix X, Navigation Safety Risk Assessment.

Once installed, it is not expected that onshore Project components would affect traffic patterns, or result in collisions or allisions. Periodic maintenance and repairs could temporarily affect road access, similar to work on any other utility infrastructure. These effects are described in Section 12, Zoning and Land Use. The onshore substation and onshore converter station will not pose a risk to onshore allisions as the facilities will be located on private property and will be properly fenced and secured away from public ROWs. Measures to reduce onshore allisions and collisions during O&M activities are listed in Section 12, Zoning and Land Use.

15.2.1.2 Unplanned Releases

Unplanned releases related to the proposed Project include the unintended release of oil, chemicals, or waste in or near the Project Area. These spills could be caused by collisions and allisions, natural events, refueling, structural/mechanical/equipment failures, and/or operational errors (Etkin, 2006).

15.2.1.2.1 Construction and Decommissioning

Sources of unplanned releases in the Project Area during construction and decommissioning are described in Section 5.2, Water Quality, as well as Appendix H, Water Quality Report. Estimated volumes of oils, chemicals, or other materials transferred and/or stored within the Project Area are listed in Appendix AA, Oil Spill Response Plan.

Measures to reduce the risks of unplanned releases in the Project Area during construction and decommissioning phases are described in Section 5.2, Water Quality, Section 13, Navigation and Vessel Traffic, Appendix X, Navigation Safety Risk Assessment, and in Appendix AA, Oil Spill Response Plan.

15.2.1.2.2 Operations and Maintenance

Sources of unplanned releases in the Project Area during O&M activities are described in Section 5.2, Water Quality, as well as Appendix H, Water Quality Report. Estimated volumes of oils, chemicals, or other materials transferred and/or stored within the Project Area during O&M activities are listed in Appendix AA, Oil Spill Response Plan.

Measures to reduce the risks of unplanned releases in the Project Area during construction and decommissioning phases of the proposed Project are described in Section 5.2, Water Quality, Section 13, Navigation and Vessel Traffic, and in Appendix AA, Oil Spill Response Plan.

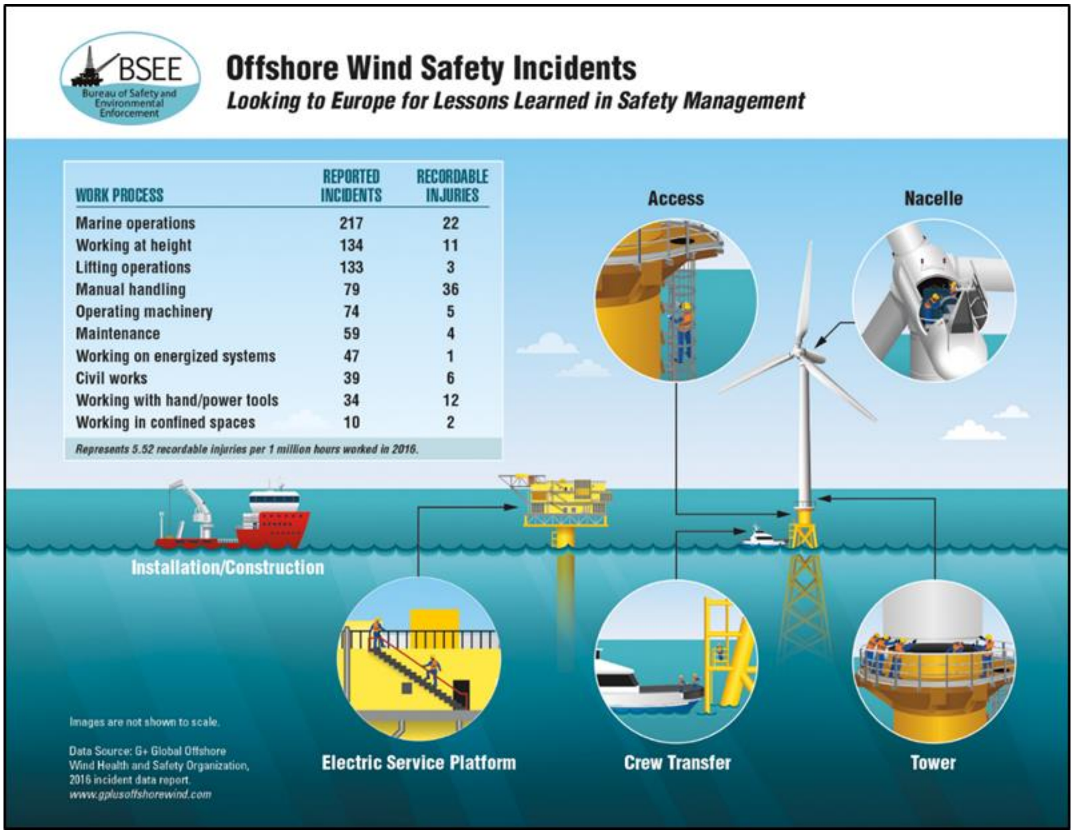
15.2.1.3 Occupational Hazards

Occupational hazards are conditions or circumstances that create risk, or danger of risk, that could cause injury to persons or damage to property at the workplace. As with any power generation worksite, occupational hazards have the potential to affect the Project's workforce.

15.2.1.3.1 Construction and Decommissioning

Commissioning activities can be very labor intensive, but typically include a smaller workforce than what is used for installation. Section 3.3, Project Components and Project Stages, describes construction and installation details in more depth.

As with construction in any industry, offshore wind projects involve activities with potential for safety risks. In 2016, BSEE reported that globally there were 826 reported incidents and 102 recordable injuries associated with the offshore wind industry (BSEE, 2019), as described in **Figure 15-1**. Hazards to workers health and safety include, but are not limited to, weather conditions, heavy-machinery use, climbing at heights, confined spaces, chemical hazards, and electrical hazards (TRBNA, 2013).



Source: BSEE, 2019

FIGURE 15-1. 2016 OFFSHORE WIND SAFETY INCIDENTS

The SMS describes worker health and safety processes and procedures that when successfully implemented, ensure the safety of anyone on or near Project facilities. Mayflower Wind's SMS strategies are summarized below, and discussed further in Appendix Z, Safety Management System:

- Provide a systematic approach to Health, Safety, Security, and Environment (HSSE) and Social Performance management (the process of setting, monitoring, and progressing towards Mayflower Wind's social goals) designed to ensure compliance with applicable law and to achieve continuous performance improvement;
- Commit to conduct all operations in a safe and diligent manner;
- Commit to reduce the HSSE and Social Performance risks associated with the operations; and
- Provide any necessary measures or plans to address emergency events.
- Sets targets for improvement and measure, appraise, and monthly performance reporting;
- Requires contractors to manage HSSE risks in line with the HSSE and Social Performance policies of Mayflower Wind;
- Ensures that HSSE and Social Performance is the responsibility of all managers, teams and individuals;
- Provides proactive and respectful engagement with neighbors and impacted communities;
- Permits any individual to stop any work, or prevent any work from starting, where adequate controls of HSSE and Social Performance risks are found not to be in place;

- Includes HSSE performance in the appraisal of operating staff and contractors, and rewards them accordingly
- Applies the Life Saving Rules for all work activities; and
- Follows prescribed Emergency Response Plans to a variety of credible emergency scenarios.

15.2.1.3.2 Operation and Maintenance

Once the proposed Project is operational, the onshore and offshore Project components will be unmanned, but remotely monitored by Project personnel at Mayflower Wind's O&M facility.[16] Project personnel may access Project components for scheduled and unscheduled inspections and maintenance. Occupational hazards will be present in the O&M phase of the proposed Project, though to a lesser extent than the construction phase, and will be similar to those hazards listed in **Figure 15-1**.

Mayflower Wind will use supervisory control, data acquisition and potentially distributed temperature sensing systems to gather, transmit, and analyze the operational status of the proposed Project. This data will help determine when unscheduled, or non-routine maintenance, or repair is needed, which helps reduce the number of necessary on-site visits, reducing the exposure of workers to potential hazards (TRBNA, 2013).

Mayflower Wind will follow all health and safety measures presented in Section 15.2.1.3.1, Appendix Z, Safety Management System, and Appendix AA, Oil Spill Response Plan, to minimize occupational hazards.

---

[16] The WTG manufacturer will manage and execute maintenance during the five-year service and maintenance agreement period, which includes a possibility for an extension.

16 Summary of Avoidance, Minimization, and Mitigation Measures of Potential Impacts

Mayflower Wind has sited, planned, and designed the proposed Project to avoid and minimize potential impacts on physical, biological, cultural, and socioeconomic resources. Project activities that have the potential to impact resources were identified as IPFs. See Section 3.4, Summary of Impact-Producing Factors, for a write up on all identified IPFs. Physical, biological, cultural, and socioeconomic resources were characterized based upon extensive desktop studies, targeted field studies, predictive modeling, and data analysis. These assessments provided a detailed background on the condition of these resources in the affected environment. Desktop studies included literature reviews, examination of publicly available datasets, direct communication with academic and government science researchers, and consultation with state and federal government entities. The duration of the impact and the overall effect that the IPFs will have on resources are assessed. Pulled from those assessments are measures proposed to avoid and minimize these potential impacts. The impact evaluation includes consideration of additional environmental protection measures.

In accordance with 30 CFR § 585.621(d), the proposed Project will not cause undue harm or damage to natural resources, human life or the human environment, wildlife, property, the marine environment, the coastal environment, or sites, structures, or objects with historical or archeological significance. **Table 16-1** below summarizes the various avoidance, minimization, and mitigation measures that Mayflower Wind intends to abide by to minimize adverse effects during the construction, operation, and decommissioning phases of the proposed Project. The table below also demonstrates that Mayflower Wind will conduct the proposed Project in a manner that includes the application of BMPs that are included in Attachment A of BOEM's *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)* (BOEM, 2020). Low probability events are discussed in Section 4.3 and Section 15. As discussed in Section 3.3.19, Conceptual Decommissioning, Mayflower Wind will decommission the proposed Project in accordance with 30 CFR § 585.902 and 30 CFR §§ 585.905-912. An approved decommissioning plan, developed by Mayflower Wind, will detail the necessary steps and may include additional avoidance, minimization, and mitigation measures beyond what is provided below.

TABLE 16-1. PROPOSED PROJECT'S AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES PER RESOURCE

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
Geological Resources			
Site Geology (4.1)	Construction	**Seabed or Ground Disturbance** Seabed preparation, offshore component installation, and vessel anchoring/spudding	• Mayflower Wind will use BMPs to minimize sediment mobilization during offshore component installation • Mayflower Wind, when feasible, will use technologies that minimize sediment mobilization and seabed sediment alteration for cable burial operations • Mayflower Wind, where practical and safe, will utilize DP vessels • Mayflower Wind will utilize HDD for sea-to-shore transition
	O&M	**Seabed or Ground Disturbance** Routine offshore operation and maintenance	• Mayflower Wind will utilize scour protection methods to avoid developing scour holes at the base of structures • Mayflower Wind will bury submarine cables at depths to guard against exposure from seabed mobility
	Decommissioning	**Seabed or Ground Disturbance** Offshore component decommissioning	• Mayflower Wind will use BMPs to minimize sediment mobilization during decommissioning
Physical Oceanography and Meteorology (4.3)	Construction, O&M, and Decommissioning	**Seabed or Ground Disturbance** Scour development	• Mayflower Wind will utilize scour protection methods to avoid developing scour holes at the base of structures • Mayflower Wind will bury submarine cables at depths to guard against exposure from seabed mobility
Physical Resources			
Air Quality (5.1)	Construction	**Planned Discharges: Air Emissions** Vehicles, onshore and offshore construction equipment, drones, helicopters and generators	• Mayflower Wind will ensure that vessels used for construction will use the jurisdictionally required compliant fuel, e.g., ultra-low sulfur diesel or a fuel with less emissions • Mayflower Wind will ensure fuels used for construction equipment comply with EPA or equivalent emissions standards • Mayflower Wind will use low-NO_x engines when possible • Mayflower Wind will engage with EPA on how to satisfy Best Available Control Technology
	O&M	**Planned Discharges: Air Emissions**	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Vehicles, onshore and offshore construction equipment, drones, helicopters, and generators	
Water Quality (5.2)	Construction	**Seabed or Ground Disturbance** Offshore component installation, routine offshore O&M, and vessel anchoring	• Mayflower Wind will select and use BMPs including the use of a SWPPP to minimize sediment mobilization during offshore construction of WTGs and OSPs, scour protection placement, and HDD operations • Mayflower Wind, when feasible, will use technologies that minimize sediment mobilization and seabed sediment alteration for cable burial operations
		Seabed or Ground Disturbance Onshore component installation	• Mayflower Wind will follow BMPs, including the use of a SWPPP, during onshore construction activities to control sedimentation and erosion
		Planned Discharges Stormwater runoff, routine releases, and duct bank installation	• Mayflower Wind will follow USCG requirements at 33 CFR Part 151 and 46 CFR Part 162 regarding bilge and ballast water • Mayflower Wind will require all Project vessels to comply with regulatory requirements related to the prevention and control of discharges and accidental spills including EPA requirements under the EPA 2013 Vessel General Permit and state and local government requirements
		Accidental Events/Natural Hazards Unplanned releases	• Mayflower Wind will comply with the regulatory requirements related to the prevention and control of discharges and accidental spills as documented in the proposed Project's OSRP • Mayflower Wind's SWPPP will include a Project-specific SPCC plan to prevent inadvertent releases of oils and other hazardous materials to the environment to the extent practicable • Mayflower Wind will have an HDD Contingency Plan in place to mitigate, control, and avoid unplanned discharges related to HDD activities
	O&M	**Seabed or Ground Disturbance** Offshore component installation, routine offshore O&M, and vessel anchoring	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Seabed or Ground Disturbance Onshore component installation	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges Stormwater runoff, routine releases, and duct bank installation	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events/Natural Hazards Unplanned releases	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
	Decommissioning	**Seabed or Ground Disturbance** Offshore and onshore component decommissioning	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges Stormwater runoff, routine releases, and duct bank installation	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events/Natural Hazards Unplanned releases	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Biological Resources			
Birds (6.1)	Construction	**Seabed or Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Avoidance/displacement	• Mayflower Wind will site the proposed Project to avoid locating Project components in or near areas of known important or high bird use (e.g., nesting, foraging and overwintering areas, migratory staging or resting areas) • Mayflower Wind will incorporate use of HDD at landfall locations to avoid disturbance to shorelines and coastal habitats to the extent practicable • Mayflower Wind will coordinate with MassWildlife, RIDEM, and USFWS to identify appropriate mitigation measures
		Changes in Ambient Lighting Displacement/attraction and collision with WTGs	• Mayflower Wind will minimize lighting, to the extent practicable, to reduce potential attraction of birds to vessels during construction activities

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Vessel Operations Collision with vessels and avoidance/displacement	
		Planned Discharges Disturbance or fatality **Accidental Events** Oiling or fatality from accidental spills, and ingestion of marine debris	• Mayflower Wind will use approved OSRP mitigation measures, as necessary, to prevent birds from going to affected areas including chumming, hazing, and relocating to unaffected areas
	O&M	**Changes in Ambient Lighting** Displacement/attraction and collision with WTGs	• Mayflower Wind will develop and implement a Post-Construction Monitoring Plan • Mayflower Wind will ensure that lighting on WTGs will be executed in accordance with FAA regulations • Lighting on OSPs will be minimized to that required for navigation safety to reduce potential attraction of birds to the extent practicable
		Presence of Structures Collision with WTGs, avoidance/displacement and barrier effects, and habitat loss/modification	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events Oiling or fatality from accidental spills, and ingestion of marine debris	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
	Decommissioning	**Seabed or Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Avoidance/displacement	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Changes in Ambient Lighting Displacement/attraction and collision with WTGs **Vessel Operations** Collision with vessels and avoidance/displacement	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges Disturbance or fatality **Accidental Events** Oiling or fatality from accidental spills, and ingestion of marine debris	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Bats (6.2)	Construction	**Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Behavioral disturbance	• Mayflower Wind will site Project components to avoid locating onshore facilities or landfall sites in or near significant fish and wildlife habitats, including known hibernacula, maternal roosting colonies or other concentration areas as practicable. The proposed onshore substation site and converter station will be constructed in primarily open, developed areas • Onshore export cables will be buried underground beneath local roadways from landfall to the onshore substation site • Mayflower Wind will coordinate with MassWildlife, RIDEM, and USFWS to identify appropriate mitigation measures
		Changes in Ambient Lighting Displacement/attraction	• Mayflower Wind will ensure that lighting will be minimized to reduce potential attraction of bats to vessels and vehicles during construction activities within the Onshore and Offshore Project Areas to the extent practicable
		Tree Clearing Roost disturbance from tree trimming or removal	• Mayflower Wind will consult with BOEM and the USFWS to discuss BMPs available to avoid and minimize potential effects from construction/decommissioning to bats
	O&M	**Ground Disturbance**	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Habitat loss/fragmentation **Introduced Sound** Behavioral disturbance	
		Changes in Ambient Lighting Displacement/attraction	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Tree Clearing Roost disturbance from tree trimming or removal	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Presence of Structures Collisions with WTGs	• Mayflower Wind will develop and implement a Post-Construction Monitoring Plan
		Changes in Ambient EMF Displacement/attraction	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
	Decommissioning	**Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Behavioral disturbance **Changes in Ambient Lighting** Displacement/attraction	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Terrestrial Vegetation and Wildlife (6.3)	Construction	**Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Behavioral disturbance and displacement	• Mayflower Wind will site Project components to avoid locating onshore facilities and landfall sites in or near significant fish and wildlife habitats to the greatest extent practicable. The proposed onshore substation site and the converter station site will be constructed in primarily open, developed areas. • Mayflower Wind will train construction staff on biodiversity management and environmental compliance requirements

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Changes in Ambient Lighting Displacement/attraction	• Mayflower Wind will bury the onshore export cables underground beneath local roadways from landfall to the onshore substation site. • If tree clearing is required, Mayflower Wind will conduct habitat assessments and presence/absence surveys and will coordinate with MassWildlife, RIDEM, and USFWS as appropriate • Mayflower Wind will, to the extent practicable, conduct construction activities outside of periods when highly sensitive species are likely to be present • Mayflower Wind will implement erosion and sediment control measures in areas adjacent to water resources, such as wetlands, ponds, and other waterbodies, or in areas with significant grades that would make them prone to erosion • Mayflower Wind will implement a Vegetation Management Plan as approved by NHESP, RIDEM, and the Massachusetts Department of Agricultural Resources • Mayflower Wind will ensure lighting will be minimized to the extent practicable to reduce potential displacement or attraction of wildlife species to Project sites during construction activities within the Project Area
		Operation of Equipment and Heavy Machinery Collision with equipment and heavy machinery	• Vehicle speed limits will be enforced at all Project sites to minimize potential for vehicle collisions with wildlife • Mayflower Wind will conduct presence/absence surveys; surveys for protected plant and wildlife species will be completed as needed to inform the detailed engineering and design of the Project facilities
		Planned Discharges Disruption of water flow or alteration of turbidity	• Mayflower Wind will ensure that standard construction BMPs (including erosion and sediment control measures) will be implemented to avoid dewatering discharge scour and siltation to nearby receiving waters, including wetlands
		Accidental Events Release of hazardous materials into environment	• Mayflower Wind will implement a construction-phase OSRP to provide procedures for containing, cleaning, and reporting any accidental spills of oil fuel, or other hazardous materials

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
	O&M	**Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Behavioral disturbance and displacement **Changes in Ambient Lighting** Displacement/attraction	• Mayflower Wind will implement a Vegetation Management Plan as approved by NHESP, RIDEM, and the Massachusetts Department of Agricultural Resources
		Changes in EMF Behavioral disturbance	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Operation of Equipment and Heavy Machinery Collision with equipment and heavy machinery	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events Release of hazardous materials into environment	• Mayflower Wind will implement an operations-phase OSRP to provide procedures for containing, cleaning, and reporting any accidental spills of oil fuel, or other hazardous materials
	Decommissioning	**Ground Disturbance** Habitat loss/fragmentation **Introduced Sound** Behavioral disturbance and displacement **Changes in Ambient Lighting** Displacement/attraction	• Mayflower Wind will implement a Vegetation Management Plan approved by NHESP, RIDEM, and the Massachusetts Department of Agricultural Resources • Mayflower Wind will implement erosion and sediment control measures in accordance with applicable regulations
		Operation of Equipment and Heavy Machinery	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Collision with utility lines or electrocution	
		Planned Discharges Disruption of water flow or alteration of turbidity	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events Release of hazardous materials into environment	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Wetlands and Waterbodies (6.4)	Construction	**Ground Disturbance** Temporary habitat disturbance	• Mayflower Wind will implement erosion and sediment control measures in accordance with Massachusetts and Rhode Island regulations and industry BMPs throughout the Onshore Project Area to abate technical and biological erosion
		Planned Discharges Dewatering and stormwater runoff	• If groundwater is encountered, Mayflower Wind will perform dewatering measures using standard construction BMPs for dewatering, including, but not limited to, use of temporary settling basins, dewatering filter bags, or temporary holding or frac tanks • Mayflower Wind will direct dewatering wastewaters to well-vegetated uplands away from wetlands or other water resources to allow for infiltration to the soil of the discharged water • Mayflower Wind will place construction mats to minimize soil disturbance in any wetland areas that cannot be avoided or are required to be temporarily crossed
		Accidental Events Release of hazardous materials into environment	• Mayflower Wind will always require the construction contractor to have spill control and containment kits on site to allow for immediate response and cleanup in the event of an accidental release of fuel, oils, or other hazardous materials • Implementation of BMPs, the SMS, and a SWPPP for construction as well as an emergency response procedure to avoid, control, and address any accidental releases during construction activities

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind and their construction contractor will store petroleum products in upland areas more than 100 ft (30.5 m) from wetlands and waterbodies • Equipment will not be parked overnight within 100 ft (30.5 m) of a wetland or waterbody, with an exception being for equipment that cannot be practically moved. Temporary containment will be required for equipment that cannot be practically moved and must be parked overnight within 100 ft (30.5 m) of a wetland or other water resources • Mayflower Wind will use a secondary containment system for refueling that needs to occur within 100 ft (30.5 m) of wetlands to contain any minor amounts of fuel inadvertently dripped or released during refueling • Mayflower Wind will set up cement cleanout tubs in areas at least 100 ft (30.5 m) from wetlands or other water resources to contain and hold any residual cement and washout from cement trucks prior to their departure from the site
	O&M	**Planned Discharges** Dewatering and stormwater runoff	• Discharges as a result of dewatering will be managed in accordance with the requirements for applicable EPA, MassDEP, RIDEM, and/or local regulations pertaining to dewatering
		Accidental Events Release of hazardous materials into environment	• Mayflower Wind and their construction contractor will store petroleum products in upland areas more than 100 ft (30.5 m) from wetlands and waterbodies
	Decommissioning	**Ground Disturbance** Temporary habitat disturbance	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges Dewatering and stormwater runoff from	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events Release of hazardous materials into environment	• Mayflower Wind will always require the decommissioning contractor to have spill control and containment kits on site to allow for immediate response and cleanup in the event of an accidental release of fuel, oils, or other hazardous materials

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower will implement BMPs, an SMS, and an SWPPP as well as an emergency response procedure to avoid, control and address any accidental releases during decommissioning activities as applicable • Equipment will not be parked overnight within 100 ft (30.5 m) of a wetland or waterbody, with an exception being for equipment that cannot be practically moved • Temporary containment will be required for equipment that cannot be practically moved and must be parked overnight within 100 ft (30.5 m) of a wetland or other water resources • The use of a secondary containment system for refueling that needs to occur within 100 ft (30.5 m) of wetlands to contain any minor amounts of fuel inadvertently dripped or released during refueling
Coastal Habitats (6.5)	Construction	**Seabed or Ground Disturbance**	• Mayflower Wind will select sites for construction that avoid areas of sensitive seafloor and benthic habitat to the extent practicable • Mayflower Wind will utilize HDD for nearshore export cable installation • Mayflower Wind will minimize trench and sidecasting widths for export cable installation and anchor outside of eelgrass beds where possible • To the extent possible, Mayflower Wind will avoid use of anchored vessels near known eelgrass beds
		Change in Ambient Lighting	• Any effects of changes to ambient lighting will be limited to proposed landfall locations where eelgrass beds or clusters of macroalgae were identified along the northern portions of the proposed export cable corridors
		Actions that May Displace Biological Resources (Eelgrass and Macroalgae) **Actions that May Cause Direct Injury or Death**	• Offshore export cable installation and the location of the HDD exit pit are planned for outside the mapped eelgrass extents at the cable landing locations

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
	O&M	**Change in Ambient EMF**	• EMF modeling conducted for the proposed Project indicates that HDD installation in nearshore areas will reduce, but not entirely eliminate magnetic fields in the area where eelgrass beds or clusters of macroalgae were identified.
		Planned Discharges/Accidental Events Project installation and vessel O&M	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
	Decommissioning	**Seabed or Ground Disturbance**	• The proposed Project's offshore export cables may be left in place to minimize environmental effects, thus resulting in minimal or no sea bottom disturbance
		Change in Ambient Lighting	• The proposed Project's offshore export cables may be left in place to minimize environmental effects, thus resulting in no change to ambient lighting
		Displacement of Eelgrass and Macroalgae **Actions that May Cause Direct Injury or Death of Biological Resources**	• The offshore export cables may be left in place to minimize environmental effects, thus resulting in no displacement
Benthic and Shellfish Resources (6.6)	Construction	**Introduced Sound into the Environment (In-air or Underwater)** Behavioral disturbance	• Mayflower Wind will incorporate lower-impact construction methods, where possible
		Seabed or Ground Disturbance/ Planned Discharges/Accidental Events Harassment/mortality	• Mayflower Wind will design the scour protection system to reduce and minimize scour and sedimentation to the extent practicable
		Actions that May Displace Biological or Cultural Resources, or Human Uses	• Mayflower Wind will use HDD at landings to avoid disturbance to nearshore productive shellfish beds to the extent practicable • Mayflower Wind will select lower impact construction methods, where possible

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Habitat Loss	• Mayflower Wind will select corridor and micro-route cables within selected corridor to avoid complex habitats, where possible • Mayflower Wind's Project cable burial layout was designed to minimize length of cable needed
			• Mayflower Wind will bury cables, where possible, to allow for benthic recolonization after construction is complete
	O&M	**Actions that May Displace Biological or Cultural Resources, or Human Uses** Habitat Loss	• Presence of Project foundation areas, scour protection, and cable burial would allow for benthic recolonization
		Change in Ambient EMF Displacement/harassment	• Mayflower Wind will employ industry standard cable burial and cable shielding methods to reduce potential effects • Mayflower Wind's Project cable burial layout was designed to minimize length of cable needed to reduce potential effects
		Planned Discharges/Accidental Events Harassment/mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
	Decommissioning	**Introduced Sound into the Environment (in-air or Underwater)** Behavioral disturbance	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Seabed or Ground Disturbance Displacement/harassment	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Actions that May Displace Biological or Cultural Resources, or Human Uses Habitat loss	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges/Accidental Events Harassment/mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
Finfish and Invertebrates (6.7)	Construction	**Introduced Sound into the Environment (in-air or underwater)** Behavioral disturbance	• Mayflower Wind will incorporate soft start methods, to the extent practicable, during initial pile driving activities to allow mobile finfish and invertebrates to migrate away from the area • Mayflower Wind will employ sound-attenuation measures (e.g., bubble curtains, insulated piles) • Mayflower Wind will limit duration of pile driving activities to reduce sound propagation/sound exposure
		Seabed or Ground Disturbance Harassment/mortality	• Mayflower Wind will design the scour protection system to reduce and minimize scour and sedimentation
		Habitat Disturbance and Modification Habitat Loss and artificial reef effect from	• Mayflower Wind will design the sea-to-shore transition to reduce the dredging footprint and effects to benthic organisms (e.g., cofferdam and/or gravity cell) • Mayflower Wind will incorporate use of HDD at landing(s) and avoid disturbance to finfish and invertebrate EFH to the extent practicable • Mayflower Wind will incorporate use of HDD of subsea cables, as appropriate, to minimize spatial and temporal effects to benthic organisms
		Change in Ambient Lighting/Planned Discharges/Accidental Events Displacement, harassment, and mortality	• Mayflower Wind will incorporate use of HDD at landings and avoid disturbance to finfish and invertebrate EFH to the extent practicable
	O&M	**Seabed or Ground Disturbance** Harassment/mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Habitat Disturbance and Modification Habitat loss and artificial reef effect	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Change in Ambient Lighting/Planned Discharges/Accidental Events	• Mayflower Wind will install offshore export cables and inter-array cables to target burial depths and use cable shielding materials to minimize effects of EMFs

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Displacement, harassment and mortality	
	Decommissioning	**Introduced Sound into the Environment (in-air or underwater)** Behavioral disturbance	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Seabed or Ground Disturbance Displacement/harassment	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Habitat Disturbance and Modification Habitat loss and artificial reef effect	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Change in Ambient Lighting Displacement/harassment	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges/Accidental Events Harassment/mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Marine Mammals (6.8)	Construction and Decommissioning	**Introduced Sound into the Environment (in-air or underwater)** Behavioral disturbance	• When technically feasible, Mayflower Wind will employ a "ramp-up" of the HRG survey equipment at the start or re-start of HRG survey activities to minimize sound source effects. • Mayflower Wind will ensure that active acoustic sound sources will not be activated until the PSO has reported the clearance zone clear of all marine mammals after the appropriate amount of pre-clearance watch time has passed based on the proposed Project's Incidental Take Authorization • Mayflower Wind will employ sound-attenuation measures (e.g., bubble curtains, insulated piles, etc.) • Mayflower Wind will limit duration of pile driving activities to reduce sound propagation/sound exposure • Mayflower Wind will incorporate soft start methods during initial pile driving activities to allow marine mammals to migrate away from the area of effect

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will employ shut-down procedure when protected species are detected in their respective clearance zones in the Project Area • Mayflower Wind will ensure that Project activities adhere to NMFS-authorized Incidental Take Authorization for the proposed Project • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan • To reduce impacts to NARW and other marine mammals, Mayflower Wind does not intend to conduct pile driving activity from January 1 through April 30
		Vessel Operations Serious injury or mortality	• Mayflower Wind will ensure all vessels maintain a separation distance of 328 ft (100 m) or greater from any sighted ESA-listed whales or humpback whales (except NARW). Ensure that the following avoidance measures are taken if a vessel comes within 328 ft (100 m) of whale: ○ If underway, the vessel must reduce speed and shift the engine to neutral and must not engage the engines until the whale has moved beyond 328 ft (100 m). ○ If stationary, the vessel must not engage engines until the whale has moved beyond 328 ft (100 m). • Mayflower Wind will ensure all vessels maintain a separation distance of 1,640 ft (500 m) or greater from any sighted NARW or unidentified large marine mammal ○ If a vessel is stationary, the vessel must not engage engines until the NARW has moved beyond 328 ft (100 m) • Mayflower Wind will ensure that all vessels underway do not divert to approach any marine mammals • Mayflower Wind will ensure that all vessels maintain a separation distance of 164 ft (50 m) or greater from any sighted small cetacean or seal, except when a small cetacean or seal approaches the vessel • If a small cetacean or seal approaches any vessel underway, the Project vessel underway must avoid excessive speed or abrupt changes in direction to avoid injury to the animal

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will require all vessels operating within and transiting to/from the Project Area comply with the vessel strike avoidance measures specified in lease stipulations, including: ○ Ensure that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking these protected species ○ Ensure that vessels 65 ft (19.8 m) in length or greater that operate between November 1 through July 31, operate at speeds of 10 knots (11.5 mph) or less ○ Ensure that vessel operators monitor NMFS NARW reporting systems from November 1 through July 31 and whenever a Dynamic Management Area is established within any area vessels operate ○ Ensure that all vessel operators comply with 10-knot (18.5 kilometers per hour [km/hr]) speed restrictions in any Dynamic Management Area • Mayflower Wind will ensure that all vessel operators reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or large assemblages of marine mammals are observed near an underway vessel • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
		Seabed or Ground Disturbance Displacement/harassment	• Habitat disturbance during the construction phase is expected to be temporary and reversible • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
		Entanglement Harassment/mortality **Accidental Events** Ingestion/entanglement	• Mayflower Wind will adhere to all regulations under the EPA Clean Water Act • Mayflower will ensure that any structures or devices attached to the seafloor for continuous periods greater than 24 hours use the best available mooring systems (vertical and float lines, swivels, shackles, and anchor designs) for minimizing the risk of entanglement or entrainment of marine mammals while still ensuring the safety and integrity of the structure or device

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will ensure that all mooring lines and ancillary attachment lines use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak-links chains, cables, or similar equipment types that prevent lines from looping or wrapping around animals, or entrapping protected species • If an entangled live or dead marine protected species is reported, Mayflower Wind personnel must provide any assistance to authorized stranding response personnel as requested by BOEM or NMFS • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
		Planned Discharges/Accidental Events Harassment/mortality	• Mayflower Wind will use approved OSRP mitigation measures to prevent animals from going to affected area including translocation to unaffected areas as necessary • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan • To minimize potential impacts to zooplankton from impingement and entrainment, the northernmost HVDC converter OSP will be located outside of a 10 km buffer of the 30 m isobath from Nantucket Shoals.
	O&M	**Introduced Sound into the Environment (in-air or underwater)** Behavioral disturbance	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Vessel Operations Serious injury or mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Seabed or Ground Disturbance Displacement/harassment	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Accidental Events Ingestion/entanglement	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Habitat Disturbance and Modification Habitat loss and artificial reef effect	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Planned Discharges/Accidental Events Harassment/mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Sea Turtles (6.9)	Construction and Decommissioning	**Introduced Sound into the Environment (in-air or underwater)** Behavioral disturbance	• Mayflower Wind will incorporate soft start methods during initial pile driving activities to allow sea turtles to migrate away from the area of effect • Mayflower Wind will ensure that active acoustic sound sources will not be activated until the PSO has reported the clearance zone clear of all sea turtles after the appropriate amount of pre-clearance watch time has passed based on the proposed Project's Incidental Take Authorization • Mayflower Wind will employ sound-attenuation measures (e.g., bubble curtains, insulated piles, etc.) • Mayflower Wind will limit duration of pile driving activities to reduce sound propagation/sound exposure • Mayflower Wind will employ shut-down procedure when protected species are detected in their respective clearance zones in the Project Area • Mayflower Wind will ensure that Project activities adhere to NMFS-authorized Incidental Take Authorization for the proposed Project • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
		Vessel Operations Serious injury or mortality	• Mayflower Wind will ensure that all vessels underway do not intentionally approach any sighted sea turtle • Mayflower Wind will ensure that all vessels maintain a separation distance of 164 ft (50 m) or greater from any sighted sea turtles • Mayflower Wind will require all vessels operating within and transiting to/from the Lease Area comply with the vessel strike

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			avoidance measures specified in lease stipulations or NMFS authorization, including: ○ Ensure that vessel operators and crews maintain a vigilant watch for sea turtles and slow down or stop their vessel to avoid striking these protected species ○ Employ reporting system to NMFS in the event of a vessel strike • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
		Habitat Disturbance and Modification Reduced prey availability/habitat loss	• Mayflower Wind will design scour protection system to reduce and minimize scour and sedimentation • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
		Entanglement Harassment/mortality or ingestion/entanglement from marine debris	• Mayflower Wind will adhere to all regulations under the EPA Clean Water Act. Mayflower Wind will ensure that any structures or devices attached to the seafloor for continuous periods greater than 24 hours use the best available mooring systems (vertical and float lines, swivels, shackles, and anchor designs) for minimizing the risk of entanglement or entrainment of sea turtles, while still ensuring the safety and integrity of the structure or device • Mayflower Wind will ensure that all mooring lines and ancillary attachment lines will use one or more of the following measures to reduce entanglement risk: shortest practicable line length, rubber sleeves, weak-links chains, cables or similar equipment types that prevent lines from looping or wrapping around animals or entrapping protected species • If an entangled live or dead marine protected species is reported, Mayflower Wind personnel must provide any assistance to authorized stranding response personnel as requested by BOEM or NMFS • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Planned Discharges/Accidental Events Harassment/mortality	• Mayflower Wind will use approved OSRP mitigation measures to prevent animals from going to affected area including translocation to unaffected areas • Mayflower will implement measures as identified in Appendix O, Marine Mammal and Sea Turtle Monitoring and Mitigation Plan
	O&M	**Introduced Sound into the Environment (in-air or underwater)** Behavioral disturbance	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Vessel Operations Serious injury or mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Habitat Disturbance and Modification Reduced prey availability/habitat loss	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Entanglement Harassment/mortality or ingestion/entanglement	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
		Changes in Ambient EMF Displacement/harassment	• Employ industry standard cable burial and cable shielding methods to reduce potential effects
		Planned Discharges/Accidental Events Harassment/mortality	• See Construction Project Phase: Avoidance, Minimization, and Mitigation Measures (above)
Cultural Resources			
Marine Archeological Resources (7.1)	Construction, O&M, and Decommissioning	**Seabed or Ground Disturbance/Sediment Suspension and Deposition** Unanticipated discovery of underwater cultural heritage	• Mayflower Wind will maintain avoidance buffers around identified wrecks and obstructions, as appropriate • Mayflower Wind will mark identified paleolandscapes for avoidance, as appropriate • Mayflower Wind will continue to develop, in consultation with the Tribes and applicable federal and state agencies, an

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			Unanticipated Discovery Plan in the unlikely event unidentified and an unanticipated underwater cultural heritage is encountered • Under the Unanticipated Discovery Plan (Appendix Q.1), in the event that a potential cultural resource is discovered during construction activities, all bottom disturbing activities in the area of discovery will cease and every effort will be made to avoid or minimize damage to the potential submerged cultural resource(s) • Mayflower Wind will continue consultation with the relevant authorities and stakeholders to determine if addition mitigation measures are required • Training to identify archaeological resources will be provided by the QMA for resident engineers and contractor field supervisors prior to the implementation of Project and contractor personnel
Terrestrial Archeological Resources (7.2)	Construction	**Ground Disturbance** Unanticipated discovery of terrestrial archaeological resources from ground disturbance	• Mayflower Wind will site the onshore Project components in locations that minimize impacts to, or avoid, potential terrestrial archaeological resources, to the extent practicable • Mayflower Wind will work with the affected Tribes, BOEM, MHC, RIHPHC, and BUAR to thoroughly identify potential effects to terrestrial archaeological resources, as well as appropriate avoidance, minimization and mitigation measures • Mayflower Wind will monitor archaeological subsurface testing during construction in areas determined to have a moderate to high potential for undiscovered archaeological resources • Mayflower Wind will implement an Unanticipated Discovery Plan that will include stop-work and notification procedures to be followed if a cultural resource is encountered during installation • Mayflower Wind will conduct additional site-specific site evaluation and site mitigation if determined to be warranted due to the identification of archaeological sites that exhibit a potential for listing in the NRHP • Mayflower Wind will perform fieldwork in accordance with current standards and consultation with the MHC and RIHPHC

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will work with a cultural resource consultant (CRC) to determine the need for a site visit by the CRC within 24 hours upon discovery of a potential cultural resource • Mayflower Wind will determine the duration of any work stoppages to be contingent upon the significance of the identified cultural resource(s) and consultation among Mayflower Wind, BOEM, the applicable SHPO, THPOs, and other parties, as appropriate and necessary • Mayflower Wind will conduct necessary archaeological investigations under archaeological permits issued by the MHC and/or RIHPHC • Mayflower Wind will handle any discoveries of human remains in accordance with the appropriate state requirements and if they appear to be Native American will be guided by the policy statement adopted by the Advisory Council on Historic Preservation • Mayflower will ensure due care will be taken in the excavation, transport, and storage of any discovered remains to ensure their security and respectful treatment
	Construction, O&M, and Decommissioning	**Accidental Events** Damage to unanticipated archaeological resources from accidental events	• Mayflower Wind will implement BMPs throughout the proposed Project phases to minimize potential effects, including accidental releases • Mayflower Wind will develop and implement a SMS and OSRP to avoid, control and address any accidental releases during all proposed Project activities • A SPCC plan will be developed for the Project, as appropriate
Visual Effects to Historic Properties (7.3)	Construction, O&M, and Decommissioning	**Altered Visual Conditions/Changes to Ambient Lighting** Change in resource setting	• Mayflower Wind will determine avoidance, minimization, and mitigation measures for terrestrial and submarine historical and archaeological resources within the Project Area in consultation with the Tribes, BOEM, MHC, RIHPHC, and the BUAR through the Section 106 process • Mayflower Wind Will locate onshore infrastructure in previously disturbed sites to the extent feasible to reduce the risk of affected undiscovered archaeological resources

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will consult with the Tribes, BOEM, MHC, the SHPOs, and THPOs on additional ways to resolve the remaining adverse effects, including if necessary, the preparation of a Memorandum of Agreement stipulating treatment measures to provide a public benefit that balances the loss to the historic properties • Mayflower Wind proposes to design the onshore substation to mitigate visual effects to the extent feasible, improving site aesthetics by adhering to landscape codes and edge treatments, and improving substation building architecture to fit local context • Mayflower Wind will work with the Towns of Falmouth, Somerset, and Portsmouth to ensure the lighting scheme complies with Town requirements • Mayflower Wind will ensure the design of outdoor light fixtures at the onshore substation complies with night sky lighting standards to the extent practicable • Mayflower Wind will keep lighting at the onshore substation to a minimum; only a few lights will be illuminated for security reasons on dusk-to-dawn sensors and other lights will utilize motion-sensing switches. The majority of lights will be switched on for emergency situations only • Mayflower Wind will implement ADLS to reduce nighttime visual impacts • Mayflower Wind will continue to develop Historic Property Treatment Plans to resolve any adverse visual effects to historic properties • Mayflower Wind will develop and implement a landscape vegetation and screening plan as part of the Historic Property Treatment Plan for the Oak Grove Cemetery in Falmouth, MA
Visual Resources			
Visual Resources (8.0)	Construction, O&M, and Decommissioning	**Altered Visual Conditions/Changes to Ambient Lighting** Change in seascape/landscape	• Mayflower Wind proposes to design the substation and converter station to mitigate visual effects to the extent feasible, including height, location, and color • Mayflower Wind proposes to design the onshore substation and converter station to mitigate visual effects to the extent feasible,

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			including improving site aesthetics by adhering to landscape codes and edge treatments, and improving building architecture to fit local context. • Mayflower Wind will work with the Towns of Falmouth, Somerset, and Portsmouth to ensure the lighting scheme complies with town requirements • Mayflower Wind will design outdoor light fixtures at the onshore substation and converter station to comply with night sky lighting standards, to the extent practicable • Mayflower Wind will ensure lighting at the onshore substation and converter station will be keep to a minimum. Only a few lights will be illuminated for security reasons on dusk-to-dawn sensors and other lights will utilize motion-sensing switches. The majority of lights will be switched on for emergency situations only • Mayflower Wind will implement an ADLS
Acoustic Resources			
In-Air Acoustics (9.1)	Construction	**Activities that Introduce Sound into the Environment: In-Air Noise** HDD activities; Presence of onshore substation and converter stations	• Mayflower Wind will minimize the amount of work conducted outside of typical construction hours • Mayflower Wind will maintain construction equipment and use newer models to the extent practicable to provide the quietest performance • Mayflower Wind will, when possible, use enclosures on continuously operating equipment such as compressors and generators • Mayflower Wind will turn off construction equipment when not in use and minimize idling times; and • Mayflower Wind will mitigate the impact of noisy equipment on sensitive locations by using temporary barriers or buffering distances as practicable • Mayflower Wind will install a temporary noise barrier, if necessary, at edges of the site, where practicable and safe • Mayflower will use equipment silencers, where required, for drilling rig exhaust, mud cleaner generator exhaust, and mud pump exhaust

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
	O&M	**Activities that Introduce Sound into the Environment: In-Air Noise** Onshore substation and converter stations	• Mayflower Wind will install noise barriers at edges of the site, where necessary, to meet regulatory requirements
Underwater Acoustics (9.2)	Construction and Decommissioning	**Introduced Sound into the Environment** Displacement; Harassment; Potential injury; Avoidance	• Mayflower Wind will utilize noise abatement systems to decrease the sound levels produced by Project activities in the water • Mayflower Wind will employ soft-start measures allowing for a gradual increase in sound levels before the full pile driving hammer energy is reached
Socio-Economic Resources			
Demographics and Employment, and Economics (10.1)	Construction, O&M, and Decommissioning	**Workforce Hiring/Procurement of Materials, Equipment and Services Including Port Use and Vessel Charters/Presence of Infrastructure/Influx of Non-Local Employees that Could Affect Housing** Increase in employment and economic opportunities	• Mayflower Wind will maintain a stakeholder engagement plan with outreach and communications mechanisms to share information and gather input from external stakeholders, including potential supply chain partners, educational institutions, and workforce training providers • Mayflower Wind will execute financial commitments pursuant to the Project's Section 83C proposal, in collaboration with the Massachusetts Clean Energy Center, including: $35 million ports and infrastructure, $10 million local innovation and entrepreneurship, $5 million applied research, $5 million workforce development, $10 million marine science, $7.5 million operations and maintenance port upgrades, and $5 million low income strategic electrification • Mayflower Wind will encourage the hiring of skilled and unskilled labor from the Project region
Environmental Justice Minority and Lower Income Groups and Subsistence Resources (10.2)	Construction and Decommissioning	**Workforce Hiring/Procurement of Materials, Equipment and Services Including Port Use and Vessel Charters/Presence of Infrastructure/ Influx of Non-Local Employees that Could Affect Housing/Vehicle Traffic/Planned Discharges: Air Emissions** Increase in employment	• Mayflower Wind will maintain a stakeholder engagement plan with outreach and communications mechanisms to share information and gather input from external stakeholders, including EJ communities • Mayflower Wind will execute financial commitments pursuant to the Project's Section 83C proposal, under the terms of an agreement with Massachusetts Clean Energy Center, for initiatives that benefit EJ communities, including: $5 million

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		opportunities; Contribution to the economy	workforce development; and $5 million low income strategic electrification • Mayflower Wind will encourage the hiring of the skilled and unskilled labor from the Project region
		Presence of Infrastructure/Influx of Non-Local Employees that Could Affect Housing/Vehicle Traffic/Planned Discharges: Air Emissions Installation, construction, and decommissioning activities	• Mayflower Wind will develop and implement a Traffic Management Plan to minimize disruptions to the community in the vicinity of construction and installation activities, especially along the underground transmission route. The Traffic Management Plan will be developed in consultation with the municipalities and will be submitted for review and approval by municipal authorities • Mayflower Wind will develop and implement an onshore construction schedule to minimize effects to recreational uses and tourism-related activities to the extent practicable • Mayflower Wind will mandate one or more independent construction and environmental monitors to ensure compliance with the Traffic Management Plan and other environmental plans. Mayflower Wind will coordinate with the municipalities to determine the need for such monitoring
	O&M	**Workforce Hiring/Procurement of Materials, Equipment and Services Including Port Use and Vessel Charters** Increase in employment opportunities	• Mayflower Wind will execute commitment to make at least 75 percent of O&M local
Recreation and Tourism (10.3)	Construction, O&M, and Decommissioning	**Construction Areas and Traffic/Saturation of Tourism-related Services/ Influx of Non-Local Employees that Could Affect Housing/Vehicle Traffic/Planned Discharges: Air Emissions** Accessibility disruption and reduced enjoyment of land-based resources due to vehicle traffic	• Mayflower Wind will develop and implement a Traffic Management Plan to minimize disruptions to residences and commercial establishments in the vicinity of onshore construction activities; pedestrian and bicycle safety and movement would also be addressed to minimize effects of construction • Mayflower Wind will develop an onshore construction schedule to minimize effects to recreational uses and tourism related activities to the extent feasible, such as scheduling nearshore construction activities to avoid the height of the summer tourist

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			season and coordinating with stakeholders/visitors' bureaus to schedule outside of major events taking place onshore
		Accessibility disruption due to saturation of tourism-related services	• Mayflower Wind will provide a 1 nm (1.9 km) space between offshore structures (WTGs and OSPs) providing room for anticipated vessels to transit through and safely maneuver within the proposed Offshore Project Area • Mayflower Wind will implement a comprehensive communication plan and a Fisheries Communication Plan to keep relevant marine stakeholders informed of the Project activities especially during the construction and decommissioning phases. This will include the distribution of notices to inform mariners of Project-related activities within the offshore export cable corridors and Lease Area • Mayflower Wind will utilize PATONs in accordance with IALA Guidance for the marking of man-made offshore structures (IALA, 2013), and USCG approval
		Reduced enjoyment of land-based resources due to noise and air emissions	• Mayflower Wind will implement BMPs throughout the Project phases to minimize potential effects • Mayflower Wind will develop an onshore construction schedule to minimize effects to recreational uses and tourism-related activities to the extent feasible
Commercial and Recreational Fishing Resources			
Commercial and Recreational Fishing (11.0)	Construction and Decommissioning	**Vessel Activity/Presence of Infrastructure** Vessel traffic and construction	• Mayflower Wind will adhere to a 1 nm x 1 nm (1.9 km x 1.9 km) grid layout agreed upon with USCG will be the mitigation measure regarding this impact • Mayflower Wind will direct communications of vessel schedules and locations during construction activities to Fisheries Liaison Officer, Fisheries Representative, local ports, and other networks • Mayflower Wind will continue to participate in the MA/RI WEA joint developer Marine Affairs Working Group • Mayflower Wind will implement construction safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing construction activities

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will work with fishermen to determine appropriate courses of action for areas that will be temporarily closed during specific construction activities • Where possible, the Mayflower Wind will avoid sensitive areas and common fishing grounds nearshore and offshore • Mayflower Wind will work with Port Agencies and Port agents to schedule and communicate activities to minimize impacts to fishing vessels coming in to not delay their ability to port and deliver their haul
		Actions that May Displace Biological Resources Vessel activity and presence of infrastructure	• Mayflower Wind will avoid locating onshore facilities or landfall sites in or near important fish habitats to the extent practicable • Mayflower Wind will apply construction methods for cable laying activities that align with regulatory guidance • To mitigate impacts of vibration from pile-driving activities, Mayflower Wind will utilize noise abatement systems around relevant construction activities • Certain construction activities have time-of-year restrictions to avoid, minimize, and mitigate impacts to marine organisms, such as sturgeon and winter flounder, which will also be protective of other demersal groundfish species • Mayflower Wind will work with municipal shellfish constables to coordinate shellfish seeding with planned activities prior to construction activities
		Gear Interactions interactions	• Mayflower Wind is currently working with commercial and recreational fishermen as well as FRs to determine construction timing and locations with fishing vessels to anticipate and avoid/minimize/mitigate gear interactions that may occur during construction • Temporary safety zone restrictions associated with construction activities will limit direct access to areas with construction activity for the safety of mariners and Project employees, but these areas will be limited spatially and temporally • Mayflower Wind will implement construction safety zones around active construction areas in consultation with USCG

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will notify mariners via LNMs of the presence and location of partially installed structures • The Mayflower Wind FLO proactively contacts fishermen if their gear is entangled by geophysical and geotechnical survey operations and will continue to do so in later phases of the proposed Project, including during construction • Mayflower Wind will consider the use of fixed mooring buoys at various strategic locations in the Project Area to avoid the need for anchoring
	O&M	**Vessel Activity/Presence of Infrastructure**	• Mayflower Wind will continue to ensure that all Project-related vessels follow appropriate navigational routes and other USCG requirements, communicate via USCG LNMs, issue regular mariner updates and/or direct offshore radio communications to help mitigate risks to the commercial and recreational fishing industries, as well as other mariners • Mayflower Wind will implement the 1 nm x 1 nm (1.9 km x 1.9 km) grid layout agreed upon with USCG and the MA/RI WEA developers • Mayflower Wind will work with Port Agencies and Port agents to schedule and communicate activities to minimize impacts to fishing vessels • Mayflower Wind will adopt best practice of an east-west orientation in the Lease Area with 1 nm (1.9 km) spacing between WTG/OSP rows. Layout orientation aligns with neighboring lease holders to provide fishermen consistent navigable routes to fishing grounds • Mayflower Wind, the Mayflower Wind FLO, and Mayflower Wind FRs have been in close communication with industry stakeholders to share information, and to avoid sensitive areas and common fishing grounds inshore and offshore to the extent practicable
		Actions that May Displace Biological Resources	• Mayflower Wind will install subsea cables to target burial depth and consider use cable shielding materials to minimize potential but unlikely effects of EMF

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Vessel activity and presence of infrastructure	• Cable routing has been designed to minimize cable crossings, cable length, and overlap with known fishing areas, while also maximizing the portion of the cable that can be buried and maintained at target burial depth, in order to mitigate potential impacts to fishing activity
		Gear Interactions Entanglement and snags	• The target cable burial depths that have been established will mitigate the risk of potential impact for anticipated gear types, regardless of penetration depth • Safety zones surrounding each foundation will partially include the scour protection on the seabed within that zone, and it is unlikely that fixed or mobile gear will be set or towed close enough to interact with the scour protection surrounding each foundation, in the interest of vessel safety procedures • Mayflower Wind will work with fishermen through a gear loss claim application form to determine if reimbursement is warranted in a process similar to the compensation application process already in place for potential gear loss due to geophysical and geotechnical survey activity • Mayflower Wind has conducted a Cable Burial Risk Assessment to calculate the target cable lowering depth to minimize risks to the offshore export cables from damage, and to mitigate potential conflicts between commercial or recreational fishermen and the new structure • To minimize conflicts between fishing gear and the proposed Project's inter-array and offshore export cables, the inter-array cables will be buried at a target depth of 3.2 to 8.2 feet (1.0 to 2.5 m), and the offshore export cables will be buried at a target depth of 3.2 to 13.1 feet (1.0 to 4.0 m) • To minimize interference with fishing activities, Mayflower Wind has sited the export cable corridors to minimize overlap with known areas of high fishing activity • Long term monitoring of cable burial depth and condition will serve as another mitigation strategy, ensuring appropriate burial depth is maintained during the O&M phase

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Where applicable, Mayflower Wind will record required cable protection on electronic charts to be distributed to fishermen
Land Use Resources			
Zoning and Land Use (12.0)	Construction and Decommissioning	Change in zoning exception or relief for the installation of the landing location landfall site and onshore substation	• Mayflower Wind will work with the local authorities and MA EFSB and RI ESFB to facilitate the authorization of the required land use
		Construction Areas and Vehicle Traffic Accessibility disruption of neighboring land uses	• Mayflower Wind will develop and implement a Traffic Management Plan prior to construction to minimize disruptions to residences and commercial establishments in the vicinity of onshore construction activities; pedestrian and bicycle safety and movement would also be addressed to minimize effects of construction • Mayflower Wind will develop and implement a Construction Management Plan, including an onshore construction schedule, in consultation with the local authorities and relevant stakeholders to minimize effects to neighboring land uses to the extent feasible • Mayflower Wind will coordinate with stakeholders to schedule work activities outside of major events taking place onshore • Mayflower Wind will ensure that onshore construction activities comply with local regulatory authority requirements
		Reduced enjoyment of neighboring land uses due to noise, vibration, and fugitive dust	• Mayflower Wind will implement BMPs throughout the proposed Project phases to minimize potential effects • Mayflower Wind will develop and implement an onshore construction schedule to minimize effects to neighboring land uses to the extent feasible • Mayflower Wind will ensure that onshore construction activities comply with local regulatory authority requirements
		Disruption of use due to accidental releases	• Mayflower Wind will implement BMPs throughout the proposed Project phases to minimize potential effects • Mayflower Wind will follow the approved SMS and OSRP to avoid, control, and address any accidental releases during all proposed Project activities

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
	O&M	Reduced enjoyment of neighboring land uses due to noise, vibration, and fugitive dust	• Mayflower Wind will implement best practices throughout the proposed Project phases to minimize potential effects • Mayflower Wind will develop and implement an onshore construction schedule to minimize effects to neighboring land uses to the extent feasible • Mayflower Wind will ensure that onshore construction activities comply with local regulatory authority requirements
		Accessibility disruption of neighboring land uses due to construction areas and vehicle traffic	• If unscheduled repairs are required, Mayflower Wind will obtain an authorization from the local authorities as required • Mayflower Wind will coordinate with stakeholders to schedule unscheduled repairs outside of major events taking place onshore, to the extent possible • Mayflower Wind will ensure that unscheduled repairs comply with local regulatory authority requirements
		Disruption of use due to accidental events	• Mayflower Wind will implement best practices throughout the proposed Project phases to minimize potential effects • Mayflower Wind will develop and implement an emergency response procedure to avoid, control and address any accidental releases during all proposed Project activities
Navigation and Vessel Traffic Resources			
Navigation and Vessel Traffic (13.0)	Construction	**Actions that may Displace Human Uses/ Activities that may Displace or Impact Fishing and Recreation and Tourism/Accidental Events/Altered Visual Conditions** Vessel operations and presence of offshore equipment	• Mayflower Wind will coordinate directly with the USCG in response to distress/Search and Rescue events • Mayflower Wind will post LNMs on the Mayflower Wind website • Mayflower Wind will submit LNMs to the USCG and Fleet Command prior to the commencement of offshore construction activities • Mayflower Wind will implement construction safety zones in consultation with USCG and communicate to local mariners regarding upcoming and ongoing construction activities. • Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of construction activity, as necessary • Mayflower Wind will investigate means to update navigation charts with NOAA to improve communications for on-water activities

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will comply with regulatory requirements • Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of construction activity, as necessary
		Change in Ambient Lighting Construction lighting	• Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of construction activity, as necessary
	O&M	**Actions that may Displace Human Uses/ Activities that may Displace or Impact Fishing and Recreation and Tourism/Accidental Events/Altered Visual Conditions** Vessel operations and presence of structures	• Mayflower Wind will coordinate directly with the USCG in response to distress/Search and Rescue events • Mariner diligence and offshore standard work safety practices will be established for all Project-related vessels • Mayflower Wind will adopt best practice of an east-west orientation in the Lease Area with 1 nm (1.9 km) spacing between WTG/OSP rows. Layout orientation aligns with neighboring lease holders to provide fishermen consistent navigable routes to fishing grounds • Mayflower Wind will include lighting and marking of offshore proposed Project structures according to permit requirements • Marking of structures will be aligned with letter and number marking of all offshore structures within the MA/RI WEA, improving SAR and general navigation • Mayflower Wind will maintain the Project's distance from the established Traffic Separation Scheme
		Changes in Ambient Lighting Lighting of offshore structures	• Mayflower Wind will submit requests for PATON permits from the USCG that consider a range of issues related to navigational safety
	Decommissioning	**Accidental Events** Vessel operations	• Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of decommissioning activity, as necessary
		Actions that may Displace Human Uses/ Activities that may Displace or Impact Fishing and Recreation and Tourism/Accidental Events/Altered Visual Conditions	• Mayflower Wind will coordinate directly with the USCG in response to distress/Search and Rescue events • Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of decommissioning activity, as necessary

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
		Presence of offshore equipment	
		Changes in Ambient Lighting Decommissioning equipment lighting	• Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of decommissioning activity, as necessary
Other Marine Uses - Military Uses, Aviation, Offshore Energy, and Cables and Pipelines			
Other Marine Uses (14.0)	Construction, O&M, and Decommissioning	**Changes in Ambient Lighting** Introduced lighting	• Mayflower Wind will comply with USCG, BOEM and FAA marking and lighting guidelines • Mayflower Wind will utilize PATONs approved by USCG and installed in accordance with IALA Guidance (IALA, 2013) for the marking of man-made offshore structures • Mayflower Wind will ensure marking of structures will be aligned with letter and number marking of all offshore structures within the MA/RI WEA, improving SAR and general navigation • Mayflower Wind will coordinate with the USCG, Air Force, Navy, NORAD, and other military and national security stakeholders to implement operational curtailment of WTGs during search and rescue operations, or other national security emergencies, near the Lease Area, as necessary • Mayflower Wind will avoid, minimize, or mitigate effects to navigation by equipping all Project-related vessels and relevant infrastructure with the required navigation marking and lighting and day shapes
		Installation and Maintenance of Infrastructure Increased marine/vessel traffic and damage to existing cables/pipelines	• Mayflower Wind will use well established standard techniques for adequately protecting existing and newly installed cables • Mayflower Wind will develop cable crossing specifics in consultation with the cable owners as proposed Project planning continues • Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of construction/decommissioning activity, as necessary • Mayflower Wind will investigate means to update navigation charts with NOAA to improve communications for on-water activities

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• Mayflower Wind will establish mariner diligence and offshore standard work safety practices for all Project-related vessels
		Presence of Infrastructure Obstruction to air navigation, and interference with radar systems	• Mayflower Wind will work with the FAA and the owner/operator of any affected systems to ensure that appropriate mitigation measures are identified and implemented • Mayflower Wind will use ADLS to reduce visual effects • Mayflower Wind will coordinate with the DoD Siting Clearinghouse, FAA, and NORAD to determine potential effects to radars and NAVAIDS and identify appropriate mitigation measures • Mayflower Wind will coordinate with NOAA and the Northeastern Regional Association of Coastal Ocean Observing Systems to determine potential effects to high frequency radars and identify appropriate mitigation measures, as necessary
	O&M [Military]	**Installation and Maintenance of Infrastructure/Presence of Infrastructure** Use conflicts—military	• Mayflower Wind will provide a 1 nm (1.9 km) space between offshore structures (WTGs and OSPs) providing room for anticipated vessels to transit through and safely maneuver within the proposed Offshore Project Area • Mayflower Wind will align marking of structures with letter and number marking of all offshore structures within the MA/RI WEA, improving SAR and general navigation • Mayflower Wind will liaise with the military and national security stakeholders to reduce potential conflicts. • Mayflower Wind will ensure mariner diligence and offshore standard work safety practices are established for all Project-related vessels

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
Public Health and Safety			
Public Health and Safety (15.0)	Construction	**Unplanned Events** Allisions and collisions, unplanned releases, and occupational hazards	• Mayflower Wind will operate under an approved SMS • Mayflower Wind will utilize on-scene safety vessel(s) and/or personnel to advise mariners of decommissioning activity, as necessary • Mayflower Wind will investigate means to update navigation charts with NOAA to improve communications for on-water activities • Mayflower Wind will develop and implement an onshore Traffic Management Plan prior to construction to address vehicular, bicycle, and pedestrian safety • Mayflower Wind will ensure onshore work would also be planned to be performed primarily off-season when there are fewer people in the area • Mayflower Wind will operate under an approved OSRP that details prevention and control measures of unplanned releases in the Project Area • Mayflower Wind will ensure Project Vessels will adhere to USCG regulations surrounding planned and unplanned discharges • Mayflower Wind will prepare and submit an SWPPP for onshore construction activities before start of construction
	O&M	**Unplanned Events** Allisions and collisions, unplanned releases, and occupational hazards	• Mayflower Wind will maintain the northeast approach Traffic Separation Scheme • Mariner diligence and offshore standard work safety practices will be established for all Project-related vessels • Mayflower Wind will adopt best practice of an east-west orientation in the Lease Area with 1 nm (1.9 km) spacing between WTG/OSP rows. Layout orientation aligns with neighboring lease holders to provide fishermen consistent navigable routes to fishing grounds • Mayflower Wind will include lighting and marking of offshore proposed Project structures according to permit requirements • Marking of structures will be aligned with letter and number marking of all offshore structures within the MA/RI WEA, improving SAR and general navigation.

Resource	Project Phase	Impact Producing Factors Potential Effect	Avoidance, Minimization, and Mitigation Measures
			• In the event that scheduled or unscheduled repairs are required that would impede onshore traffic flow, an authorization will be obtained from the local authorities as required. • Mayflower Wind will follow measures prescribed and detailed in the approved SMS and OSRP • Mayflower Wind will operate under an approved OSRP that details prevention and control measures of unplanned releases in the Project Area • Project Vessels will adhere to USCG regulations surrounding planned and unplanned discharges

17 References

Executive Summary

Bureau of Ocean Energy Management. (BOEM). (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *Mayflower Wind Energy LLC (OCS-A 0521)*. United States Department of the Interior, Bureau of Ocean Energy Management. https://www.boem.gov/renewable-energy/state-activities/massachusetts/mayflower-wind-energy-llc-ocs-0521.

BOEM. (2018). *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan*. https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf.

Congressional Research Services. (2020). *In Focus: The Legal Framework of the Federal Power Act.* https://crsreports.congress.gov/product/pdf/IF/IF11411.

Massachusetts Clean Energy. (2020). *83C II: Long-Term Contracts for the Mayflower Wind 804 MW Project Filed for DPU Approval*. https://macleanenergy.com/2020/02/11/83c-ii-long-term-contracts-for-the-mayflower-wind-804-mw-project-filed-for-dpu-approval/.

Section 1.0 Introduction

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *Mayflower Wind Energy LLC (OCS-A 0521)*. United States Department of the Interior, Bureau of Ocean Energy Management. https://www.boem.gov/renewable-energy/state-activities/massachusetts/mayflower-wind-energy-llc-ocs-0521.

BOEM. (2018). *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan*. United States Department of the Interior, Bureau of Ocean Energy Management. https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf.

Congressional Research Services. (2020). *In Focus: The Legal Framework of the Federal Power Act.* https://crsreports.congress.gov/product/pdf/IF/IF11411.

Massachusetts Clean Energy. (2020). *83C II: Long-Term Contracts for the Mayflower Wind 804 MW Project Filed for DPU Approval*. https://macleanenergy.com/2020/02/11/83c-ii-long-term-contracts-for-the-mayflower-wind-804-mw-project-filed-for-dpu-approval/.

Massachusetts Clean Energy. (2021). *The Distribution Companies and Department of Energy Resources Have Completed the Evaluation of 83C III Bids Received*. https://macleanenergy.com/2021/12/17/the-distribution-companies-and-department-of-energy-resources-have-completed-the-evaluation-of-83c-iii-bids-received/.

National Oceanic and Atmospheric Administration. (NOAA). (2020). *Fast Facts Massachusetts.* National Oceanic and Atmospheric Administration. Office for Coastal Management. https://coast.noaa.gov/states/massachusetts.html.

U.S. Department of Energy. (2019). *Advantages and Challenges of Wind Energy*. Office of Energy Efficiency & Renewable Energy. https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy.

SECTION 2.0 PROJECT SITING AND DESIGN DEVELOPMENT

Epsilon Associates, Inc. (2018). *Construction and Operations Plan Vineyard Wind Project.* https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-construction-and-operations-plan-cop-volume-i.

Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC. (2019). *Letter to Mr. Michael Emerson, RE: Proposal for a uniform 1 x 1 NM wind turbine layout for New England Offshore Wind. 1 November 2019.* https://static1.squarespace.com/static/5a2eae32be42d64ed467f9d1/t/5dd3d3e476d4226b2a83db25/1574163438896/Proposed+1x1+layout+from+RI-MA+Leaseholders+1+Nov+19+%281%29.pdf.

Mayflower Wind. (2020). *RE: Vineyard Wind 1 COP Supplement to the Draft EIS Docket No. BOEM-2020-0005*. https://www.regulations.gov/document?D=BOEM-2020-0005-13019

National Renewable Energy Laboratory. (NREL). (2020). *Floating Wind Turbines on the Rise: NREL Offshore Wind Expert Discusses Future Powered by Floating Offshore Wind.* Golden, CO. U.S. Department of Energy. https://www.nrel.gov/news/program/2020/floating-offshore-wind-rises.html.

Responsible Offshore Development Alliance. (RODA). (2020). *Re: Proposal for New England Wind Energy Project Layout with Transit Lanes for Safe Passage of Vessels*. https://rodafisheries.org/wp-content/uploads/2020/01/200103-MA_RI-layout-proposal.pdf.

USCG. (2020). *Massachusetts and Rhode Island Port Access Route Study. Final Report. USCG-2019-0131.* https://www.federalregister.gov/documents/2020/05/27/2020-11262/port-access-route-study-the-areas-offshore-of-massachusetts-and-rhode-island.

USCG. (2019). *Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations (OREI). Navigation and Vessel Inspection Circular No.* 01-19. p. 2-5. https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/NVIC/2019/NVIC%2001-19-COMDTPUB-P16700-4-dtd-01-Aug-2019-Signed.pdf?ver=2019-08-08-160540-483.

SECTION 3.0 DESCRIPTION OF PROPOSED ACTIVITIES

BOEM. (2018). *Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan*. United States Department of the Interior. https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf.

BOEM. (2019). *Draft Proposed Guidelines for Providing Information on Lighting and Marking of Structures Supporting Renewable Energy Development*. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/renewable-energy/Lighting-and-Marking-Guidelines.pdf.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

Bureau of Safety and Environmental Enforcement. (BSEE). (2018). *Marine Trash and Debris Program.* Bureau of Safety and Environmental Enforcement. Washington, D.C. https://www.bsee.gov/what-we-do/environmental-compliance/environmental-programs/marine-trash-and-debris-program.

BSEE. (2015). *Marine Trash and Debris Awareness and Elimination*. Bureau of Safety and Environmental Enforcement NTL No. 20 l 5-G03. December 17, 2015. https://www.bsee.gov/sites/bsee.gov/files/notices-to-lessees-ntl/alerts/ntl-2015-g03.pdf

Equinor Wind, U.S., Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC. (2019). *Letter to Mr. Michael Emerson, RE: Proposal for a uniform 1 x 1 NM wind turbine layout for New England Offshore Wind, 1 November 2019*. https://static1.squarespace.com/static/5a2eae32be42d64ed467f9d1/t/5dd3d3e476d4226b2a83db25/1574163438896/Proposed+1x1+layout+from+RI-MA+Leaseholders+1+Nov+19+%281%29.pdf.

International Association of Marine Aids to Navigation and Lighthouse Authorities. (IALA). (2013). *IALA Recommendation O-139 in the Marking of Man-Made Offshore Structures O-139*. Edition 2. Laye, France. https://www.iala-aism.org/product/marking-of-man-made-offshore-structures-o-139/

Jan de Nul. (2020). *Cable Installation Vessels*. https://www.jandenul.com/fleet/cable-installation-vessels.

Kyowa Co., LTD (Kyowa). (2015). *Filter Unit*. https://www.kyowa-inc.co.jp/en/study.html.

Seabed Scour Control Systems. (SSCS). (2020). *Scour Protection Controls*. https://sscsystems.com/scour.

Soil Machine Dynamics. (SMD). (2016). *QT1600 Inter array & Export cable burial* Graeme Walker Sales & BDM Presentation. https://www.smd.co.uk/brochure-download/#0.

SPT Offshore. (2020). *Scour Protection System (ScPS)*. https://www.sptoffshore.com/scour-protection-system-scps/.

Subsea Protection Solutions. (2021). *Concrete Mattresses*. https://www.subseaprotectionsystems.co.uk/images/downloads/Concrete%20Mattresses.pdf.

USCG. (2020). *ME, NH, MA, RI, CT, NY, NJ-Atlantic Ocean-Offshore Structure Paton Marking Guidance.* Local Notice to Mariners. LNM: 32/20. https://www.navcen.uscg.gov/pdf/lnms/lnm01372020.pdf.

U.S. Environmental Protection Agency. (EPA). (2019). *2017 Construction General Permit (as modified June 2019)*. https://www.epa.gov/sites/production/files/2019-06/documents/final_2017_cgp_current_as_of_6-6-2019.pdf.

Vineyard Wind. (2020). *Draft Construction and Operations Plan, Volume 1*. https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-COP-Volume-I-Appendix-I-B.pdf.

SECTION 4.1 SITE GEOLOGY AND ENVIRONMENTAL CONDITIONS

Baldwin, W. E., Foster, D. S., Pendleton, E. A., Barnhardt, W. A., Schwab, W. C., Andrews, B. D., & Ackerman, S. D. (2016). *Shallow geology, sea-floor texture, and physiographic zones of Vineyard and western Nantucket Sounds, Massachusetts* (2331-1258). USGS Open File Report. https://pubs.usgs.gov/of/2016/1119/.

BOEM. (2020a). *Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585.* https://www.boem.gov/sites/default/files/documents/about-boem/GandG%20Guidelines.pdf.

BOEM. (2020b). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP).* https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

Curray J.R.,& Moore. (1963). *D.G. Structure of the continental margin off central California*. *Trans.* N.Y. Acad. Sci., (II), 27 pp. 794-801.

Fugro. (2022a). *Mayflower Wind Project, Geohazard Report for Lease Area* (02.20030002-GHRLA).

Fugro. (2022b). *Mayflower Wind Project, Marine Site Investigation Report* (02.2003002-MSIR).

Fugro. (2022c). *Mayflower Wind Project, Geohazard Report for Export Cable Corridor* (02.20030002-GHRECC).

Geoquip Marine Operations AG. (2019). *Volume I - Field Operations and Preliminary Results, Mayflower Project—Reconnaissance Geotechnical Investigation (GMOP19-G-013-FLD-01).* Switzerland. December 02, 2019.

Long, D. (2006). *BGS detailed explanation of seabed sediment modified Folk classification.* https://www.researchgate.net/publication/284511408_BGS_detailed_explanation_of_seabed_sediment_modified_folk_classification.

Oldale, R. N. (1980). *Geologic History of Cape Cod, Massachusetts.* U.S. Department of the Interior, Geological Survey.

Oldale, R.N. (1992). *Cape Cod and the Islands: The Geological Story.* Parnassus Imprints, East Orleans, MA.

Pollock, S.J. (1964). *Bedrock Geology of the Tiverton Quadrangle Rhode Island-Massachusetts.* https://pubs.usgs.gov/bul/1158d/report.pdf.

Quinn, A.W. (1971). *Bedrock Geology of Rhode Island*. https://pubs.usgs.gov/bul/1295/report.pdf.

Raposa, K.B. & Schwartz, M.L. (n.d.). *An Ecological Profile of Narragansett Bay National Estuarine Research Reserve*. https://coast.noaa.gov/data/docs/nerrs/Reserves_NAR_SiteProfile.pdf.

TerraSond Ltd. (2020). *Geophysical and Geohazard Report, Mayflower Wind Energy, LLC, BOEM Renewable Energy Lease Number OCS-A 0521 (2019-016).*

Uchupi, E. (1970). Atlantic continental shelf and slope of the United States - shallow structure. *U.S. Geol. Surv*., Prof. Pap., 529-I (1970).

Uchupi, E., Oldale, R.N. (1994). Spring sapping origin of the enigmatic relict valleys of Cape Cod and Martha's Vineyard and Nantucket islands, Massachusetts: *Geomorphology*, v. 9, no. 2, p.

SECTION 4.2 SHALLOW HAZARDS

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

Diesing, M., Kubicki, A., Winter, C., & Schwarzer, K. (2006). *Decadal scale stability of sorted bedforms, German Bight, southeastern North Sea.* Continental Shelf Research, 26(8), 902-916.

Fugro. (2022). *Mayflower Wind Project, Marine Site Investigation Report* (02.2003002-MSIR). Norfolk, VA.

Goff, J. A., Mayer, L. A., Traykovski, P., Buynevich, I., Wilkens, R., Raymond, R., Glang, G., Evans, R. L., Olson, H., & Jenkins, C. (2005). Detailed investigation of sorted bedforms, or “rippled scour depressions,” within the Martha's Vineyard Coastal Observatory, Massachusetts. *Continental Shelf Research,* 25(4), 461-484.

Long, D. (2006). *BGS detailed explanation of seabed sediment modified Folk classification*. https://www.researchgate.net/publication/284511408_BGS_detailed_explanation_of_seabed_sediment_modified_folk_classification.

Schmidt, J. S., Hale, J. C., Perrin, M., Himmelstein, A., Wright, O., Williams, M., & May, K. (2021). *Marine Archaeological Resources Assessment for the Mayflower Offshore Wind Farm Project and Export Cable Located in Massachusetts State Waters and OCS Block OCS-A-0521, Offshore Massachusetts.* R. Christopher Goodwin & Associates, Inc., Frederick, MD.

Section 4.3 Physical Oceanography and Meteorology

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2018). *Vineyard Wind Offshore Wind Energy Project Draft Environmental Impact Statement*. December 2018.

DHI. (2020). *Mayflower Pre-FEED* and *FEED Metocean Conditions*.

Gleen, D.H. (1992). Measurement of long-period, low amplitude Swell in the Western North Atlantic. *Journal of Atmospheric and Oceanic Technology*, vol. 9, pp. 645-658.

ISO 19906. (2010). *Petroleum and natural gas industries - Arctic offshore structures* (pp 131-133). Danish Standards, Charlottenlund, Denmark.

National Hurricane Center (NHS). (2019). *The National Hurricane Center's Best Track Data (HURDAT2)*. https://www.nhc.noaa.gov/data/.

NOAA. (2020). National Weather Service. *What is a Nor'easter*? https://www.weather.gov/safety/winter-noreaster#:~:text=A%20Nor'easter%20is%20a,violent%20between%20September%20and%20April.

NOAA. (2018). National Weather Service. *What is a Hurricane*? https://oceanservice.noaa.gov/facts/hurricane.html.

Section 4.4 Geological Recommendations and Design Criteria

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

Section 5.1 Air Quality

BOEM. (2021). *BOEM Offshore Wind Energy Facilities Emission Estimating Tool - Version 2.0: User's Guide.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2021-046. Retrieved from https://www.boem.gov/sites/default/files/documents/about-boem/BOEM-Wind-Power-User-Guide-V2.pdf.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP). Version 4.0: May 27, 2020*. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept.

of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

Chang, R., B. Do, and R. Billings. (2017). Technical Documentation for the Offshore Wind Energy Facilities Emission Estimating Tool. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Sterling, VA. OCS Study BOEM 2017-079. 51 pp. Accessed from: https://www.boem.gov/Technical-Documentation-stakeholder/.

US Environmental Protection Agency. (EPA). (2021a). *Nonattainment areas for criteria pollutants (Green Book).* Accessed from https://www.epa.gov/green-book.

EPA. (2021b). Motor Vehicle Emission Simulator (MOVES). https://www.epa.gov/moves.

EPA. (2020). *Commercial Marine Vessels – 2017 NEI Commercial Marine Vessels Final.* Accessed from: https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.

EPA. (2016). *NAAQS Table*. https://www.epa.gov/criteria-air-pollutants/naaqs-table.

EPA. (2015). *Memorandum: Implementing the 2015 ozone National Ambient Air Quality Standards*. Accessed from: https://www.epa.gov/sites/production/files/2015-10/documents/implementation_memo.pdf.

EPA. (2010). *Exhaust and Crankcase Emission Factor for Nonroad Engine Modeling –Compression Ignition report*. Accessed from: https://nepis.epa.gov.

EPA. (2009). *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories: Final Report.* Accessed from: https://archive.epa.gov/sectors/web/pdf/ports-emission-inv-april09.pdf.

EPA. (2007). *Draft regulatory impact analysis: control of emissions of air pollution from locomotive engines and marine compression-ignition engines less than 30 liters per cylinder states*. Accessed from: https://nepis.epa.gov/Exe/ZyPDF.cgi/P10023S4.PDF?Dockey=P10023S4.PDF.

EPA. (1995). *AP 42, Fifth Edition Compilation of Air Pollutant Emissions Factors and subsequent updates*. Accessed from: https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors.

Intergovernmental Panel on Climate Change. (IPCC). (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Massachusetts Department of Environmental Protection. (MassDEP). (2018). *Massachusetts Reasonably Available Control Technology State Implementation Plan Revision For the 2008 and 2015 Ozone NAAQS*. Retrieved from https://www.mass.gov/lists/massachusetts-state-implementation-plans-sips.

Section 5.2 Water Quality

Barbaro, J.R., Masterson, J.P., and LeBlanc, D.R. (2014). *Science for the Stewardship of the Groundwater Resources of Cape Cod, Massachusetts.* USGS Factsheet 2014–3067.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *Mayflower Wind Energy LLC (OCS-A 0521)*. United States Department of the Interior, Bureau of Ocean Energy Management. https://www.boem.gov/renewable-energy/state-activities/massachusetts/mayflower-wind-energy-llc-ocs-0521.

BOEM-NOAA. (2019). *Ocean Reports, A BOEM/NOAA Partnership*. Website last modified December 5, 2019. https://marinecadastre.gov/oceanreports.

Calabretta, C. J., & Oviatt, C. A. (2008). The response of benthic macrofauna to anthropogenic stress in Narragansett Bay, Rhode Island: a review of human stressors and assessment of community conditions. *Marine pollution bulletin*, *56*(10), 1680-1695.

Center for Coastal Studies. (CCS). (2020). Water quality monitoring data file. https://coastalstudies.org/cape-cod-bay-monitoring-program/.

EPA. (2015). *National Coastal Condition Assessment 2010.* Office of Water and Office of Research and Development. EPA 841-R-15-006. https://www.epa.gov/national-aquatic-resource-surveys/ncca.

Narragansett Bay Fixed-Site Monitoring Network. (NBFSMN). (2018). Mount Hope Bay Marine Buoys [Water Quality Continuous Multiprobe Data Files]. Retrieved from: https://www.mass.gov/info-details/mount-hope-bay-marine-buoy-continuous-probe-data#data-files-for-mount-hope-bay-marine-buoys-.

National Oceanic Atmospheric Administration National Data Buoy Center. (NOAA NDBC). (2020). Water quality monitoring data file. https://www.ndbc.noaa.gov/historical_data.shtml.

Northeast Fisheries Science Center. (NEFSC). (2020). *Multispecies bottom trawl survey*. Water quality monitoring data files. https://catalog.data.gov/dataset/fall-bottom-trawl-survey.

Rhode Island Department of Environmental Management. (RIDEM). (2009). *Summary of Rhode Island Groundwater Classification and Groundwater Standards*. Office of Water Resources. https://semspub.epa.gov/work/01/633120.pdf#:~:text=Groundwater%20classified%20GA%20are%20groundwater,drinking%20water%20use%20without%20treatment.

RIDEM GIS. (2020). *Environmental Resource Map. https://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=87e104c8adb449eb9f905e5f18020de5.*

Rhode Island Geographic Information System. (RIGIS). (n.d.) *Public Water Reservoirs*. https://www.rigis.org/datasets/edc::public-water-reservoirs/about.

RIGIS. (n.d.) *Surface Water Protection Areas*. https://www.rigis.org/datasets/edc::surface-water-protection-areas/about.

RIGIS. (n.d.) *Community Wellhead Protection Areas.* https://www.rigis.org/datasets/edc::community-wellhead-protection-areas/about.

RIGIS. (n.d.) *Non-Community Wellhead Protection Areas.* https://www.rigis.org/datasets/edc::non-community-wellhead-protection-areas/about.

United Sates Geological Survey. (USGS). (2019). *Water Quality Samples for USA: Sample Data*. https://nwis.waterdata.usgs.gov/nwis/qwdata.

SECTION 6.1 COASTAL AND MARINE BIRDS

Adams, J., Kelsey, E.C., Felis, J.J., & D.M. Pereksta. (2017). *Collision and displacement vulnerability among marine birds of the California Current System associated with offshore wind energy infrastructure* (ver. 1.1, July 2017): U.S. Geological Survey Open-File Report 2016-1154, 116 p., https://doi.org/10.3133/ofr20161154.

Alerstam, T. (1985). Strategies of migratory flight, illustrated by Arctic and Common Terns, *Sterna paradisaea and Sterna hirundo*. *Contributions in Marine Science* 27:580–603.

Bailey, H., Brookes, K. L. & Thompson, P. M. (2014). Assessing Environmental Impacts of Offshore Wind Farms: Lessons Learned and recommendations for the Future. *Aquatic Biosystems*, 10:8.

Baker, A., P. Gonzalez, R. I. G. Morrison, and B. A. Harrington (2020). Red Knot (Calidris canutus), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.redkno.01.

Bierregaard, R. O., A. F. Poole, M. S. Martell, P. Pyle, and M. A. Patten. (2020). Osprey (*Pandion haliaetus*), version 1.0. In *Birds of the World* (P.G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.osprey.01.

Billerman, S. M, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, (Editors). (2020*). Birds of the World*. Cornell Laboratory of Ornithology, Ithaca, NY, USA.

Blodget, B. C. (2017). *Bird List for the Commonwealth of Massachusetts.* Massachusetts Division of Fisheries and Wildlife. Accessed from: https://www.mass.gov/doc/bird-list/download. Originally published in 2002. Last updated August 27, 2017. Accessed November 16, 2020.

Buehler, D. A. (2020). Bald Eagle (*Haliaeetus leucocephalus*), version 1.0. In *Birds of the World* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.baleag.01.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0. United States Department of the Interior (USDI), Office of Renewable Energy Programs. June 2020. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *Mayflower Wind Energy LLC (OCS-A 0521)*. United States Department of the Interior, Bureau of Ocean Energy Management. https://www.boem.gov/renewable-energy/state-activities/massachusetts/mayflower-wind-energy-llc-ocs-0521.

BOEM. (2019a). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf.* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

BOEM. (2019b). *Draft Proposed Guidelines for Providing Information on Lighting and Marking of Structures Supporting Renewable Energy Development*. United States Department of the Interior (USDI), Office of Renewable Energy Programs. Draft released October 2019. Accessed from: https://www.boem.gov/sites/default/files/documents/renewable-energy/Lighting-and-Marking-Guidelines.pdf.

BOEM. (2018). *Vineyard Wind Offshore Wind Energy Project Draft Environmental Impact Statement*. OCS EIS/EA BOEM 2018-060. https://www.boem.gov/sites/default/files/renewable-energy-program/State-Activities/MA/Vineyard-Wind/Vineyard_Wind_Draft_EIS.pdf.

BOEM. (2016). *Guidelines for Information Requirements for a Renewable Energy Construction and Operations Plan (COP).* Version 3.0: April 7, 2016. Accessed from: https://www.boem.gov/sites/default/files/renewable-energy-program/COP-Guidelines.pdf.

BOEM. (2014). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts Revised Environmental Assessment.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS EIS/EIA BOEM 2014-603.

Bowlin, M.S., Enstrom, D.A., Murphy, B.J., Plaza, E., Jurich, P. & J. Cochran. (2015). Unexplained altitude changes in a migrating thrush: Long-flight altitude data from radio-telemetry. *The Auk: Ornithological Advances*, 132(4), 808-816.

Brown, P. W. & L.H. Fredrickson (2020). White-winged Scoter (*Melanitta deglandi*), version 1.0. In *Birds of the World* (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Bruderer, B., & F. Lietchi. (1999). Bird migration across the Mediterranean. In *Proceedings of the 22nd International Ornithological Congress* (N. J. Adams and R. H. Slotow, Editors). Durban, Johannesburg, South Africa, pp. 1983–1999.

Burger, J. (2020). Laughing Gull (*Leucophaeus atricilla*), version 1.0. In *Birds of the World* (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.laugul.01.

Burger, C., Schubert, A., Heinänen, S., Dorsch, M., Kleinschmidt, B., Žydelis, R., Morkunas, J., Quillfeldt, P., & G. Nehls. (2019). A novel approach for assessing effects of ship traffic on distributions and movements of seabirds*. Journal of environmental management, 251, 109511.*

Burger, J., Gordon, C., Niles, L., Newman, J., Forcey, G., and Vlietstra, L. (2011). Risk evaluation for federal listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: a first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. *Renewable Energy 36: 338-351.*

BSEE. (2015). *Marine trash and debris awareness and elimination. Notice to Lessees and Operators (NTL) of Federal Oil, Gas, and Sulphur Leases and Pipeline Right-Of-Way Holders in the OCS, Gulf of Mexico OCS Region*. BSEE NTL No. 20 l 5-G03. https://www.bsee.gov/sites/bsee.gov/files/notices-to-lessees-ntl/alerts/ntl-2015-g03.pdf.

Cleasby, I. R., Wakefield, E. D., Bearhop, S., Bodey, T. W., Votier, S. C., and Hamer, K. C. (2015). Three-dimensional tracking of a wide-ranging marine predator: Flight heights and vulnerability to offshore wind farms. *Journal of Applied Ecology 52*:1474–1482.

Cochran, W. W. (1985). *Ocean migration of Peregrine Falcons: is the adult male pelagic?* In *Proceedings of Hawk Migration Conference IV* (M. Harwood, Editor). Hawk Migration Association of North America, Rochester, N.Y., pp. 223–237.

Cook, A. , Johnston, A., Wright, L., & Burton, N. (2012). *A Review of Flight Heights and Avoidance Rates Birds in Relation to Offshore Wind Farms.* Report prepared on behalf of The Crown Estate. https://tethys.pnnl.gov/publications/review-flight-heights-avoidance-rates-birds-relation-offshore-wind-farms.

Copping, A., Hanna, L., Van Cleve, B., Blake, K., and Anderson, R.M. (2015). Environmental Risk Evaluation System—an Approach to Ranking Risk of Ocean Energy Development on Coastal and Estuarine Environments. *Estuaries and Coasts* 38, 287–302. https://doi.org/10.1007/s12237-014-9816-3.

Cranmer, A., Smetzer, J.R., Welch, L., & Baker, E. (2017). A Markov model for planning and permitting offshore wind energy: A case study of radio-tracked terns in the Gulf of Maine, USA. *Journal of Environmental Management,* 193, 400-409.

Curtice, C., Cleary, J., Shumchenia, E., and Halpin, P.N. (2016). *Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean planning and management.* Prepared on behalf of the Marine-life Data and Analysis Team (MDAT). Available online: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report-v1_1.pdf. Accessed October 2020.

DeGraaf, R. & Yamasaki, M. (2001). *New England Wildlife: Habitat, Natural History, and Distribution.* Hanover, NH: University Press of New England.

DeLuca, W.V, Woodworth, B.K., Rimmer, C.C., Marra, P.P., Taylor, P.D., McFarland, K.P., Mackenzie, S.A., & Norris, D.R. (2015). Transoceanic migration by a 12 g songbird. *Biology Letters* 11.

Dernie, K.M., M.J. Kaiser, and R.M. Warwick. (2003). Recovery rates of benthic communities following physical disturbance. *Journal of Annual Ecology*. 72: 1043-1056.

Desholm, M., & J. Kahlert. (2005). Avian collision risk at an offshore wind farm. *Biology Letters 1*:296–298. https://doi.org/10.1098/rsbl.2005.0336

DeSorbo, C. R., Persico, C., Gray, R. B., & Gilpatrick, L. (2017). *Studying migrant raptors using the Atlantic Flyway.* Block Island Raptor Research Station, RI: 2016 season.

DeSorbo, C.R., R.B. Gray, J. Tash, C.E. Gray, K.A. Williams, & D. Riordan. (2015). Offshore migration of peregrine falcons (*Falco peregrinus*) along the Atlantic flyway. In *Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Outer Continental Shelf: Final Report to the Department of Energy EERE Wind & Waterpower Technologies Office.* K.A. Williams, E.E. Connelly, S.M. Johnson, and I.J. Stenhouse (eds.) Award Number: DE EE0005362. Report BRI 2015-11, Biodiversity Research Institute, Portland, Maine. 31 pp.

DeSorbo, C. R., Wright, K. G., & Gray, R. (2012). *Bird migration stopover sites: ecology of nocturnal and diurnal raptors at Monhegan Island.*

Dorr, B. S., J. J. Hatch, and D. V. Weseloh (2020). Double-crested Cormorant (*Phalacrocorax auritus*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.doccor.01

Drewitt, A.L. & Langston, R.H.W. (2006). Assessing the impacts of wind farms on birds. *Ibis 148:29-42.* https://doi.org/10.1111/j.1474-919X.2006.00516.x.

eBird. (2020). eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org. Accessed November 2020.

Ecology and Environment Engineering, P.C. (2017). *New York State Offshore Wind Master Plan Birds and Bats Study: Final Report.* Prepared for New York State Energy Research and Development Authority (NYSERDA). NYSERDA Report 17-25d. November 2017. 142 pp.

Egevang, C., Stenhouse, I. J., Phillips, R. A., Petersen, A., Fox, J. W., & Silk, J. R. D. (2010). Tracking of Arctic Terns Sterna paradisaea reveals longest animal migration. *Proceedings of the National Academy of Sciences USA 107: 2078–2081.*

Elliott-Smith, E. & Haig, S. M. (2020). Piping Plover (*Charadrius melodus*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.pipplo.01.

Elliott-Smith, E., Haig, S.M., & B. M. Powers. (2009). Data from the *2006 International Piping Plover Census*. United States Geological Survey Data Series 426. 340 pp.

Enser, R. W. (1992). *The Atlas of Breeding Birds in Rhode Island*. Rhode Island Department of Environmental Management.

Erickson, W. P., Wolfe, M. M., Bay, K. J., Johnson, D. H., & Gehring, J. L. (2014). A Comprehensive Analysis of Small-Passerine Fatalities from Collision with Turbines at Wind Energy Facilities. *PLoS ONE* 9:18.

Everaert, J., & Stienen, E. W. M. (2007). Impact of wind turbines on birds in Zeebrugge (Belgium): Significant effect on breeding tern colony due to collisions. Biodiversity and Conservation 16:3345–3359.

Faaborg, J., Holmes, R. T., Anders, A. D., Bildsteing, K. L., Dugger, K. M., Gauthreaux, S. A., Heglun, P., Hobson, K. A. Hobson, Jahn, A. E., Johnson, D. H., & S.C. Latta. (2010). Recent advances in understanding migration systems of New World land birds. *Ecological Monographs* 80:3–48. doi:10.1890/09-0395.1.

Fijn, R. C., Krijgsveld, K. L., Poot, M. J., & Dirksen, S. (2015). Bird movements at rotor heights measured continuously with vertical radar at a Dutch offshore wind farm. *Ibis 157*(3), 558-566.

Finn, J., J. Carlsson, T. Kelly, & J. Davenport. (2012). Avoidance of Headwinds or Exploitation of Ground Effect – Why Do Birds Fly Low? *Journal of Field Ornithology 83*: 192-202.

Fox, A.D. & I.K. Petersen (2019). Offshore wind farms and their effects on birds. *Dansk Ornitologisk Forenings Tidsskrift,* 113, pp.86-101.

Fox, A. D., Desholm, M., Kahlert, J., Christensen, T. K., & Petersen, I. K. (2006). Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. *Ibis 148*:129–144.

French, T. (2002). Summary of Leach's Storm-petrel Nesting on Penikese Island, MA, and a Report of Probable Nesting on Noman's Land Island. *Bird Observer, 30*(3), 183.

Furness, R.W., H.M. Wade, and E.A. Masden. (2013). Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management 119*: 56-66.

Garthe, S., Markones, N., & Corman, A.M. (2017). Possible impacts of offshore wind farms on seabirds: a pilot study in Northern Gannets in the southern North Sea. *Journal of Ornithology* 158:345–349.

Garthe, S., Guse, N., Montevecchi, W. A., Rail, J.F., & Grégoire, F. (2014). The daily catch: Flight altitude and diving behavior of northern gannets feeding on Atlantic mackerel. *Journal of Sea Research 85*:456–462.

Garthe, S., & Hüppop, O. (2004). Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. *Journal of Applied Ecology 41*:724–734.

Gauthreaux, S. A., & Belser, C.G. (1999). Bird migration in the region of the Gulf of Mexico. In Proceedings of the 2nd International Ornithological Congress (N. J. Adams and R. H. Slotow, Editors). *BirdLife South Africa*, Durban, Johannesburg, South Africa, pp. 1931–1947.

Gochfeld, M. and J. Burger (2020). Roseate Tern (*Sterna dougallii*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.roster.01.

Good, T. P. (2020). Great Black-backed Gull (*Larus marinus*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Goodale, M. W., & Milman, A. (2016). Cumulative adverse effects of offshore wind energy development on wildlife. *Journal of Environmental Planning and Management* 59:1–21.

Goodale, M. W., Evers, D. C., Mierzykowski, S. E., Bond, A. L., Burgess, N. M., Otorowski, C. I., et al. (2008). Marine foraging birds as bioindicators of mercury in the Gulf of Maine. *EcoHealth*, 5(4), 409-425.

Gordon, C. E., & Nations, C. (2016). *Collision Risk Model for "rufa" Red Knots (Calidris canutus rufa) Interacting with a Proposed Offshore Wind Energy Facility in Nantucket Sound, Massachusetts*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-045. 90 pp. + frontmatter and appendix.

Goudie, R. I., G. J. Robertson, and A. Reed (2020). Common Eider (*Somateria mollissima*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Gray, C. E., Gilbert, A.T., Stenhouse, I., & Berlin, A.M. (2017). *Occurrence Patterns and Migratory Pathways of Red-throated Loons Wintering in the Offshore Mid-Atlantic US, 2012-2016*. In Determining Fine- scale Use and Movement Patterns of Diving Bird Species in Federal Waters of the Mid- Atlantic United States Using Satellite Telemetry (C. S. Spiegel, Editor). US. Department of the Interior, Bureau of Ocean Energy Management, Division of Environmental Sciences, Sterling, VA.

Green, M. (2004). Flying with the wind - spring migration of arctic breeding waders and geese over south Sweden. *Ardea 92: 145-160.*

Griffin, L., Rees, E., & Hughes, B. (2011). Migration routes of whooper swans and geese in relation to wind project footprints. Final Report to the UK Department of Energy and Climate Change (DECC), London. The Wildfowl and Wetlands Trust, Slimbridge, Gloucestershire, England, United Kingdom.

Gudmundsson, G. A., T. Alerstam, M. Green, and A. Hedenström. (2002). Radar observations of Arctic bird migration at the Northwest Passage, Canada*. Arctic* 55: 21-43.

Hartman, J. C., Krijgsveld, K.L., Poot, M.J.M., Fijn, R.C., Leopold, M.F., & Dirksen, S. (2012). *Effects on birds of Offshore Wind farm Egmond aan Zee (OWEZ).* An overview and integration of insights obtained.

Hatch, S. A., Robertson, G. J., and Baird, P. H. (2020). Black-legged Kittiwake (*Rissa tridactyla*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Hayman, P., J. Marchant, and T. Prater. (1986). *Shorebirds: An Identification Guide to the Waders of the World*. Houghton Mifflin Co., Boston, MA.

Hedd, A., Montevecchi, W.A., Otley, H., Phillips, R.A., Fifield, D.A. (2012). Trans-equatorial migration and habitat use by sooty shearwaters (*Puffinus griseus*) from the South Atlantic during the nonbreeding season. *Marine Ecology Progress Series* 449: 277–290.

Heinänen, S., Žydelis, R., Kleinschmidt, B., Dorsch, M., Burger, C., Morkūnas, J., et al. (2020). Satellite telemetry and digital aerial surveys show strong displacement of red-throated divers (*Gavia stellata*) from offshore wind farms. *Marine Environmental Research,* 104989.

Hill, J.M., Sandercock, B.K., & Renfrew, R.B. (2019). Migration patterns of Upland Sandpipers in the western hemisphere. *Frontiers in Ecology and Evolution*, 7, 426.

Hill, R., Hill, K., Aumuller, R., Schulz, A., Dittmann,T., Kulemeyer, C., & T. Coppack. (2014). Of birds, blades, and barriers: Detecting and analysing mass migration events at alpha ventus. In *Ecological Research at the Offshore Windfarm alpha ventus - Challenges, Results, and*

Perspectives (Federal Maritime and Hydrographic Agency (BSH), Federal Ministry of the Environment Nature Conservation and Nuclear Safety (BMU), A. Beiersdorf and K. Wollny Goerke, Editors). Springer Spektrum, Hamburg and Berlin, Germany, pp. 111–132.

Horton, T.W., R.O. Bierregaard, P. Zawar-Reza, R.N. Holdaway, and P. Sagar. (2014). Juvenile Osprey navigation during trans-oceanic migration. *PLOS One* 9(12):1–32.

Hüppop, O., & Hilgerloh, G. (2012). Flight call rates of migrating thrushes: effects of wind conditions, humidity and time of day at an illuminated offshore platform. *Journal of Avian Biology*:85.

Hüppop, O., J. Dierschke, K.M. Exo, E. Fredrich, and R. Hill. (2006). Bird migration studies and potential collision risk with offshore wind turbines*. Ibis.* 148:90–109.

Imber, M.J. (1975). Behaviour of petrels in relation to the Moon and artificial lights. *Notornis 22*:302–306.

Jarvis, C. (2005). *An evaluation of the wildlife impacts of offshore wind development relative to fossil fuel power production.* Master of Marine Policy thesis, University of Delaware, Newark, Delaware.

Johnson, S., Connelly, E., Williams, K., Adams, E., Stenhouse, I., & Gilbert, A. (2015). *Integrating data across survey methods to identify spatial and temporal patterns in wildlife distributions.* Wildlife Densities and Habitat Use Across Temporal and Spatial Scales on the Mid-Atlantic Continental Shelf: Final Report to the Department of Energy EERE Wind & Waterpower Program. [Online.] Accessed from: http://www.briloon.org/uploads/BRI_Documents/Wildlife_and_Renewable_Energy/MABSProject Chapter 17 - Johnson et al 2015.pdf.

Johnson, J.A., Storrer, J. Fahy, K. & B. Reitherman. (2011). *Determining the potential effects of artificial lighting from Pacific Outer Continental Shelf (POCS) region oil and gas facilities on migrating birds.* Prepared by Applied Marine Sciences, Inc. and Storrer Environmental Services for the US. Department of the Interior, Bureau of Ocean Energy Management, Regulations and Enforcement. Camarillo, CA. OCS Study BOEMRE 2011-047:29 pp.

Johnston, A., A.S. Cook, L.J. Wright, E.M. Humphreys, and N.H. Burton. (2014). Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology 51*: 31-41.

Jongbloed, R. H. (2016). Flight height of seabirds. A literature study.

Kahlert, J., Petersen, I.K., Fox, A.D., Desholm, M. & I. Clausager. (2004). *Investigations of birds during construction and operation of Nysted Offshore Wind Farm at Rodsand. Annual status report 2003.* Report Commissioned by Energi E2 A/S 2004. Rønde, Denmark: National Environmental Research Institute.

Kamm, M., J. Walsh, J. Galluzzo & W. Petersen. (2013). *The Massachusetts Breeding Bird Atlas 2.* Scott & Nix, Inc., New York, NY, 892 pp.

Katzner, T.E., M.N. Kochert, K. Steenhof, C.L. McIntyre, E.H. Craig, and T.A. Miller (2020). Golden Eagle (*Aquila chrysaetos*), version 2.0. In *Birds of the World* (P. G. Rodewald and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.goleag.02.

Kenney, R.D. & K.F. Wishner. (1995). The South Channel Ocean Productivity Experiment. *Continental Shelf Research 15*: 373-384.

Kerlinger, P. (2000). *Avian mortality at communication towers: a review of recent literature, research, and methodology.* Prepared for U.S. Fish and Wildlife Service. Office of Migratory Bird Management.

Kerlinger, P., J. L. Gehring, W. P. Erickson, R. Curry, A. Jain, and J. Guarnaccia. (2010). Night Migrant Fatalities and Obstruction Lighting at Wind Turbines in North America. *The Wilson Journal of Ornithology, 122(4)*:744-754.

Kerlinger, P. (1985). Water-crossing behavior of raptors during migration. *Wilson Bull., 97*(l):109-l 13.

Krijgsveld, K. L., Fljn, R.C., Japink, M., van Horssen, P.W., Heunks, C., Collier, M.P., Poot, M.J.M., Beuker, D. & Birksen, S. (2011). *Effect Studies Offshore Wind Farm Egmond aan Zee: Final report on fluxes, flight altitudes and behaviour of flying birds.* Report commissioned by NoordzeeWind.

Larsen, J. K., & Guillemette, M. (2007). Effects of wind turbines on flight behaviour of wintering common eiders: implications for habitat use and collision risk. *Journal of Applied Ecology 44*:516–522.

Lindeboom, H. J., Kouwenhoven, H.J., Bergman, M.J.N., Bouma, S., Brasseur, S., Daan, R., Fijn, R.C., Dirksen, S., van Hal, R., Hille Ris Lambers, R., et al. (2011). Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. *Environmental Research Letters 6*.

Loring, P.H., Lenske, A.K., McLaren, J.D., Aikens, M., Anderson, A.M., Aubry, Y., Dalton, E., Dey, A., Friis, C., Hamilton, D., Holberton B., Kriensky D., Mizrahi D., Niles L., Parkins K.L. Paquet J., Sanders F., Smith A., Turcotte Y., Vitz A. & P.A. Smith. (2020). *Tracking Movements of Migratory Shorebirds in the U.S. Atlantic Outer Continental Shelf Region*. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-008. 104 p.

Loring, P.H., P.W.C. Paton, J.D. McLaren, H. Bai, R. Janaswamy, H.F. Goyert, C.R. Griffin, and P.R. Sievert. (2019). Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017. 140 pp.

Loring, P.H., McLaren, J.D., Smith, P.A., Niles, L.J., Koch, S.L., Goyert, H.F. & H. Bai. (2018). Tracking movements of threatened migratory *rufa* Red Knots in U.S. Atlantic Outer Continental Shelf Waters. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-046. 145 p.

Loring, P., Goyert, H., Griffin, C., Sievert, P., & P. Paton. (2017). *Tracking Movements of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers in the Northwest Atlantic: 2017 Annual Report to the Bureau of Ocean Energy Management (BOEM)*. In. Interagency Agreement No. M13PG00012 to US. Fish and Wildlife Service Northeast Region Division of Migratory Birds, Hadley, Massachusetts.

Marques, A.T., H. Batalha, S. Rodrigues, H. Costa, M.J.R. Pereira, C. Fonseca, M. Mascarenhas, and J. Bernardino. (2014). Understanding bird collisions at wind farms: an updated review on the causes and possible mitigation strategies*. Biological Conservation 179:40-52.*

Masden, E.A., Reeve, R., Desholm, M., Fox, A.D., Furness, R.W. and Haydon, D.T., 2012. Assessing the impact of marine wind farms on birds through movement modelling. *Journal of the Royal Society Interface*, 9(74), 2120-2130.

Masden, E. A., Haydon, D. T., Fox, A. D., Furness, R. W., Bullman, R., and Desholm, M. (2009). Barriers to movement: impacts of wind farms on migrating birds. *ICES Journal of Marine Science*, 66: 746–753.

MassGIS (Massachusetts Bureau of Geographic Information) and NHSEP. (2018). *MassGIS Data: NHESP Priority Habitats of Rare Species*. Accessed from: https://docs.digital.mass.gov/dataset/massgis-data-nhesp-priority-habitats-rare-species. Last updated December 04, 2018.

Massachusetts Division of Fisheries and Wildlife (MassWildlife). (2015a). Massachusetts State Wildlife Action Plan 2015. Westborough, MA.

MassWildlife. (2015b). Upland sandpiper Fact Sheet. Available online at: https://www.mass.gov/doc/upland-sandpiper/download.

MassWildlife. (2015c). Pied-billed grebe Fact Sheet. Available online at: https://www.mass.gov/doc/pied-billed-grebe/download.

MassWildlife. (2015d). Leach's storm-petrel Fact Sheet. Available online at: https://www.mass.gov/doc/leachs-storm-petrel/download.

MassWildlife. (2015e). Massachusetts State Wildlife Action Plan Species Summary: Least Tern (*Sterna antillarum)*. https://www.mass.gov/doc/least-tern/download.

MassWildlife. (2015f). Massachusetts State Wildlife Action Plan Species Summary: Common Tern (*Sterna hirundo*). https://www.mass.gov/doc/common-tern/download.

MassWildlife. (2019). Bald eagle Fact Sheet. Available online at: https://www.mass.gov/doc/bald-eagle-factsheet/download.

Mayflower Wind Energy, LLC. (2020a). Mayflower Quarterly Survey Report: November 2019 - January 2020. Scientific Quarterly Report P00003850. Mayflower, 29 April 2020, v2.0, 24 pp.

Mayflower Wind Energy, LLC. (2020b). Mayflower Quarterly Survey Report: February 2020 - April 2020. Scientific Quarterly Report P00003850. Mayflower, 31 July 2020, 24 pp.

Mayflower Wind Energy, LLC. (2020c). Mayflower Quarterly Survey Report: May 2020 - July 2020. Scientific Quarterly Report P00003850. Mayflower, 29 October 2020, 28 pp.

Mayflower Wind Energy, LLC. (2020d). Mayflower Quarterly Survey Report: August 2020 – October 2020. Scientific Quarterly Report P00003850. Mayflower, 32 December 2020, 28 pp.

McGovern, S., J.R. Wilmott, G. Lampman, A. Pembroke, S. Warford, M. Rehfisch, & S. Clough, (2019). The First Large-Scale Offshore Aerial Survey Using a High-Resolution Camera System. In *Wind Energy and Wildlife Impacts* (pp. 115-123). Springer, Cham.

McGrady, M. J., Young, G.S., & Seegar, W.S. (2006). Migration of a Peregrine Falcon Falco peregrinus over water in the vicinity of a hurricane. *Ringing and Migration 23:80–84*.

Metheny, N., & G. Davis. (2017*). Seabird Survey Report: 16-26 May, 30 May-7, June 2017*. Prepared for Northeast Fisheries Science Center, Woods Hole. Nd.

MMS. (2008). *Programmatic Environmental Impact Statement for alternative energy development and production and alternate use of facilities on the Outer Continental Shelf: Final Environmental Impact Statement*.

Mojica, E.K., B.D. Watts, and C.L. Turrin. (2016). Utilization Probability Map for Migrating Bald Eagles in Northeastern North America: A Tool for Siting Wind Energy Facilities and Other Flight Hazards. *PLoS ONE* 11(6): e0157807. doi:10.1371/journal. pone.0157807.

Montevecchi, W. A. (2006). Influences of Artificial Light on Marine Birds. In *Ecological Consequences of Artificial Night Lighting* (C. Rich and T. Longcore, Editors). Island Press, Washington D.C., pp. 94–113.

Mowbray, T. B. (2020). Northern Gannet (*Morus bassanus*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.norgan.01.

Muller, M. J. and R. W. Storer (2020). Pied-billed Grebe (*Podilymbus podiceps*), version 1.0. In *Birds of the World* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.pibgre.01.

National Audubon Society, *The Christmas Bird Count Historical Results, 2020*. Online: https://netapp.audubon.org/CBCObservation/. Accessed December 2020.

National Oceanic Atmospheric Administration (NOAA), National Marine Fisheries Service. (NMFS). (2004). *Mid-Atlantic Offshore Seabird Survey Protocol*. Summer 2004.

Natural Heritage & Endangered Species Program. (2020). *Consultation with NHESP regarding state-listed rare species*. Received on May 01, 2020. NHESP Tracking No.:19-38917.

Newton, I. (2010). *The Ecology of Bird Migration*. Academic Press, London, United Kingdom.

Niles, L. J., J. Burger, R. R. Porter, A. D. Dey, C. D. T. Minton, P. M. Gonzalez, A. J. Baker, J. W. Fox, C. Gordon. (2010). First results using light level geolocators to track Red Knots in the Western Hemisphere show rapid and long intercontinental flights and new details of migration pathways. *Wader Study Group Bulletin. 117*:123-130.

Nisbet, I.C.T., R.R. Veit, S.A. Auer & T.P. White. (2013). Marine Birds of the Eastern United States and the Bay of Fundy. *Nuttall Ornithological Monographs, No. 29*, Cambridge, Massachusetts.

Nisbet, I.C.T. (1984). Migration and winter quarters of North American Roseate Terns as shown by banding recoveries. *J. Field Ornithol 55*:1-17.

Noer, H., T. K. Christensen, I. Clausager, & I. Petersen. (2000). *Effects on birds of an offshore windpark at Horns Rev: environmental impact assessment*, pp. 63-98. Unpublished Report. Ministry of Environment and Energy, National Environmental Research Institute, Department of Coastal Ecology, Rønde, Denmark. https://www.etde.org/etdeweb//servlets/purl/20772842-HYUKtG/20772842.pdf.

Normandeau Associates, Inc. (2011). *New insights and new tools regarding risk to roseate terns, piping plovers, and red knots from wind facility operations on the Atlantic Outer Continental Shelf.* A Final Report for the U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Report No. BOEMRE 048-2011. Contract No. M08PC20060. 287 pp.

Northeast Fisheries Science Center (NEFSC). (2020a). *Bottom Trawl Surveys.* Project ID 22557. Available online at: https://www.fisheries.noaa.gov/inport/item/22557.

NEFSC. (2020b). *Oceanography Branch Plankton Database*. Project ID 9286. Available online at: https://www.fisheries.noaa.gov/inport/item/9286.

NYSERDA. (2015). *Advancing the Environmentally Responsible Development of Offshore Wind Energy in New York State: A Regulatory Review and Stakeholder Perceptions NYSERDA Report 15-16.*

O'Connell, A., Spiegel, C. S., and Johnson, S. (2011). *Compendium of Avian Occurrence Information for the Continental Shelf Waters along the Atlantic Coast of the United States, Final Report (Database Section - Shorebirds).* Prepared by the U.S. Fish and Wildlife Service, Hadley, MD for the USGS Patuxent Wildlife Research Center, Beltsville, MD. U.S. Department of the Interior, Geological Survey, and Bureau of Ocean Energy Management Headquarters, OCS Study BOEM 2012-076.

Owen, M., & Black, J. M. (1990). *Waterfowl Ecology*. In. Chapman & Hall, New York, NY.

Paine, R. T., Wootton, J. T., & Boersma, P. D. (1990). Direct and indirect effects of peregrine falcon predation on seabird abundance. *The Auk*, 107(1), 1-9.

Palka, D.L., S. Chavez-Rosales, E. Josephson, D. Cholewiak, H.L. Haas, L. Garrison, M. Jones, D. Sigourney, G. Waring (retired), M. Jech, E. Broughton, M. Soldevilla, G. Davis, A. DeAngelis, C.R. Sasso, M.V. Winton, R.J. Smolowitz, G. Fay, E. LaBrecque, J.B. Leiness, Dettloff, M. Warden, K. Murray, and C. Orphanides. (2017). *Atlantic Marine Assessment Program for Protected Species: 2010-2014*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2017-071. 211 pp.

Paton, P. (2016). *Assessing nearshore and offshore movements of Piping Plovers in southern New England*. In Presentation at the 2016 North American Ornithological Conference (NAOC). Washington, D. C.

Paton, P., Winiarski, K., Trocki, C., & McWilliams, S. (2010). Spatial distribution, abundance, and flight ecology of birds in nearshore and offshore waters of Rhode Island. *Rhode Island Ocean Special Area Management Plan (Ocean SAMP), 2*, 304.

Patterson, J. W. (2012). *Evaluation of New Obstruction Lighting Techniques to Reduce Avian Fatalities*. U.S. Department of Transportation Federal Aviation Administration.

Percival, S. M. (2010). *Kentish Flats Offshore Wind Farm: Diver Surveys 2009-10*. Accessed from: https://tethys.pnnl.gov/sites/default/files/publications/Pervical-2010.pdf.

Perkins, S., Allison, T., Jones, A., & Sadoti, G. (2004). *A Survey of Tern Activity Within Nantucket Sound, Massachusetts During the 2003 Fall Staging Period*. Final Report to the Massachusetts Technology Collaborative, 10 September 2004.

Petersen, I. K., Christensen, T.K., Kahlert, J., Desholm, M. & Fox, A.D. (2006). *Final results of bird studies at the offshore wind farms at Nysted and Horns Rev, Denmark*. Report commissioned by DONG Energy and Vattenfall A/S.https://tethys.pnnl.gov/sites/default/files/publications/NERI_Bird_Studies.pdf.

Petersen, W. R. and Meservey, W. R. (2003). *Massachusetts Breeding Bird Atlas*. Massachusetts Audubon Society. ISBN 1-55849-420-0.

Pettersson, J. (2005). *The Impact of Offshore Wind Farms on Bird Life in Southern Kalmar Sound, Sweden. A final report based on studies 1999–2003*. Report for the Swedish Energy Agency. Lund, Sweden: Lund University.

Pettersson, J., & Fågelvind, J. (2011). *Night Migration of Songbirds and Waterfowl at the Utgrunden Off-Shore Wind Farm: A Radar-Assisted Study in Southern Kalmar Sound.*

Plonczkier, P., & Simms, I.C. (2012). Radar monitoring of migrating pink-footed geese: behavioral responses to offshore wind farm development. *Journal of Applied Ecology* 49:1187-1194.

Pollet, I. L., A. L. Bond, A. Hedd, C. E. Huntington, R. G. Butler, & R. Mauck (2020a). Leach's Storm-Petrel (Oceanodroma leucorhoa), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Pollet, I. L., D. Shutler, J. W. Chardine, and J. P. Ryder (2020b). Ring-billed Gull (*Larus delawarensis*), version 1.0. In *Birds of the World* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.

Pollet, I. L., Hedd, A., Taylor, P. D., Montevecchi, W. A., & Shutler, D. (2014). Migratory movements and wintering areas of Leach's Storm-Petrels tracked using geolocators. *Journal of Field Ornithology*, 85(3), 321-328.

Pollet, I. L., Ronconi, R. A., Leonard, M. L., & Shutler, D. (2019). Migration routes and stopover areas of Leach's Storm Petrels Oceanodroma leucorhoa*. Marine Ornithology, 47, 55-65.*

Rebke, M., Dierschke, V., Weiner, C.N., Aumüller, R., Hill, K. & R. Hill. (2019). Attraction of nocturnally migrating birds to artificial light: The influence of colour, intensity and blinking mode under different cloud cover conditions. *Biological Conservation*, *233*, 220-227.

RIDEM. (2015). Rhode Island Wildlife Action Plan. Available online at: http://www.dem.ri.gov/programs/fish-wildlife/wildlifehuntered/swap15.php.

RIDEM. (2006). Rare Native Animals of Rhode Island. Revised: March 2006. https://rinhs.org/wp-content/uploads/2012/05/ri_rare_animals_2006.pdf.

RIBird.org. (2020). Rhode Island Checklist. https://ribird.org/ri_checklist.

RIBird.org. (n.d.). Rhode Island Breeding Bird Atlas. https://ribird.org/ri_checklist.

Robinson Willmott, J.C., G. Forcey, & A. Kent. (2013). *The relative vulnerability of migratory bird species to offshore wind energy projects on the Atlantic Outer Continental Shelf: An assessment method and database*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM, 207/275.

Roman, L., Bell, E., Wilcox, C., Hardesty, B. D., & Hindell, M. (2019). Ecological drivers of marine debris ingestion in Procellariiformes Seabirds. *Scientific reports, 9(1), 1-8.*

RPS Group. (2020). Mayflower Wind, Geoquip Saentis, *Avian Survey Final Report*. Dated January 27, 2020.

RPS Group. (2019). TerraSond, Mayflower Avian Survey Final Report. Dated December 18, 2019.

Rubega, M. A., D. Schamel, and D. M. Tracy (2020). Red-necked Phalarope (*Phalaropus lobatus*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, N.Y., USA. https://doi.org/10.2173/bow.renpha.01

Senner, N.R., Stager, M., Verhoeven, M.A., Cheviron, Z.A., Piersma, T., & Bouten, W. (2018). High-altitude shorebird migration in the absence of topographical barriers: avoiding high air temperatures and searching for profitable winds. *Proceedings of the Royal Society B: Biological Sciences, 285*(1881), 20180569.

Sibley, D.A. (2000). *The Sibley guide to birds. National Audubon Society*. New York, NY: A.A. Knopf. 235 pp.

Silverman, E. D., Saalfeld, D.T., Leirness, J.B., & M.D. Koneff. (2013). Wintering Sea Duck Distribution Along the Atlantic Coast of the United States. *Journal of Fish and Wildlife Management* 4:178–198. doi:10.3996/122012-JFWM-107

Silverman, E.D., Leirness, J.B., Saalfeld, T., Koneff, M.D., & K.D. Richkus. (2012). *Atlantic Coast Wintering Sea Duck Survey, 2008-2011.*

Spiegel, C.S., A.M. Berlin, A.T. Gilbert, C.O. Gray, W.A. Montevecchi, I.J. Stenhouse, S.L. Ford, G.H. Olsen, J.L. Fiely, L. Savoy, M.W. Goodale, and C.M. Burke. (2017). *Determining Fine- scale Use and Movement Patterns of Diving Bird Species in Federal Waters of the Mid- Atlantic United States Using Satellite Telemetry*. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-069.

Staudinger, M.D., H. Goyert, J.J. Suca, K. Coleman, L. Welch, J.K. Llopiz, D. Wiley, I. Altman, A. Applegate, P. Auster, H. Baumann, J. Beaty, D. Boelke, L. Kaufman, P. Loring, J. Moxley, S. Paton, K. Powers, D. Richardson, J. Robbins, J. Runge, B. Smith, C. Spiegel, and H. Steinmetz. (2020). The role of sand lances (*Ammodytes* sp.) in the Northwest Atlantic Ecosystem: A synthesis of current knowledge with implications for conservation and management. *Fish and Fisheries* 21:522–556. DOI: 10.1111/faf.12445.

Stenhouse, I.J., Adams, E.M., Goyette, J.L., Regan, K.J., Goodale, M.W., & Evers, D.C. (2018). Changes in mercury exposure of marine birds breeding in the Gulf of Maine, 2008–2013. *Marine pollution bulletin*, *128*, 156-161.

Stucker, J.H. & Cuthbert, F.J. (2006). *Distribution of non-breeding Great Lakes piping plovers along Atlantic and Gulf of Mexico coastlines*: *10 years of band resightings*. A report to the U.S. Dept. of the Interior, Fish and Wildlife Service. 20 pp.

Thaxter, C. B. G. M. Buchanan, J. Carr, S. H. M. Butchart, T. Newbold, R. E. Green, J. A. Tobias, W. B. Foden, S. O'Brien, and J. W. Pearce-Higgins. (2017). *Bird and bat species' global vulnerability to* *collision mortality at wind farms revealed through a trait-based assessment*. *Proc. R. Soc*. B284:20170829. http://dx.doi.org/10.1098/rspb.2017.0829.

Townsend, D.W., Thomas, A.C., Mayer, L.M., Thomas, M.A., and Quinlan, J.A. (2006). Oceanography of the Northwest Atlantic continental shelf (1, W). Chapter 5 in A.R. Robinson and 76 K.H. Brink (Eds) *The Sea: The Global Coastal Ocean: Interdisciplinary Regional Studies and Syntheses*. Harvard University Press.

Tracy, D. M., D. Schamel, & J. Dale. (2020). Red Phalarope (Phalaropus fulicarius), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.redpha1.01.

U.S. Fish and Wildlife Service. (USFWS). (2018). Endangered and Threatened Wildlife and Plants; Threatened Species Status for Black-Capped Petrel with a Section 4(d) Rule, 50 CFR Part 17. Docket No. FWS-R4-ES-2018-0043. 83 FR 50560. Proposed Rule published 9 October 2018. Accessed from: https://www.regulations.gov/document?D=FWS-R4-ES-2018-0043-0001.

USFWS. (2017). Species profile: Piping Plover. Accessed from: https://www.fws.gov/northeast/pipingplover/

USFWS. (2011). Species profile: Roseate tern (*Sterna dougallii dougallii*). https://www.fws.gov/northeast/pdf/Roseatetern0511.pdf.

USFWS. (2010a). *Caribbean roseate tern and north Atlantic roseate tern (Sterna dougallii dougallii) 5-year review: Summary and evaluation.* U.S. Dept. of the Interior, Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico and Northeast Region, New England Field Office, Concord, NH. September 2010.

USFWS. (2010b). *Species assessment and listing priority assignment form for the red knot* (*Calidris canutus rufa*).

USFWS. (2009). *Piping plover (Charadrius melodus) 5-year review: Summary and evaluation*. U.S. Dept. of the Interior, Fish and Wildlife Service Northeast Region, Hadley, Massachusetts and Midwest Region, East Lansing, MI.

USFWS. (2008). *Birds of Conservation Concern 2008*. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. http://www.fws.gov/migratorybirds/.

USFWS. (2001). *Common Tern Habitat Model*. http://www.fws.gov/r5gomp/gom/habitatstudy/metadata/common_tern_model.htm.

USFWS. (1998). *Roseate tern (Sterna dougallii) northeastern population recovery plan. First update*. U.S. Dept. of the Interior, Fish and Wildlife Service, Hadley, MA. 75 pp.

USFWS. (1996). *Piping plover (Charadrius melodus) Atlantic Coast population. Revised recovery plan.* U.S. Dept. of the Interior, Fish and Wildlife Service, Hadley, MA. 236 pp.

Vanermen, N., T. Onkelinx, W. Courtens, M. Van de walle, H. Verstraete, & E.W.M. Stienen. (2015). Seabird avoidance and attraction at an offshore wind farm in the Belgian part of the North Sea. *Hydrobiologia 756: 51-61.*

Veit, R.R., White, T.P., Perkins, S.A., & S. Curley. (2016). *Abundance and Distribution of Seabirds off Southeastern Massachusetts, 2011-2015.* US. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-067. 82 pp.

Veit, R.R., Goyert, H.F., White, T.P., Martin, M.C., Manne, L.L. Manne, & A. Gilbert. (2015). *Pelagic Seabirds off the East Coast of the United States 2008-2013*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2015-024. 186 pp.

Veit, R.R. & S.A. Perkins. (2014). *Aerial Surveys for Roseate and Common Terns South of Tuckernuck and Muskeget Islands July-September 2013.* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2014-665. 13 pp.

Veit, R.R. & W.R. Petersen. (1993). *Birds of Massachusetts.* Massachusetts Audubon Society. ISBN 0-932691-11-0.

Vlietstra, L. S. (2007). Potential Impact of the Massachusetts Maritime Academy Wind Turbine on Common (*Sterna hirundo*) and Roseate (*S. dougallii*) Terns. Paper presented at OCEANS 2007 Aberdeen, Aberdeen, UK. https://tethys.pnnl.gov/publications/potential-impact-massachusetts-maritime-academy-wind-turbine-common-roseate-terns.

Weseloh, D. V., C. E. Hebert, M. L. Mallory, A. F. Poole, J. C. Ellis, P. Pyle, and M. A. Patten (2020). Herring Gull (*Larus argentatus*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.hergul.01.

White, T.P., & R.R. Veit. (2020). Spatial ecology of long-tailed ducks and white-winged scoters wintering on Nantucket Shoals. *Ecosphere, 11*(1), e03002.

White, T.P., Veit, R.R., & M.C. Perry. (2009). Feeding ecology of long-tailed ducks Clangula hyemalis wintering on the Nantucket Shoals. *Waterbirds, 32*(2), 293-299.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W., Linke, J., & Anonymous. (2001). Seabirds at risk around offshore oil platforms in the North-west Atlantic. *Marine Pollution Bulletin 42*:1285–1290.

Winiarski, K., C.L. Trocki, P. Paton, and S. McWilliams. (2011). *Spatial Distribution, Abundance, and Flight Ecology of Birds in Nearshore and Offshore Waters of Rhode Island: January 2009 to August 2010*. Interim Technical Report for the Rhode Island Ocean Special Area Management Plan (OSAMP). Dated 1 June 2011.

Winship, A.J., Kinlan, B.P., White, T.P., Leirness, J.B., & J. Christensen. (2018). *Modeling At-Sea Density of Marine Birds to Support Atlantic Marine Renewable Energy Planning: Final Report.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA.OCS Study BOEM 2018-010. x+67 pp.

Zhao, X., Zhang, M., Che, X. and Zou, F., 2020. Blue light attracts nocturnally migrating birds. *The Condor,* 122(2). https://doi.org/10.1093/condor/duaa002.

SECTION 6.2 BATS

3D/E. (1996). Biological Assessment of the Master Plan and Ongoing Mission for the U.S. Army Engineering Center and Fort Leonard Wood; Appendix I: Impacts to Indiana Bats and Gray Bats from Sound Generated on Training Ranges at Fort Leonard Wood, Missouri. Unpublished report to U.S. Army Corps of Engineers, Kansas City, 277 + appendices.

Ahlén, I., Baagoe, H. J. & Bach, L. (2009). Behavior of Scandinavian bats during migration and foraging at sea. *Journal of Mammalogy*, 90, 1318-1323.

Allen, G.M. (1923). The Red Bat in Bermuda. *Journal of Mammalogy*, 4, 61.

Alves, D.M.C.C., Terrible, L.C., & D. Brito. (2014). The potential impact of white-nose syndrome on the conservation status of North American bats. *PLoS One*, 9(9).

Arnett, E.B., Brown, W.K., Erickson, W.P., Fiedler, J.K., Hamilton, B.L., Henry, T.H., Jain, A., Johnson, G.D., Kerns, J., Koford, R.R., Nicholson, C.P., O'Connell, T.J., Piorkowski, M.D., & R.D. Tankersley. (2008). Patterns of Bat Fatalities at Wind Energy Facilities in North America. *Journal of Wildlife Management*, 72(1), 61-78.

Bailey, H., Brookes, K.L. & P.M. Thompson. (2014). Assessing Environmental Impacts of Offshore Wind Farms: Lessons Learned and recommendations for the Future. *Aquatic Biosystems*, 10, 8.

Bat Conservation International, BCI. (2021). Species Profiles. Available online at: https://www.batcon.org/about-bats/bat-profiles/.

BatGuys Corporation. (2019). https://www.batguys.com/contact/ri-newport.html.

Bennett, V.J., Hale, A.M., & D.A. Williams. (2017). When the excrement hits the fan: fecal surveys reveal species-specific bat activity at wind turbines. *Mammalian Biology*, 87(1), 125-129.

Bennet, V.J., & A.M. Hale. (2014). Red Aviation Lights on Wind Turbines Do Not Increase Bat-Turbine Collisions. *Animal Conservation, 17*, 354-358.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0*. United States Department of the Interior (USDI), Office of Renewable Energy Programs. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

Brack, V., Whitaker, J.O., & S.E. Pruitt. (2004). Bats of Hoosier National Forest. *Proceedings of the Indiana Academy of Science, 113*(1), 76-86.

Broders, H.G. & G.J. Forbes. (2004). Interspecific and intersexual variation in roost-site selection of northern long-eared and little brown bats in the Greater Fundy National Park ecosystem. *Journal of Wildlife Management*, 68, 602-610.

Brooks, R. T. & W. M. Ford. (2005). Bat activity in a forest landscape of central Massachusetts. *Northeastern Naturalist*, 12, 447-462.

Caceres, C. & Barclay, R. M. R. (2000). Myotis septentrionalis. *Mammalian species, 2000* (634), 1–4.

Cryan, P.M., Gorresen, P.M., Hein, C.D., Schirmacher, M.R., Diehl, R.H., Huso, M.M., Hayman, D.T.S., Fricker, P.D., Bonaccorso, F.J., Johnson, D.H., Heist, K., & D.C. Dalton. (2014). Behavior of Bats at Wind Turbines. *Proceedings of the National Academy of Sciences of the United States of America*, 111(42), 15126-15131.

Cryan, P.M. & R.M.R. Barclay. (2009). Causes of bat fatalities at wind turbines: Hypotheses and predictions. *Journal of Mammalogy*, 90, 1330-1340.

Cryan, P.M. & A.C. Brown. (2007). Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. *Biological Conservation*, 139, 1-11.

Dowling, Z., Sievert, P.R., Baldwin, E., Johnson, L., Von Oettingen, S. & J. Reichard. (2017). *Flight Activity and Offshore Movements of Nano-Tagged Bats on Martha's Vineyard*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, Virginia. OCS Study BOEM 2017-054. 39 pp.

FAA. (1992). *Final Environmental Impact Statement: Master Plan Development, Indianapolis International Airport*.

Foo, C.F., Bennett, V.J., Hale, A.M., Korstian, J.M., Schildt, A.J., & D.A. Williams. (2017). Increasing evidence that bats actively forage at wind turbines. *PeerJ*, *5*, e3985.

Fraser, E.E., McGuire, L.P., Eger, J.L., Longstaffe, F.J., & M.B. Fenton. (2012). Evidence of latitudinal migration in tri-colored bats, *Perimyotis subflavus*. *PLoS One,* 7(2).

Goodale, M. W., & Milman, A. (2016). Cumulative adverse effects of offshore wind energy development on wildlife. *Journal of Environmental Planning and Management* 59, 1–21.

Grady, F.V., & Olson, S.L. (2006). Fossil Bats from Quaternary Deposits on Bermuda (*Chiroptera: Vespertillionidae). Journal of Mammalogy*, 87(1), 148-152.

Greif, S., Borissov, I., Yovel, Y., & Holland, R. (2014). A Functional Role of the Sky's Polarization for Orientation in the Greater Mouse-eared Bat. *Nature Communications, 5*, 4488. https://doi.org/10.1038/ncomms5488.

Griffin, D. (1945). Travels of Banded Cave Bats. *Journal of Mammalogy*, 26(1), 15-23.

Hale, J.D. Fairbrass, A.J., Matthews, T.J., Davies, G. & Sadler, J.P. (2015). The Ecological Impact of City Lighting Scenarios: Exploring Gap Crossing Thresholds for Urban Bats. *Global Change Biology*, 21, 2467-2478.

Hatch, S. K., Connelly, E. E., Divoll, T. J., & Williams, K. A. (2013). Offshore observations of eastern red bats (*Lasiurus borealis*) in the mid-Atlantic United States using multiple survey methods. *PLoS ONE* 8, 1-8. https://doi.org/10.1371/journal.pone.0083803.

Hayes, M. A. (2013). Bats Killed in Large Numbers at United States Wind Energy Facilities. *BioScience*, 975.

Horn, J. W., Arnett, E.B., & Kunz, T.H. (2008). Behavioral responses of bats to operating wind turbines. *Journal of Wildlife Management* 72(1), 123-132.

Jameson, J.W. & Willis, K.R. (2014). Activity of Tree Bats at Anthropogenic Tall Structures; Implications for Mortality of Bats at Wind Turbines. *Animal Behaviour, 97*(1), 145-152. https://doi.org/10.1016/j.anbehav.2014.09.003.

Johnson, J.B., J.E. Gates & N.P. Zegre. (2011). Monitoring seasonal bat activity on a coastal barrier island in Maryland, USA. *Environmental Monitoring and Assessment*, 173, 1-4.

Kiser, J.D., MacGregor, J.R., Bryan, H.D., & Howard, A. (2002). Use of Concrete Bridges as Nightroosts. In Kurta, A. & Kennedy, J (Eds.) *The Indiana Bat: Biology and Management of an Endangered Species.* Bat Conservation International, Austin, TX.

Kunz, T.H., Arnett, E.B., Cooper, B.M., Erickson, W.P., Larking, R.P., Mabee, T., Morrison, M.L., Strickland,M.D., & Szewczak, J.M. (2007). Assessing Impacts of Wind-energy Development on Nocturnally Active Birds and Bats: A Guidance Document. *Journal of Wildlife Management*, 71(8), 2449-2486.

Lewis, S.E. (1995). Roost Fidelity of Bats: A Review. *Journal of Mammalogy, 76*(2), 481-496.

Lindecke, O., Voigt, C.C., Pēterson, G., & Holland, R. (2015). Polarized Skylight Does Not Calibrate the Compass System of a Migratory Bat. *Biology Letters, 11*(9), 20150525. https://doi.org/10.1098/rsbl.2015.0525.

Martin, C. M., Arnett, E. B., Stevens, R. D. & Wallace, M. C. (2017). Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation. *Journal of Mammalogy*, 98, 378-385.

MassGIS and NHESP. (2018). *MassGIS Data: NHESP Priority Habitats of Rare Species*. https://docs.digital.mass.gov/dataset/massgis-data-nhesp-priority-habitats-rare-species.

MassWildlife. (2020). Bat Mortality in Massachusetts. Retrieved from: https://www.mass.gov/service-details/bat-mortality-in-massachusetts.

MassWildlife. (2019). The Small-footed Myotis, (*Myotis leibii)*. Accessed from: https://www.mass.gov/files/documents/2016/08/vm/myotis-leibii.pdf?_ga=2.230302556.1787251893.1586805414-669525899.1586505081.

MassWildlife. (2017). The Northern Long-eared Bat. *(Myotis septentrionalis)*.Accessed from: https://www.mass.gov/service-details/the-northern-long-eared-bat.

MassWildlife. (2015a). The Little Brown Bat (*Myotis lucifugus)*. Accessed from: https://www.mass.gov/files/documents/2016/08/qd/myotis-lucifugus.pdf?_ga=2.138029040.1787251893.1586805414-669525899.1586505081.

MassWildlife. (2015b). The Tricolored Bat (*Perimyotis subflavus)*. Accessed from: https://www.mass.gov/files/documents/2017/11/08/Perimyotis_subflavus_2015.pdf.

MassWildlife. (2012). The Northern Long-eared Bat (*Myotis septentrionalis)*. Accessed from:https://archives.lib.state.ma.us/bitstream/handle/2452/423153/ocn954245169.pdf?sequence=1&isAllowed=y.

Mathews, F., Roche, N., Aughney, T., Jones, N., Day, J., Baker, J., & S. Langton. (2015). Barriers and Benefits: Implications of Artificial Night-lighting for the Distribution of Common Bats in Britain and Ireland. *Philosophical Transactions of the Royal Society B, 370*(1667), 20140124.

Menzel, M.A., Owen, S.F., Ford, W.M., Edwards, J.W., Wood, P.B., Chapman, B.R. & K.V. Miller. (2002). Roost tree selection by northern long-eared bat (*Myotis septentrionalis*) maternity colonies in an industrial forest of the central Appalachian Mountains. *Forest Ecology and Management*, 155, 107-114.

Naughton, D. (2012). *The natural history of Canadian mammals*. University of Toronto Press.

NHESP. (2020). Consultation with NHESP regarding state-listed rare species. NHESP Tracking No.:19-38917.

NHESP. (2019). *Northern Long-eared Bat Locations datalayer*. Available from: https://masseoeea.maps.arcgis.com/apps/Viewer/index.html?appid=de59364ebbb348a9b0de55f6febdfd52.

Nicholls, B. & P.A. Racey. (2009). The Aversive Effect of Electromagnetic Radiation on Foraging Bats–A Possible Means of Discouraging Bats from Approaching Wind Turbines. *PLoS ONE, 4*(7), e6246. https://doi.org/10.1371/journal.pone.0006246.

Nicholls, B. & P.A. Racey. (2007). Bats Avoid Radar Installations: Could Electromagnetic Fields Deter Bats from Colliding with Wind Turbines? *PLoS ONE, 2*(3), e297. https://doi.org/10.1371/journal.pone/0000297.

Normandeau Associates, Inc. (2014). *Acoustic Monitoring of Temporal and Spatial Abundance of Birds Near Outer Continental Shelf Structures: Synthesis Report*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Herndon, VA. BOEM 2014-004. 172 pp.

Norquay K.J.O., Matinez-Nunez, F., Dubois, J. E., Monson, K. M., & Willis, C. K. R. (2013). Long-distance movements of little brown bats (*Myotis lucifugus*), 94(2), 506-515.

Pelletier, S., Peterson, T., Boyden, S., Watrous, K. & Perkins, J. (2013). *Ongoing offshore Atlantic & Great Lakes acoustic bat research*. U.S. Department of Energy Offshore Wind Webinar.https://tethys.pnnl.gov/sites/default/files/2013-04-24-Steve-Pelletier-3.pdf.

Perry, R.W. (2011). Fidelity of Bats to Forest Sites Revealed from Mist-Netting Recaptures. *Journal of Fish and Wildlife Management, 2*(1), 112-116.

Perry, R.W., & R.E. Thill. (2007) Tree roosting by male and female eastern pipistrelles in a forested landscape. *Journal of Mammalogy*, 884(4), 974-981.

Peters, K., I. Evans, E. Traiger, J. Collins, C. Mathews, & A. Klehr. (2020). *Landscape Factors Associated with Fatalities of Migratory Tree-Roosting Bats at Wind Energy Facilities: An Initial Assessment*. AWWI Technical Report. Washington, DC. Accessed online: www.awwi.org.

Peterson, T. S., Pelletier, S. K., Boyden, S. A. & Watrous, K. S. (2014). Offshore acoustic monitoring of bats in the Gulf of Maine. *Northeastern Naturalist*, 21, 86-107.

Peterson, R.L. (1970). Another Red Bat, *Lasiurus borealis*, Taken Aboard Ship Off Coast of Nova Scotia. *The Canadian Field-Naturalist*, 84, 401.

Pettit, J. L. & O'Keefe, J. M. (2017). Day of year, temperature, wind, and precipitation predict timing of bat migration. *Journal of Mammalogy*, 98(5), 1236-1248.

RIDEM. (2015). Rhode Island Wildlife Action Plan. Available online at: http://www.dem.ri.gov/programs/fish-wildlife/wildlifehuntered/swap15.php.

Rollins, K.E., Meyerholz, D.K., Johnson, G.D., Capparella, A.P., & Loew, S.S. (2012). A Forensic Investigation into the Etiology of Bat Mortality at a Wind Farm; Barotrauma or Traumatic Injury? *Veterinary Pathology, 49*(2), 362-371.

Rydell, J., Bogdanowicz, W., Boonman, A., Pettersson, S., Suchecka, E. & J.J. Pomorski. (2016). Bats may eat diurnal flies that rest on wind turbines. *Mammalian Biology 81*(3), 331–339.

Rydell, J. & A. Wickman. (2015). Bat Activity at a Small Wind Turbine in the Baltic Sea. *Acta Chiropterologica*, 17, 359-364.

Rydell, J., & P. Racey. (1995). Streetlamps and the Feeding Ecology of Insectivorous Bats. In P. Racey & S.M. Swift (Eds.) *Symposia of the Zoological Society of London*, 291-207.

Rydell, J. (1992). Exploitation of Insects Around Streetlamps by Bats in Sweden. *Functional Ecology, 6*(6), 744-750.

Sjollema, A.L., Gates, J. E., Hilderbrand, R. H. & J. Sherwell. (2014). Offshore Activity of Bats Along the Mid-Atlantic Coast. *Northeastern Naturalist*, 21, 154-163.

Smallwood, K.S. & Bell, D.A. (2020). Effects of Wind Turbine Curtailment on Bird and Bat Fatalities. *Journal of Wildlife Management*, 84(4) 686-696.

Smallwood, K.S. (2013). Comparing bird and bat fatality-rate estimates among North American wind-energy projects. *Wildlife Society Bulletin*, 37(1), 19-33.

Smith, A.D., & McWilliams, S.R. (2016). Bat activity during autumn relates to atmospheric conditions: implication for coastal wind energy development. *Journal of Mammalogy*, 97(6), 1565-1577.

Smith, A.D., & McWilliams, S.R. (2012). *Acoustic monitoring of migrating bats on Rhode Island National Wildlife Refuges Final Report*. Department of Natural Resources Science, University of Rhode Island, Kingston, RI.

Spoelstra, K., van Grunsven, R.H.A., Ramakers, J.J.C., Ferguson, K.B., Raap, T., Donners, M., Veenendaal, E.M., & Visser, M.E. (2017). Response of Bats to Light with Different Spectra: Light-shy and Agile Bat Presence is Affected by White and Green, but not Red Light. *Proceedings of the Royal Society B*, 284(1855), 20170075.

Stantec Consulting Services, Inc. (Stantec). (2018). *Avian and Bat Risk Assessment: South Fork Wind Farm and South Fork Export Cable.* Final report to Deepwater Wind South Fork, LLC.

Stantec (2016a). *Long-term Bat Monitoring on Islands, Offshore Structures, and Coastal Sites in the Gulf of Maine, mid-Atlantic, and Great Lakes*. Final report to U.S. Department of Energy. Prepared by Stantec Consulting Services, Inc.

Stantec (2016b). *Vessel-based Acoustic Bat Monitoring, Block Island Wind Farm, Rhode Island.* Final Report to Deepwater Wind, LLC.

Taylor, D.A.R. (2006). Forest management and bats. *Bat Conservation International*, 13.

Tetra Tech, Inc. (2017). *Camp Edwards Joint Base Cape Cod, Massachusetts 2016 Northern Long-eared Bat Survey*. Final report to Massachusetts Army National Guard.

Tetra Tech, Inc. (2015). *Camp Edwards Joint Base Cape Cod, Massachusetts 2015 Northern Long-eared Bat Survey*. Final report to Massachusetts Army National Guard.

Tetra Tech & Mead & Hunt (2015). *Camp Edwards Northern Long-eared Bat Planning Level Survey*. Final report to Massachusetts Army National Guard.

Tetra Tech & DeTect (2012). *Pre-construction Avian and Bat Assessment: 2009-2011, Block Island Wind Farm, Rhode Island State Waters*. Final report to Deepwater Wind.

Thompson, R.H., Thompson, A.R., & R.M. Brigham. (2015). A Flock of Myotis Bats at Sea. *Northeastern Naturalist,* 22 (4).

Tuttle, M.D. & D.A.R. Taylor. (1998). Bats and mines. *Bat Conservation International*.

USFWS. (2016). *4(d) Rule for the Northern Long-Eared Bat*. 50 CFR Part 17, Docket No. FWS–R5–ES–2011–0024; 4500030113. RIN 1018–AY98. Federal Register 81(9): 1900-1922.

USFWS. (2012). *White-nose Syndrome*. http://whitenosesyndrome.org/

Van Gelder, R.G., & Wingate, D.B. (1961). The Taxonomy and Status of Bats in Bermuda. *American Museum Novitates*, 1-9.

Voigt, C.C., Rehnig, K., Lindecke, O., & G. Pētersons. (2018). Migratory Bats are Attracted by Red Light But Not by Warm-White Light: Implications for the Protection of Nocturnal Migrants. *Ecology and Evolution, 8*(18), 9353-9361.

Voigt, C.C., Roeleke, M., Marggraf, L., Pētersons, G.,& S.L. Voigt-Heucke. (2017). Migratory Bats Respond to Artificial Green Light with Positive Phototaxis. *PLoS ONE, 12*(5), e0177748.

Western EcoSystems Technology, Inc. (WEST). (2017). *Northern Long-Eared Bat Survey Report for the Camp Edwards Training Site*. Final report to Massachusetts Army National Guard.

Zenon, C., Wong, S.N.P, & C.K.R. Willis. (2011). Observations of Eastern Red Bats (*Lasiurus borealis*) 160 kilometers from the coast of Nova Scotia. *Bat Research News*, 52(1), 28-30.

SECTION 6.3 TERRESTRIAL VEGETATION AND WILDLIFE

Balmori, A. (2010). The incidence of electromagnetic pollution on wild mammals: A new “poison” with a slow effect on nature? *Environmentalist 30*: 90–97.

Berger, R.P. (2010). *Fur, Feathers, Fins & Transmission Lines; How transmission lines and rights-of-way affect wildlife*. Manitoba Hydro. Third Edition.

Burchard, J.F., Nguyen, D.H., Richard, L., and Block, E. (1996). Biological effects of electric and magnetic fields on productivity of dairy cows. *J. Dairy Sci. 79*:1549–1554.

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. United States Department of the Interior (USDI), Office of Renewable Energy Programs. June 2020. Accessed from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

DeGraaf, R.M. & Rudis, D.D. (1983). New England Wildlife: Habitat, Natural History, and Distribution. USDA Northeastern Forest Experiment Station. General Technical Report NE-108. 491 pp.

DeGraaf, R.M. & Rudis, D.D. (1981). *Forest Habitat for Reptiles and Amphibians of the Northeast*. USDA Northeastern Forest Experiment Station. General Technical Report NE. 239 pp.

DeGraaf, R.M. & M. Yamasaki. (2001). *New England Wildlife: Habitat, Natural History, and Distribution*. University Press of New England, Hanover, New Hampshire.

eBird. (2020). An online database of bird distribution and abundance [web application]. eBird, Ithaca, New York. Available: http://www.ebird.org. Accessed August 28, 2020.

Fernie, K.J., & Reynolds, S.J. (2005). The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: a review. *Journal of Toxicology and Environmental Health*, part b, 8(2), 127-140.

Greenberg, B., Bindokas, V.P., & J.R. Gaujer. (1981). Biological effects of a 760 kV transmission line: Exposures and thresholds in honeybee colonies. *Bioelectromagnetics 2*:315.

Griffith, G.E., Omernik, J. M., Bryce, S.A., Royte, J., Hoar, W.D., Homer, J., Keirstead, D., Metzler, K.J., & Hellyer, G. (2009). *Ecoregions of New England* (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,325,000). http://ecologicalregions.info/data/vt/new_eng_front.pdf.

International Commission on Non-Ionizing Radiation Protection (ICNIRP). (2020). Guidelines for limiting exposure to Electromagnetic Fields (100 kHz to 300 kHz). *Health Physics, 118*(5), 483-524.

Jackson, S.D., R.M. Richmond, T.F. Tyning & C.W. Leahy (eds). (2010). *Massachusetts Herpetological Atlas* 1992-1998, Massachusetts Audubon Society & University of Massachusetts (massherpatlas.org).

Leonard, J.G., and R.T. Bell. (1999). Northeastern tiger beetles. *A field guide to tiger beetles of New England and Eastern Canada*. CRC Press, Boca Raton, Florida. 176 pp.

Massachusetts Army National Guard. (MARNG). (2020a). Rare Species. Within Cape Cod, the greatest number of state-listed rare species can be found at Joint Base Cape Cod. Available online: https://www.massnationalguard.org/ERC/rare_species.htm. Accessed May 27, 2020.

MARNG. (2020b). Natural Habitat. Camp Edwards has one of the few remaining stands of Pine Barrens in the Nation. Available online: https://www.massnationalguard.org/ERC/natural_habitat.htm. Accessed May 27, 2020.

MARNG. (2020c). Common Plants. A list of common plants found on Camp Edwards. Available online: https://www.massnationalguard.org/ERC/common_plants.htm. Accessed May 27, 2020.

MARNG. (2009). *Camp Edwards Training Site Integrated Natural Resources Management Plan*. Retrieved from: https://www.massnationalguard.org/ERC/publications/Natural_Cultural/CE-INRMP2009.pdf.

Mass Audubon. (2011). *Massachusetts Breeding Bird Atlas 2*. Available online: https://www.massaudubon.org/our-conservation-work/wildlife-research-conservation/statewide-bird-monitoring/breeding-bird-atlases/bba2. Accessed May 27, 2020.

MassWildlife. (2020a). NHESP Rare Species Viewer. Retrieved from: https://www.mass.gov/info-details/rare-species-viewer.

MassWildlife. (2020b). *Bald eagle numbers soar in 2020*. May 27, 2020. Retrieved from: https://www.mass.gov/news/bald-eagle-numbers-soar-in-2020.

MassWildlife. (2019). Natural Heritage & Endangered Species Program Fact Sheet. Adder's Tongue Fern (*Ophioglossum pusillum*). Retrieved from: https://www.mass.gov/doc/adders-tongue-fern/download.

MassWildlife. (2016). Northern red-bellied cooter *Pseudemys rubriventris.* Pop. 1. State Wildlife Action Plan Fact Sheet. Available online at: https://www.mass.gov/files/documents/2016/08/wj/pseudemys-rubriventris.pdf.

MassWildlife. (2015a). Natural Heritage & Endangered Species Program Fact Sheet. Eastern Box Turtle (*Terrapene carolina*). Retrieved from: https://www.mass.gov/doc/eastern-box-turtle/download.

MassWildlife. (2015b). Natural Heritage & Endangered Species Program Fact Sheet. Eastern spadefoot (*Scaphiopus holbrookii*). Retrieved from: https://www.mass.gov/doc/eastern-spadefoot/download.

MassWildlife. (2015c). Natural Heritage & Endangered Species Program Fact Sheet. Broad Tinker's-weed (*Triosteum perfoliatum*). Retrieved from: https://www.mass.gov/doc/broad-tinkers-weed/download.

MassGIS. (2019). MassGIS Data: MassGIS Data: MA DFW Coldwater Fisheries Resources (1:25, 000). [Online WWW]. September 2019. Retrieved from: %09https:/docs.digital.mass.gov/dataset/massgis-data-ma-dfw-coldwater-fisheries-resources-125-000.

Mello, M.J. (2018). *Two-year survey of Lepidoptera and other insects of conservation concern focusing on species listed in the Massachusetts Endangered Species Act at Camp Edwards, MA Army National Guard.* March 2018. Lloyd Center for the Environment.

National Audubon Society. (n.d.). Lee and Cole Rivers. Important Bird Areas. Available online at: https://www.audubon.org/important-bird-areas/lee-and-cole-rivers.

National Audubon Society. (2020a). Massachusetts Important Bird Areas (IBAs). Available online: https:/www.audubon.org/important-bird-areas/state/massachusetts. Accessed November 5, 2020.

National Audubon Society. (2020b). The Christmas Bird Count. Historical Results. 2020. Available Online: https://netapp.audubon.org/CBCObservation/. Accessed December 2020.

Native Plant Trust. (2021) Go Botany Native Plant Trust. [Online WWW]. Available URL: https://gobotany.nativeplanttrust.org/. Accessed July 8, 2021.

NHESP. (2020). Consultation with NHESP regarding state-listed rare species. Received on May 01, 2020. NHESP Tracking No.:19-38917.

Peterson, R.T. (2010). *Peterson field guide to birds of Eastern and Central North America*. Sixth Edition. Mariner Books. Boston.

Redlarski, G., Lewczuk, B., Żak, A., Koncicki, A., Krawczuk, M., Piechocki, J., & Skarbek, Ł. (2015). The influence of electromagnetic pollution on living organisms: historical trends and forecasting changes. *BioMed research international, 2015*.

Save the Bay. (2018). Narragansett Bay. Save the Bay. 2018. Birds and Marine Mammals. Available online at: https://www.savebay.org/bay_issues/water-quality/marine-life/birds-marine-mammal/)

Swain, P.C. (2020). *Classification of the Natural Communities of Massachusetts.* Massachusetts Division of Fisheries and Wildlife, Westborough, MA.

USFWS. (n.d.) Information for Planning and Consultation (IPaC) Online Database. Available online: https://ecos.fws.gov/ipac/.

USGS. (n.d.). Patuxent Wildlife Research Center. North American Breeding Bird Survey (BBS). Available online: https://www.usgs.gov/centers/eesc/science/north-american-breeding-bird-survey?qt-science_center_objects=0#qt-science_center_objects.

World Health Organization. (WHO). (2005). *Electromagnetic Fields and Public Health Effects of EMF on the Environment. International EMF Project Information Sheet*, February 2005.

SECTION 6.4 WETLANDS AND WATERBODIES

Berger, R.P. (2010). *Fur, Feathers, Fins & Transmission Lines; How transmission lines and rights-of-way affect wildlife*. Manitoba Hydro. Third Edition.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *Mayflower Wind Energy LLC (OCS-A 0521)*. United States Department of the Interior, Bureau of Ocean Energy Management. https://www.boem.gov/renewable-energy/state-activities/massachusetts/mayflower-wind-energy-llc-ocs-0521.

MassGIS. (2018). MassGIS Data: NHESP Potential Vernal Pools, Online WWW. Available URL: https://docs.digital.mass.gov/dataset/massgis-data-nhesp-potential-vernal-pools. Accessed May 20, 2020.

MassGIS. (2020). MassGIS Data: NHESP Certified Vernal Pools. https://massgis.maps.arcgis.com/home/item.html?id=dbe5591721504490ba22a2fa8644b774.

NHESP. (2016a). *Atlantic White Cedar Bog*. https://www.mass.gov/files/documents/2016/08/no/atlantic-white-cedar-bog-fs_0.pdf. Accessed May 29, 2020.

NHESP. (2016b). *Kettlehole Level Bog*. https://www.mass.gov/files/documents/2016/08/sj/kettlehole-level-bog-fs.pdf. Accessed May 29, 2020.

NHESP. (2016c). *Highbush Blueberry Thicket*. https://www.mass.gov/files/documents/2016/08/qd/highbush-blueberry-thicket-fs.pdf. Accessed May 29, 2020.

RIDEM. (2021). *Environmental Resource Map*. Accessed online: https://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=9a067e507b514a5397cd1ea041f9ba0f.

RIGIS. (2011). (URI Geographic Information Center and Rhode Island Geographic Information System). May 2021. RIGIS Data:Land Use and Land Cover (2011). https://www.rigis.org/datasets/edc::land-use-and-land-cover-2011/about . Last Updated May 2021. Accessed July 1, 2021.

Swain, P.C. (2020). *Classification of the Natural Communities of Massachusetts*. Massachusetts Division of Fisheries and Wildlife, Westborough, MA.

USGS. (1972). Falmouth, MA. 7.5 minute USGS Topographic Map Series.

SECTION 6.5 COASTAL HABITATS

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*. Version 4.0: May 27, 2020. United States Department of the Interior. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant* to 30 CFR Part 585. United States Department of the Interior, Bureau of Ocean Energy Management Office of Renewable Energy Programs, June 2019.

Costello, C.T., & W.J. Kenworthy. (2011). Twelve-Year Mapping and Change Analysis of Eelgrass (*Zostera marina)* Areal Abundance in Massachusetts (USA) Identifies Statewide Declines. Estuaries and Coasts. 34: 232-242. https://www.mass.gov/doc/twelve-year-mapping-change-analysis-of-eelgrass-zostera-marina-areal-abundance-in-massachusetts/download.

CR Environmental, Inc. (CR). (2020). *Eelgrass Survey Report. Proposed Mayflower Wind Landing Sites*. Vineyard Sound, Falmouth, MA.

Cucurachi, S., Tamis, W.L.M. Vijver, M.G., Peijnenburg, Bolte, J.F.B. (2013). A review of the ecological effects of radio frequency electromagnetic fields (RF-EMF). *Environmental International,* 51(2013), 116-140.

ESS Group, Inc. (2006). *Submerged Aquatic Vegetation Investigation, Cape Wind Energy Project, Nantucket Sound, Massachusetts.* 24 August 2006.

Macreadie, P.I., Jarvis, J., Trevathan-Tackett, S.M., & A. Bellgrove. (2017). Seagrasses and macroalgae: Importance, vulnerability and impacts. *Climate Change Impacts on Fisheries and Aquaculture: A Global Analysis (Wiley-Blackwell)*, 729-770.

MassDEP. (2020). *Eelgrass Mapping Project*. Available online at: https://docs.digital.mass.gov/dataset/massgis-data-massdep-eelgrass-mapping-project. Accessed on: September 4, 2020.

NMFS. (2020). *Recommendations for Mapping Fish Habitat*. National Oceanic and Atmospheric Administration, National Marine Fisheries Service GARFO Habitat Conservation and Ecosystem Services Division, January 2020.

Raven, J.A. & Hurd, C.L. (2012). Ecophysiology of photosynthesis in macroalgae. *Photosynthesis Research*, 113: 105–125.

Rhode Island Geographic Information System. (RIGIS). (2016). 2016 Rhode Island Eelgrass Mapping Taskforce Orthophotography. https://www.rigis.org/pages/2016-eelgrass-imagery. Last accessed June 30, 2021.

Vian, Alain; Davies E., Gendraud, M. & Bonnet, P. (2016). Plant Responses to High Frequency Electromagnetic Fields. *Biomed Research International*, 2016(2):1-13.

Zimmerman, R.C. (2006). Light and photosynthesis in seagrass meadows. In: A.W.D. Larkum, Orth, R.J. & Duarte, C.M. (Eds) *Seagrasses: Biology, Ecology and Conservation*. Dordrecht, The Netherlands: Springer.

SECTION 6.6 BENTHIC AND SHELLFISH RESOURCES

Abraham, B.J., & Dillon, P.L. (1986). Species Profiles: life histories and environmental requirements of coastal fisheries and invertebrates (mid-Atlantic—softshell clam. *U.S. Fish and Wildlife Service Biological Report* 82, 19 pp.

Ackerman, S.D., Pappal, A.L., Huntley, E.C., Blackwood, D.S., & Schwab, W.C. (2015). Geological Sampling Data and Benthic Biota Classification—Buzzards Bay and Vineyard Sound, Massachusetts: U.S. Geological Survey Open-File Report 2014–1221, 30 pp. http://dx.doi.org/10.3133/ofr20141221.

AECOM. (2020). *Benthic Infaunal and Seafloor Habitat Study Quality Assurance Project Plan*. May 1, 2020 and subsequent revisions.

AECOM. (2012). ENV12 CZM 01 Benthic Infaunal Analysis Report. Final. 223 pp. https://www.mass.gov/files/documents/2016/08/pm/benthic-infauna-report-2011.pdf.

Anderson, W. D. (2005). Knobbed whelk. *South Carolina State Documents Depository*. Available online: https://dc.statelibrary.sc.gov/bitstream/handle/10827/10946/DNR_Species_Knobbed_Whelk_2005.pdf?sequence=1&isAllowed=y.

Anderson, M. G., J. Greene, D. Morse, D. Shumway, and M. Clark. (2010). Benthic Habitats of the Northwest Atlantic in Greene, J.K., M.G. Anderson, J. Odell, and N. Steinberg, eds. *The Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems. Phase One.* The Nature Conservancy, Eastern U.S. Division, Boston, MA. http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/Documents/Chapter-3-Benthic-Habitatas-20100329.pdf.

André, M., Solé, M., Lenoir, M., Durfort, M., Quero, C., Mas, A., Lombarte, A., van der Schaar, M., López-Bejar, M., Morell, M., Zaugg, S. & Houégnigan. (2011). Low-frequency sounds induce acoustic trauma in cephalopods. *Front Ecol Environ*, 9(9): 489–493. Doi:10.1890/100124.

Atlantic States Marine Fisheries Commission. (2018). *Jonah Crab Habitat Factsheet*. Available online: http://www.asmfc.org/uploads/file/5dfd4c3cJonahCrab.pdf.

Boles, L.C., & Lohmann, K.J. (2003). True navigation and magnetic maps in spiny lobsters. *Nature*, 421(6918), 60-63. Available online: https://www.nature.com/articles/nature01226.

Botton, M.L., Loveland, R.E. & Jacobsen, T.R. (1988). Beach erosion and geochemical factors: influence on spawning success of horseshoe crabs (*Limulus polyphemus*) in Delaware Bay. *Marine Biology*, 99, 325-332.

Brand, A.R. (2016). Scallop ecology: distributions and behaviour. In *Developments in Aquaculture and Fisheries Science*, 40, 469-533. Available online: https://doi.org/10.1016/B978-0-444-62710-0.00011-0.

Bricelj, V.M. (1993). Aspects of the biology of the northern quahog, (*Mercenaria mercenaria)*, with emphasis on growth and survival during early life history. In *Proceedings of the Second Rhode Island Shellfish Industry Conference. Rhode Island Sea Grant, Univ. of Rhode Island, Narragansett.* 29-48. https://nsgl.gso.uri.edu/riu/riuw92002/riuw92002_pt-7,8.pdf.

Bureau of Offshore Energy Management (BOEM.) (2021). *South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement*. United States Department of the Interior, Bureau of Ocean Energy Management Office of Renewable Energy Programs. OCS EIS/EA BOEM 2020-057. https://www.boem.gov/sites/default/files/documents/renewable-energy/SFWF-DEIS_0.pdf.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*, Version 4.0. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019a). *Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.* United States Department of the Interior, Bureau of Ocean Energy Management Office of Renewable Energy Programs. https://www.boem.gov/sites/default/files/renewable-energy-program/Regulatory-Information/BOEM-Renewable-Benthic-Habitat-Guidelines.pdf.

BOEM. (2019b). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study 2019- 036. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/IPFs-in-the-Offshore-Wind-Cumulative-Impacts-Scenario-on-the-N-OCS.pdf.

BOEM. (2014). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts Revised Environmental Assessment*. OCS EIS/EA BOEM 2013-1131. U.S. Department of the Interior Bureau of Ocean Energy Management Office of Renewable Energy Programs. https://www.boem.gov/sites/default/files/uploadedFiles/BOEM/Renewable_Energy_Program/State_Activities/BOEM%20RI_MA_Revised%20EA_22May2013.pdf.

BOEM. (2013). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts Revised Environmental Assessment*. OCS EIS/EA BOEM 2013-1131. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs.

Brooks, R., Purdy, C., Bell, S., and Sulak, K. (2006). The benthic community of the eastern U.S. continental shelf: A literature synopsis of benthic faunal resources. *Continental Shelf Research* 26:804-818. https://doi.org/10.1016/j.csr.2006.02.005.

Cargnelli, L.M. (1999a). *Essential fish habitat source document. Atlantic surfclam, Spisula solidissima, life history and habitat characteristics*. NOAA Technical Memorandum NMFS-NE-142. https://repository.library.noaa.gov/view/noaa/3144.

Cargnelli, L.M. (1999b). *Essential fish habitat source document. Ocean quahog, Arctica islandica, life history and habitat characteristics*. NOAA Technical Memorandum NMFS-NE-142. https://repository.library.noaa.gov/view/noaa/3153.

Collie, J.S. & King, J.W. (2016). *Spatial and Temporal Distributions of Lobsters and Crabs in the Rhode Island Massachusetts Wind Energy Area*. OCS Study BOEM 2016-073. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/BOEM-final-report-formatted_12072016.pdf.

Coolen, J.W., Van Der Weide, B., Cuperus, J., Blomberg, M., Van Moorsel, G.W., Faasse, M.A., & Lindeboom, H.J. (2020). Benthic biodiversity on old platforms, young wind farms, and rocky reefs. *ICES Journal of Marine Science*, 77(3) 1250-1265. https://doi.org/10.1093/icesjms/fsy092.

Coquereau, L., Grall, J., Chauvaud, L., Gervaise, C., Clavier, J., Jolivet, A. & Di Iorio, L. (2016). Sound production and associated behaviours of benthic invertebrates from a coastal habitat in the north-east Atlantic. *Marine Biology*, 163. DOI:10.1007/s00227-016-2902-2.

Rhode Island Coastal Resources Management Council (CRMC). (2010). *Rhode Island Ocean Special Area Management Plan: Ocean SAMP – Volumes 1 and 2.* Report by Rhode Island Coastal Resources Management Council. https://seagrant.gso.uri.edu/oceansamp/documents.html.

CSA Ocean Sciences, Inc. (2019). Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England. Report to U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM). OCS Study BOEM 2019-049. 62pp. https://espis.boem.gov/final%20reports/BOEM_2019-049.pdf.

Dannheim, J., Bergström, L., Birchenough, S.N.R., Brzana, R., Boon, A.R., Coolen, J.W.P., Dauvin, J., De Mesel, I., Derweduwen, J., … & Norkko., J. (Ed.). (2019). Benthic effects of offshore renewables: identification of knowledge gaps and urgently needed research. *ICES Journal of Marine Science*, 77(3), 1092-1108. https://doi.org/10.1093/icesjms/fsz018.

Department of Business, Enterprise and Regulatory Reform. (2008). *Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry*. Technical Report from BERR to the Department of Enterprise & Regulatory Reforms (BERR) in association with DEFRA. Retrieved October 2020 from: http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file43527.pdf.

Dernie, K.M., Kaiser, M.J., & Warwick, R.M. (2003). Recovery rates of benthic communities following physical disturbance, *Journal of Annual Ecology*, 72, 1043-1056. https://doi.org/10.1046/j.1365-2656.2003.00775.x.

Dorgan, K. M., Ballentine, W., Lockridge, G., Kiskaddon, E., Ballard, M.S., Lee, K.M. & Wilson, P.S. (2020). Impacts of simulated infaunal activities on acoustic wave propagation in marine sediments. *The Journal of the Acoustical Society of America*, 147(2), 812-823. DOI:10.1121/10.0000558.

Edmonds, N. J., Firmin, C. J., Goldsmith, D., Faulkner, R. C. & Wood, D. T. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin*, 108(1-2), 5-11. https://doi.org/10.1016/j.marpolbul.2016.05.006.

English, P.A., Mason, T.I., Backstrom, J.T., Tibbles, B.J., Mackay, A.A. Smith, M. J. & T. Mitchell. (2017). *Improving Efficiencies of National Environmental Policy Act Documentation for Offshore Wind Facilities Case Studies Report. U.S. Department of the Interior, Bureau of Ocean Energy*

Management, Office of Renewable Energy Programs; OCS Study – BOEM 2017-026. March. Prepared by Fugro Marine GeoServices, Inc. and Fugro GB Marine Ltd., under BOEM Contract M16PC00007. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/Improving-Efficiencies-of-National-Environmental.pdf.

Epsilon Associates, Inc. (2020). *Vineyard Wind Draft Construction and Operations Plan*, Volume III. March 15, 2018. Updated June 3, 2020. https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-construction-and-operations-plan-volume-iii.

Federal Geographic Data Committee (FGDC). (2012). Coastal and Marine Ecological Classification Standard. Retrieved September 2020 from: https://www.fgdc.gov/standards/projects/cmecs-folder/CMECS_Version_06-2012_FINAL.pdf.

Gates, A.R. & Jones, D.O. (2012). Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380 m depth in the Norwegian Sea). *PloS One*, 7(10). https://doi.org/10.1371/journal.pone.0044114.

Gendron, L., Fradette, P., & Godbout, G. (2001). The importance of rock crab (*Cancer irroratus*) for growth, condition and ovary development of adult American lobster (*Homarus americanus*). *Journal of Experimental Marine Biology and Ecology*, 262, 221-241. https://doi.org/10.1016/S0022-0981(01)00297-0.

Gill, A.B., Gloyne-Phillips, I., Neal, K.J., & Kimber J.A. (2005). *The potential effects of electromagnetic fields generated by sub-sea power cables associated with offshore wind farm developments on electrically and magnetically sensitive marine organisms – a review*. Collaborative Offshore Wind Research into the Environment (COWRIE), Ltd, UK. 128 pp. https://tethys.pnnl.gov/sites/default/files/publications/The_Potential_Effects_of_Electromagnetic_Fields_Generated_by_Sub_Sea_Power_Cables.pdf.

Glarou, M., Zrust, M., & Svendsen, J.C. (2020). Using Artificial-Reef Knowledge to Enhance the Ecological Function of Offshore Wind Turbine Foundations: Implications for Fish Abundance and Diversity. *Journal of Marine Science*, 8(332), 25 p. DOI:10.3390/jmse8050332.

Grabowski, J.H., Bachman, M., Demarest, C., Eayrs, S., Harris, B.P., Malkoski, V., Packer, D., and Stevenson, D. (2014). Assessing the vulnerability of marine benthos to fishing gear impacts. *Reviews in Fisheries Science & Aquaculture* 22(2):142–155. https://doi.org/10.1080/10641262.2013.846292.

Gray, J. S., & Elliott, M. (2009). *Ecology of marine sediments: from science to management*. Oxford University Press.

Guarinello, M., Carey, D. & Read, L.B. (2017). Year 1 Report for 2016 Summer Post-Construction Surveys to Characterize Potential Impacts and Response of Hard Bottom Habitats to Anchor Placement at the Block Island Wind Farm (BIWF). INSPIRE Environmental prepared for Deepwater Wind Block Island LLC. May.

Guarinello, M. L. and D. A. Carey. (2020). Multi-modal Approach for Benthic Impact Assessments in Moraine Habitats: a Case Study at the Block Island Wind Farm. *Estuaries and Coasts*: 16.

Guida, V., A. Drohan, H. Welch, J. McHenry, D. Johnson, V. Kentner, J. Brink, D. Timmons & E. Estela-Gomez. (2017). Habitat Mapping and Assessment of Northeast Wind Energy Areas. Sterling, VA: U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2017-088. 312 p. https://espis.boem.gov/final%20reports/5647.pdf.

Hart, D.R. (2004). Essential fish habitat source document. Sea scallop, *Placopecten magellanicus*, life history and habitat characteristics. NOAA Technical Memorandum NE-189. https://repository.library.noaa.gov/view/noaa/4031.

Hemery, Lenaig G. (2020). *2020 State of the Science Report, Chapter 6: Changes in Benthic and Pelagic Habitats Caused by Marine Renewable Energy Devices*. United States. https://doi.org/10.2172/1633182.

Hewitt, J., Thrush, S., Lohrer, A., and Townsend, M. (2010). A latent threat to biodiversity: consequences of small-scale heterogeneity loss. *Biodivers. Conserv.* 19, 1315–1323. DOI:10.1007/s10531-009-9763-7.

HDR. (2019). *Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Year 2*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-019. 318 pp. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/BOEM-2018-047.pdf.

HDR. (2020a). *Benthic and Epifaunal Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Project Report.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-044. 380 pp. https://espis.boem.gov/final%20reports/BOEM_2020-044A.pdf.

HDR. (2020b). *Seafloor Disturbance and Recovery Monitoring at the Block Island Wind Farm, Rhode Island – Summary Report*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-019. 317 pp. https://espis.boem.gov/final%20reports/BOEM_2020-019.pdf.

HDR. (2019). *Benthic Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Year 2.* Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-019. 318 pp. https://espis.boem.gov/final%20reports/BOEM_2019-019.pdf.

Hemery, L.G., Politano, K.K., & Henkel, S.K. (2017). Assessing differences in macrofaunal assemblages as a factor of sieve mesh size, distance between samples, and time of sampling. Environmental Monitoring and Assessment, 189(8), 18. doi:10.1007/s10661-017-6127-8.

Hiddink, J.G., Jennings, S., Sciberras, M., Szostek, C. L., Hughes, K.M., Ellis, N., Rijnsdorp, A.D., McConnaughey, R.A., Mazor, T., Hilborn, R., Collie, J.S., Pitcher, C.R., Amoroso, R.O., Parma, A.M., Suuronen, P., Kaiser, M.J. (2017). Effects of bottom trawling on seabed biota. *Proceedings of the National Academy of Sciences*, 114(31): 8301-8306. https://doi.org/10.1073/pnas.1618858114.

Hutchison, Z., Sigray, P., He, H., Gill, A.B., King, J., & Gibson, C. (2018). *Electromagnetic Field (EMF) impacts on elasmobranch (shark, rays, and skates) and American lobster movement and migration from direct current cables*. OCS Study BOEM 2018-003. https://espis.boem.gov/final%20reports/5659.pdf.

Hutchison, Z.L., Bartley, M.L., King, J.W., English, P., Grace, S., & Khan, A. (2020a). *Benthic habitat and epifaunal monitoring at the Block Island Wind Farm*. Report presented at the New York State Environmental Technical Working Group 2020 State of the Science Workshop.

Hutchison, Z.L., Bartley, M.L., Degraer, S., English, P., Khan, A., Livermore, J., Rumes, B.,& J. King. (2020b). Offshore Wind Energy and Benthic Habitat Changes: Lessons from Block Island Wind Farm. *Special Issue on Understanding the Effects of Offshore Wind Energy Development on Fisheries*. Retrieved January 2021 from: https://tethys.pnnl.gov/sites/default/files/publications/Hutchison-et-al-2020-Block-Island.pdf.

Hutchison, Zoe L., Secor, D.H., Gill, A.B. (2020c). *The Interaction Between Resource Species and Electromagnetic Fields Associated with Electricity Production by Offshore Wind Farms*. https://research-repository.st-andrews.ac.uk/handle/10023/21420.

ICF Incorporated, L.L.C. (2020). *Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2020-041. 42 pp. https://www.boem.gov/sites/default/files/documents/environment/Wind-Turbine-Foundations-White%20Paper-Final-White-Paper.pdf.

Integral Consulting, Inc. (2020a). *Sediment Profile and Plan View Imaging Survey of the Mayflower Wind Project Areas - May 12-25, 2020*. Prepared for Fugro and Mayflower Wind Energy, LLC.

Integral Consulting, Inc. (2020b). *Sediment Profile and Plan View Imaging Survey of the Mayflower Wind Offshore Project Areas - August 22-September 1, 2020*. Prepared for Fugro and Mayflower Wind Energy, LLC.

Jacobson, L.D. (2005). *Essential fish habitat source document. Longfin inshore squid, Loligo pealeii, life history and habitat characteristics*. NOAA Technical Memorandum NMFS-NE-193. https://repository.library.noaa.gov/view/noaa/4035.

Janus, U., Burska, D., Kendzierska, H., Pryputniewicz-Flis, D. & Łukawska-Matuszewska, K. (2019). Importance of benthic macrofauna and coastal biotopes for ecosystem functioning – Oxygen and nutrient fluxes in the coastal zone. *Estuarine, Coastal and Shelf Science*, 225. https://doi.org/10.1016/j.ecss.2019.05.020.

Joschko, T., Buck, B., Gutow, L., Der, A. (2008). Colonization of an artificial hard substrate by *Mytilus edulis* in the German Bight. *Marine Biology Research,* 4. https://www.tandfonline.com/doi/abs/10.1080/17451000801947043.

King, J.R., Camisa, M.J., & Manfredi, V.M. (2010). *Massachusetts Division of Marine Fisheries trawl survey effort. Lists of species recorded, and bottom temperature trends*, 1978-2007. Massachusetts Division of Marine Fisheries. https://archives.lib.state.ma.us/handle/2452/431304.

Kramer, S., Hamilton, C., Spencer, G., & H. Ogston. (2015). *Evaluating the Potential for Marine and Hydrokinetic Devices to Act as Artificial Reefs or Fish Aggregating Devices, Based on Analysis of Surrogates in Tropical, Subtropical, and Temperate U.S. West Coast and Hawaiian Coastal Waters*. Report by H. T. Harvey & Associates for U.S. Department of Energy Efficiency and Renewable Energy, Golden, CO. https://tethys.pnnl.gov/sites/default/files/publications/Kramer-et-al-2015.pdf.

Kraus, C., & L. Carter. (2018). Seabed recovery following protective burial of subsea cables–Observations from the continental margin. *Ocean Engineering* 157:251-261. https://doi.org/10.1016/j.oceaneng.2018.03.037.

Langhamer, Olivia. (2012). Artificial reef effect in relation to offshore renewable energy conversion: State of the Art. *The Scientific World Journal*, 2012(1): 386713. https://doi.org/10.1100/2012/386713.

Leavitt, D. (2011). *Biology of the Atlantic Jacknife (Razor) Clam (Ensis directus Conrad, 1843*). Northeast Regional Aquaculture Center, University of Maryland. http://fisheries.tamu.edu/files/2013/09/NRAC-Publication-No.-217-2010-%E2%80%93-Biology-of-the-Atlantic-Jacknife-Razor-Clam-Ensis-directus-Conrad-1843.pdf.

Lohmann, K.J., & D.A. Ernst. (2014). The geomagnetic sense of crustaceans and its use in orientation and navigation. *Crustacean Nervous Systems and Control of Behavior*, 321-336. https://www.researchgate.net/profile/Kenneth-Lohmann/publication/280533822_The_geomagnetic_sense_of_crustaceans_and_its_use_in_orientation_and_navigation/links/56f2d7e408ae95e8b6cb454d/The-geomagnetic-sense-of-crustaceans-and-its-use-in-orientation-and-navigation.pdf.

Love, M.S., M.M. Nishimoto, L. Snook, D.M. Schroeder & A.S Bull. (2017). A Comparison of Fishes and Invertebrates Living in the Vicinity of Energized and Unenergized Submarine Power Cables and Natural Sea Floor off Southern California, USA. *Journal of Renewable Energy,* 2017, Article ID 8727164. 13 pages. https://doi.org/10.1155/2017/8727164.

MacKenzie, C. L. (2008). The Bay Scallop, *Argopecten irradians*, Massachusetts Through North Carolina: Its Biology and the History of Its Habitats and Fisheries. *Marine Fisheries Review*, 70(3-4): 5-79. https://spo.nmfs.noaa.gov/content/bay-scallop-argopecten-irradians-massachusetts-through-north-carolina-its-biology-and.

Macy, W.K. & J. Brodziak. (2001). Seasonal maturity and size at age of *Loligo pealeii* in waters of southern New England. *ICES Journal of Marine Science*, 58, 852-864. https://doi.org/10.1006/jmsc.2001.1076.

Magalhaes, H. (1948). An ecological study of the genus *Busycon* at Beaufort, North Carolina. *Ecological Monographs*, 18(3),377-409. https://doi.org/10.2307/1948577.

Malek, A.J., J.S. Collie, and J. Gartland. (2014). Fine-scale spatial patterns in the demersal fish and invertebrate community in a northwest Atlantic ecosystem. *Estuarine and Coastal Shelf Science* 147:1-10. https://doi.org/10.1016/j.ecss.2014.05.028.

Marinelli, R. L., & S.A. Woodin. (2004). Disturbance and recruitment: a test of solute and substrate specificity using *Mercenaria mercenaria and Capitella sp. 1. Marine Ecology Progress Series*, 269: 209-221. https://doi.org/10.3354/meps269209.

Massachusetts Division of Marine Fisheries. (MA DMF). (2020). *Shellfish suitability area figure layer*. https://www.mass.gov/info-details/massgis-data-shellfish-suitability-areas.

Massachusetts Office of Coastal Zone Management. (MA CZM). (2020). *Guide to Marine Invaders in R.I. Coastal Waters.* http://www.crmc.ri.gov/invasives/invasives_refcards/O_edulis.pdf.

MA CZM. (2015). *2015 Massachusetts Ocean Management Plan. Volume 1: Management and Administration.* Report by Massachusetts Office of Coastal Zone Management for the Executive Office of Environmental Affairs. https://www.mass.gov/files/documents/2016/08/ua/2015-ocean-plan-v1-complete-low-res.pdf.

Maurer, D. & R.L. Wigley. (1984). Biomass and Density of Macrobenthic Invertebrates on the U.S. Continental Shelf off Martha's Vineyard, Mass., in Relation to Environmental Factors. NOAA Technical Report NMFS SSRF-783. 26 pp. https://spo.nmfs.noaa.gov/content/biomass-and-density-macrobenthic-invertebrates-u-s-continental-shelf-marthas-vineyard-mass.

Mayflower Wind, LLC. (2020). *WTG Substructures PDE Inputs*. Report MW01-FOU-COP-ENG-0001.

Morton, B., (2011). The biology and functional morphology of *Arctica islandica* (*Bivalvia: Arcticidae*)-A gerontophilic living fossil. *Marine Biology Research*, 7(6), 540-553. https://doi.org/10.1080/17451000.2010.535833.

Narragansett Bay Estuary Program. (NBEP). (2017). *The State of Narragansett Bay and Its Watershed: Technical Report*. https://web.uri.edu/gso/news/2017-state-of-narragansett-bay-and-its-watershed-summary-report/.

National Oceanic and Atmospheric Administration. (NOAA). (2017). *National Database for Deep-Sea Corals and Sponges* (version 20200710-2). NOAA Deep Sea Coral Research & Technology Program. Retrieved September 2020 from: https://deepseacoraldata.noaa.gov/.

National Oceanic and Atmospheric Administration's National Marine Fisheries Service. (NOAA Fisheries). (2020). Recommendations for Mapping Fish Habitat. National Oceanic and Atmospheric Administration, National Marine Fisheries Service GARFO Habitat Conservation and Ecosystem Services Division, January 2020.

NOAA Fisheries. (2021a). Updated Recommendations for Mapping Fish Habitat. Greater Atlantic Regional Field Office. March. https://media.fisheries.noaa.gov/2021-03/March292021_NMFS_Habitat_Mapping_Recommendations.pdf?null

NOAA Fisheries. (2021b). Oyster Reef Habitat. Retrieved August 2021 from: https://www.fisheries.noaa.gov/national/habitat-conservation/oyster-reef-habitat.

Normandeau (Normandeau Associates, Inc.). (2014). Understanding the Habitat Value and Function of Shoal/Ridge/Trough Complexes to Fish and Fisheries on the Atlantic and Gulf of Mexico Outer Continental Shelf: Draft Literature Synthesis pursuant to BOEM Contract No. M12PS00031. https://www.boem.gov/sites/default/files/non-energy-minerals/Final-Draft-Report.pdf.

NOAA National Geophysical Data Center. (2008). Nantucket, Massachusetts 1/3 arc-second MHW Coastal Digital Elevation Model. NOAA National Centers for Environmental Information. https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ngdc.mgg.dem:385.

NOAA National Geophysical Data Center. (1999). U.S. Coastal Relief Model Vol.1- Northeast Atlantic. NOAA National Centers for Environmental Information. https://doi.org/10.7289/V5MS3QNZ.

National Wildlife Federation. (NWF). (2021). National Wildlife Federation Species Description Page, Horseshoe Crab. https://www.nwf.org/Educational-Resources/Wildlife-Guide/Invertebrates/Horseshoe-Crab.

Nelson, G.A., Wilcox, S. H., Glenn, R. P., & T.L. Pugh. (2018). *A Stock Assessment of Channeled Whelk (Busycotypus Canaliculatus) in Nantucket Sound, Massachusetts*. Massachusetts Division of Marine Fisheries. https://www.mass.gov/doc/marine-fisheries-technical-report-66/download.

Newell, R. I. (1989). Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North and Mid-Atlantic): Blue mussel. TR EL-82-4. U.S. Army Corps of Engineers. https://apps.dtic.mil/sti/citations/ADA212654.

Norden, W. (2012). Monterey Bay Aquarium Seafood Watch–Sea Scallop (*Placopecten magellanicus*). U.S. Atlantic Region Dredge, June 9, 2012.

Normandeau Associates, Inc., T. Tricas & A. Gill (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEM RE 2011-09. https://espis.boem.gov/final%20reports/5115.pdf.

Normandeau Associates, Inc. (2012). *Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities*. A Workshop Report for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 72 pp. plus Appendices. https://www.cbd.int/doc/meetings/mar/mcbem-2014-01/other/mcbem-2014-01-submission-boem-04-en.pdf.

NEFSC. (2020a). *Ecology of the Northeast U.S. Continental Shelf.* https://www.nefsc.noaa.gov/ecosys/ecosystem-ecology/physical.html.

NEFSC. (2020b). *Spring Bottom Trawl Survey*. https://www.fisheries.noaa.gov/inport/item/22561.

NEFSC. (2005). *Essential Fish Habitat Source Document: Longfin Inshore Squid, Loligo pealeii, Life History and Habitat Characteristics*. NOAA Technical Memorandum NMFS-NE-193. https://repository.library.noaa.gov/view/noaa/4035.

Ptatscheck, C., S. Gehner, & W. Traunspurger. (2020). Should we redefine meiofaunal organisms? The impact of mesh size on collection of meiofauna with special regard to nematodes. *Aquatic Ecology,* 54(4), 1135-1143. doi:10.1007/s10452-020-09798-2.

Rastelli, E., B. Petani, C. Corinaldesi, et al. (2020). A high biodiversity mitigates the impact of ocean acidification on hard-bottom ecosystems. *Sci Rep* 10, 2948. https://doi.org/10.1038/s41598-020-59886-4.

Roberts, L., Harding, H. R., Voellmy, I., Bruintjes, R., Simpson, S. D., Radford, A. N., Elliott, M. (2016). Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving. *Proceedings of Meetings on Acoustics: Fourth International Conference on the Effects of Noise on Aquatic Life, 27*, 1-10.

Schlacher, T. A., & Wooldridge, T. H. (1996). How sieve mesh size affects sample estimates of estuarine benthic macrofauna. *Journal of Experimental Marine Biology and Ecology*, 201(1), 159-171. https://doi.org/10.1016/0022-0981(95)00198-0.

Schweitzer, C. C. and B. G. Stevens. (2019). The relationship between fish abundance and benthic community structure on artificial reefs in the Mid-Atlantic Bight, and the importance of sea whip corals Leptogorgia virgulata."*Peerj* 7: 20.

Schwemmer, P., Adler, S., Enners, L., Volmer, H., Kottsieper, J., Ricklefs, K. Stage, M., Schwarzer, K., Wittbrodt, K., …& Garthe, S. (2019). Modelling and predicting habitats for the neobiotic American razor clam *Ensis leei* in the Wadden Sea, *Estuarine, Coastal and Shelf Science*, 231. https://doi.org/10.1016/j.ecss.2019.106440.

Scott, K., Harsanyi, P. & Lyndon, A. R. (2019). *Understanding the effects of electromagnetic field emissions from Marine Renewable Energy Devices (MREDs) on the commercially important edible crab*, *Cancer pagurus (L*.). Front. Mar. Sci. Conference Abstract: IMMR'18 | International Meeting on Marine Research 2018. https://doi.org/10.3389/conf.FMARS.2018.06.00105.

Shumchenia, E. J., M. L. Guarinello and J. W. King. (2016). A Re-assessment of Narragansett Bay Benthic Habitat Quality Between 1988 and 2008. *Estuaries and Coasts* 39(5): 1463-1477.

Shuster, C.N., Jr. (1982). A pictorial review of the natural history and ecology of the horseshoe crab *Limulus polyphemus*, with reference to other *Limulidae*, In *Physiology and biology of horseshoe crabs: studies on normal and environmentally stressed animals*, Alan R. Liss, Inc., NY: 1-52.

Shuster, C.N., Jr. (1990). The American horseshoe crab, *Limulus polyphemus*. In R.B. Prior, (ed.), *Clinical applications of the Limulus amoebocyte lysate test*. CRC Press, Boston, MA: 15-25.

Smit, M., Holthaus, K., Trannum, H., Neff, J., Kjeilen-Eilertsen, G., Jak, R., Singsaas, I., Huijbregts, M. & Hendriks, J. (2008). Species Sensitivity Distributions for Suspended Clays, Sediment Burial and Grain Size Change in the Marine Environment. *Environmental toxicology and chemistry* 27(4): 1006-12. https://doi.org/10.1897/07-339.1.

South Fork Wind Farm. (SFWF). (2018). *South Fork Wind Farm Construction and Operations Plan.* 677 pp. https://www.boem.gov/sites/default/files/documents/renewable-energy/South-Fork-Construction-Operations-Plan.pdf.

Spiga, I., Caldwell, G. & R. Bruintjes. (2016). *Influence of Pile Driving on the Clearance Rate of the Blue Mussel*, *Mytilus edulis* (L.). Proceedings of Meetings on Acoustics. 27. 040005. https://doi.org/10.1121/2.0000277.

Stokesbury, K.D.E. (2014). *Final Report: SMAST video survey of Western portion of the offshore Windfarm area.* School for Marine Science and Technology, University of Massachusetts. Dartmouth.

Stokesbury, K.D.E. (2012). *Final Report: SMAST video survey of Western portion of the offshore Windfarm area*. School for Marine Science and Technology, University of Massachusetts Dartmouth.

Taylor, R. B. (2019). Epiflora and Epifauna. In: Fath, B.(eds). *Encyclopedia of Ecology (Second Edition),* 375-380. https://doi.org/10.1016/B978-0-12-409548-9.10922-4.

Theroux, R.B. & R.L. Wigley. (1998). *Quantitative Composition and Distribution of the Macrobenthic Invertebrate Fauna of the Continental Shelf Ecosystems of the Northeastern United States*. NOAA Technical Report NMFS 140. 246 pp. https://spo.nmfs.noaa.gov/sites/default/files/legacy-pdfs/tr140.pdf.

Topçu, N., Turgay, E., Yardımcı, R., Topaloğlu, B., Yüksek, A., Steinum, T., B. Öztürk. (2019). Impact of excessive sedimentation caused by anthropogenic activities on benthic suspension feeders in the Sea of Marmara. *Journal of the Marine Biological Association of the United Kingdom*, 99(5): 1075-1086. https://doi.org/10.1017/S0025315418001066.

U.S. Geological Survey. (2005). U.S. Geological Survey East-Coast Sediment Texture Database. http://woodshole.er.usgs.gov/project-pages/sediment/.

Vineyard Wind. (2020). *Vineyard Wind Draft Construction and Operations Plan Volume 1* Vineyard Wind *Project*. 345 pp. https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-construction-and-operations-plan-cop-volume-i.

Volety, A. K., V.G. Encomio, & F. Myers. (2006). *Biological effects of suspended sediments on shellfish in the Charlotte Harbor Watershed–implications for water releases and dredging activities*. Final Report Submitted to Charlotte Harbor National Estuary Program. http://chnep.wateratlas.usf.edu/upload/documents/SedimentsShellfishCaloosa_FGCU.pdf.

Wehkamp, S., & P. Fischer. (2013). Impact of coastal defense structures (tetrapods) on a demersal hard-bottom fish community in the southern North Sea. Marine Environmental Research, 83, 82-92. https://doi.org/10.1016/j.marenvres.2012.10.013.

Wigley, R. L., Theroux, R. B. and Murray, H. E. (1975). Deep-Sea red crab, Geryon quinquedens, survey off northeastern United States. Marine Fisheries Review, 37,1-21. https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/MFR/mfr378/mfr3781.pdf.

SECTION 6.7 FINFISH AND INVERTEBRATES

Anasco, N.C., J. Koyoma, S. Imai, and K. Nakamura. (2008). Toxicity of Residual Chlorines from Hypochlorite-treated Seawater to Marine Amphipod *Hyale barbicornis* and Estuarine Fish *Oryzias javanicus.* Water Air Soil. Pollut. 195:129-136

André, M., Solé, M., Lenoir, M., Durfort, M., Quero, C., Mas, A., Lombarte, A., van der Schaar, M., López-Bejar, M., Morell, M., Zaugg, S. & Houégnigan. (2011). Low-frequency sounds induce acoustic trauma in cephalopods. *Front Ecol Environ*, 9(9): 489–493. Doi:10.1890/100124.

Atlantic States Marine Fisheries Commission. (2017). Habitat Addendum IV to Amendment 1 to the Interstate Fisheries Management Plan for Atlantic Sturgeon. Available online: http://www.asmfc.org/species/atlantic-sturgeon. Accessed July 6, 2020.

Barnthouse, L. W. (2013). Impacts of entrainment and impingement on fish populations: A review of the scientific evidence. *Environmental Science & Policy, 31*, 149-156. doi:10.1016/j.envsci.2013.03.001

Bass, M. L. and A. G. Heath. (1975). Physiological Effects of Intermittent Chlorination on Fish. American Zoologist 15(3):818-818

Borja, A., Belzunce, M., Garmendia, J, Rodriguez, J. G., Solaun, O. & I. Zorita. (2011). Impact of Pollutants on Coastal and Benthic Marine Communities. *Ecological Impacts of Toxic Chemicals*. Sánchez-Bayo, F., van den Brink, PJ, Mann, RM (Eds.). Bentham Science Publishers Ltd. 165-186 p. doi:10.2174/978160805121210165.

Bracciali, C., Campobello, D., Giacoma, C. & G. Sara. (2012). Effects of nautical traffic and noise on foraging patterns of Mediterranean damselfish (*Chromis chromis*). *PLOS One*, 7: e40582.

Bruintjes, R. & Radford, A.N. (2013). Context-dependent impacts of anthropogenic noise on individual and social behaviour in a cooperatively breeding fish. *Animal Behaviour*, 85: 1343-1349.

Bureau of Ocean Energy Management. (BOEM). (2021). *South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS EIS/EA BOEM 2020-057.

BOEM. (2020b). *Environmental Studies Electromagnetic Fields (EMF) & Marine Life*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. https://www.boem.gov/sites/default/files/documents/renewable-energy/mapping-and-data/Electromagnetic-Fields-Marine-Life.pdf.

BOEM. (2019a). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Programs, Sterling, VA. OCS Study 2019- 036. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2014). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts. Revised Environmental Assessment*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. BOEM 2014-603.

Buscaino, G., Filiciotto, F., Buffa, G., Bellante, A., Stefano, V.D., Assenza, A., Fazio, F., Caola, G. & Mazzola, S. (2009). Impact of an acoustic stimulus on the motility and blood parameters of European sea bass (*Dicentrarchus labrax L.*) and gilthead sea bream (*Sparus aurata L.*). *Marine Environmental Research*, 69(3): 136-142.

Carlson, T. J. (2012). Barotrauma in fish and barotrauma metrics. In *The Effects of Noise on Aquatic Life* (pp. 229-233). Springer, New York, NY.

Codarin, A., Wysocki, L.E., Ladich, F. & Picciulin, M. (2009). Effects of ambient and boat noise on hearing and communication in three fish species living in a marine protected area. *Marine Pollution Bulletin*, 58(12):1880-1887.

Collie, J.S. & King, J.W. (2016). *Spatial and Temporal Distributions of Lobsters and Crabs in the Rhode Island Massachusetts Wind Energy Area*. OCS Study BOEM 2016-073. Sterling, Virginia: U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region.

Coquereau, L., Grall, J., Chauvaud, L., Gervaise, C., Clavier, J., Jolivet, A. & Di Iorio, L. (2016). Sound production and associated behaviours of benthic invertebrates from a coastal habitat in the north-east Atlantic. *Marine Biology*, 163. DOI:10.1007/s00227-016-2902-2.

DeCelles, G. R., Martins, D., Zemeckis, D. R., Cadrin, S. X., & Neis, B. (2017). Using Fishermen's Ecological Knowledge to map Atlantic cod spawning grounds on Georges Bank. *ICES Journal of Marine Science, 74*(6), 1587-1601. doi:10.1093/icesjms/fsx031

Department of Business, Enterprise and Regulatory Reform. (BERR). (2008). *Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry*. Technical Report from BERR to the Department of Enterprise & Regulatory Reforms (BERR) in association with DEFRA. Retrieved October 2020 from: https://tethys.pnnl.gov/sites/default/files/publications/Cabling_Techniques_and_Environmental_Effects.pdf.

Dernie, K.M., M.J. Kaiser, and R.M. Warwick. (2003). Recovery rates of benthic communities following physical disturbance. *Journal of Animal Ecology*. Vol. 72, Issue 6, pp. 1043-1056.

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.G. Frisk. (2010). Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. U.S. *National Marine Fisheries Service Fishery Bulletin*, 108, 450–464.

Edmonds, N. J., Firmin, C. J., Goldsmith, D., Faulkner, R. C. & Wood, D. T. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species. *Marine Pollution Bulletin*, 108(1-2): 5-11. https://doi.org/10.1016/j.marpolbul.2016.05.006.

United States Environmental Protection Agency (EPA). (2014). Benefits Analysis for the Final Section 316(b) Existing Facilities Rule (EPA-821-R-14-005). Retrieved from https://www.epa.gov/sites/default/files/2015-05/documents/cooling-water_phase-4_benefits_2014.pdf.

EPA. (2006). Technical Development Document for the Final Section 316(b) Phase III Rule (EPA-821-R-06-003). Retrieved from https://www.epa.gov/sites/default/files/2015-04/documents/cooling-water_phase-3_tdd_2006.pdf.

Epsilon Associates, Inc. (2020). *Vineyard Wind Draft Construction and Operations Plan Volume III: Environmental Information*. Vineyard Wind Project.

Erbe, C., Marley, S. A., Schoeman, R. P., Smith, J. N., Trigg, L. E. & C.B. Embling (2019). The Effects of Ship Noise on Marine Mammals – A Review. *Frontiers in Marine Science* 6. 606 pp. DOI:10.3389/fmars.2019.00606.

ESS Group, Inc. and Battelle. (2006). *Cape Wind Energy Project. Appendix 3.8-B: Draft Fisheries Report*. Prepared for Cape Wind Associates, LLC. September 2006.

Evans, N.T., K.H. Ford, B.C. Chase, & J.J. Sheppard. (2015). *Recommended Time of Year Restrictions (TOYs) for Coastal Alteration Projects to Protect Marine Fisheries Resources in Massachusetts*. Report by the Massachusetts Division of Marine Fisheries.

FAA. (2020). FAA Regulations. https://www.faa.gov/regulations_policies/faa_regulations/.

Forsythe, J. (2004). Accounting for the effect of temperature on squid growth in nature: From hypothesis to practice. *Marine and Freshwater Research - MAR FRESHWATER RES, 55*. doi:10.1071/MF03146

Freitas, C., Villegas-Rios, D., Moland, E., & Olsen, E. M. (2021). Sea temperature effects on depth use and habitat selection in a marine fish community. *J Anim Ecol*, 90(7), 1787-1800. doi:10.1111/1365-2656.13497

Fugro. (2020). *Scour Potential Impacts from Operational Phase and Post Construction Infrastructure*. Report C170693-01 (05). Completed for AECOM and Mayflower Wind Energy, LLC.

Fugro. (2022). *Marine Site Investigation Report*. Completed for AECOM and Mayflower Wind Energy, LLC.

Greater Atlantic Regional Fisheries Office. (GARFO). (2019a). The Greater Atlantic Region ESA Section 7 Mapper (vers. 2.0). Retrieved October 2020 from: https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=1bc332edc5204e03b250ac11f9914a27.

Greater Atlantic Regional Fisheries Office. (2019b). Section 7 Species Presence Table: Shortnose Sturgeon in the Greater Atlantic Region. Retrieved December 2020 from: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-species-presence-table-shortnose-sturgeon-greater.

Greater Atlantic Region Fisheries Office. (2016). GARFO Acoustic Tool: Analyzing the effects of pile driving on ESA-listed species in the Greater Atlantic Region. Retrieved October 2020 from: http://www.greateratlantic.fisheries.noaa.gov/protected/section7/guidance/consultation/index.html.

Guarinello, Marisa, Carey, D., & Read, L.B. (2017). *Year 1 Report for 2016 Summer Post-Construction Surveys to Characterize Potential Impacts and Response of Hard Bottom Habitats to Anchor Placement at the Block Island Wind Farm (BIWF).* INSPIRE Environmental prepared for Deepwater Wind Block Island LLC. May.

Halvorsen, M.B., B.M. Casper, C.M. Woodley, T.J. Carlson, and A.N. Popper. (2012). Threshold for Onset of Injury in Chinook Salmon from Exposure to Impulsive Pile Driving Sounds. *PLOS One*, 7(6): e38968. https://doi.org/10.1371/journal.pone.0038968.

Hare, J. A., & Govoni, J. J. (2005). Comparison of average larval fish vertical distributions among species exhibiting different transport pathways on the southeast United States continental shelf. *Fishery Bulletin, 103*(4), 728-736.

Hawkins, A.D., Pembroke, A.E. & Popper, A.N. (2014). Information gaps in understanding the effects of noise on fishes and invertebrates. *Reviews in Fish Biology and Fisheries*: 1-26.

Henderson, M. J., & Fabrizio, M. C. (2014). Small-Scale Vertical Movements of Summer Flounder Relative to Diurnal, Tidal, and Temperature Changes. *Marine and Coastal Fisheries, 6*(1), 108-118. doi:10.1080/19425120.2014.893468

HDR. (2020). *Benthic and Epifaunal Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island – Project Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2020-044. 380 pp.

Huebert, K. B., Sponaugle, S., Cowen, R. K., & Jech, J. M. (2010). Predicting the vertical distributions of reef fish larvae in the Straits of Florida from environmental factors. *Canadian Journal of Fisheries and Aquatic Sciences, 67*(11), 1755-1767. doi:10.1139/f10-116

Hutchison, Z. L. Bartley, M. L., King, J. W., English, P., Grace, S., and Khan, A. (2020). *Benthic habitat and epifaunal monitoring at the Block Island Wind Farm*. Report presented at the New York State Environmental Technical Working Group 2020 State of the Science Workshop.

Hutchison, Z. L., P. Sigray, H. He, A. B. Gill, J. King, and C. Gibson. (2018). *Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables*. Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-003.

ICF Incorporated, LLC. (2020). *Comparison of Environmental Effects from Different Offshore Wind Turbine Foundations*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Sterling, VA. OCS Study BOEM 2020-041. 42 pp.

Keenan, S.F., M.C. Benfield, and J.K. Blackburn. (2007). Importance of the artificial light field around offshore petroleum platforms for the associated fish community. *Marine Ecol. Prog. Ser*., 331: 219–231.

Langhamer, Olivia. (2012). Artificial Reef Effect in relation to Offshore Renewable Energy Conversion: State of the Art. *The Scientific World Journal*, 2012(1) DOI: 386713. 10.1100/2012/386713.

Leffler, C. W. (1972). Some effects of temperature on the growth and metabolic rate of juvenile blue crabs, Callinectes sapidus, in the laboratory. *Marine Biology*, 14(2), 104-110. doi:10.1007/BF00373209

Macy, W.K. & Brodziak, J. (2001). Seasonal maturity and size at age of *Loligo pealeii* in waters of southern New England. *ICES Journal of Marine Science*, 58: 852-864.

Magnuson-Stevens Fishery Conservation and Management Act of 2007, 16 U.S.C. § 1801 (2007). Retrieved October 2020 from: https://www.fisheries.noaa.gov/resource/document/magnuson-stevens-fishery-conservation-and-management-act.

Malek, A.J., J.S. Colllie, & J. Gartland. (2014). Fine-scale spatial patterns in the demersal fish and invertebrate community in a northwest Atlantic ecosystem. *Estuarine and Coastal Shelf Science,* 147,1-10.

Marchesan, M., M. Spoto, L. Verginella, and E.A. Ferrero. (2005). Behavioral effects of artificial light on fish species of commercial interest. *Fisheries Research* 73:171 – 185.

Martins, R. S. & Perez, J. A. A. (2006). Cephalopods and fish attracted by night lights in coastal shallow-waters, off southern Brazil, with the description of squid and fish behavior. *Rev. etol.*, 8(1): 27-34. ISSN 1517-2805.

Malek, A.J., J.S. Collie, and J. Gartland. (2014). Fine-scale spatial patterns in the demersal fish and invertebrate community in a northwest Atlantic ecosystem. *Estuarine and Coastal Shelf Science* 147:1-10.

MassWildlife. (2015a). Atlantic Sturgeon (*Acipenser oxyrincus*) fact sheet. Massachusetts Division of Fish & Wildlife. Natural Heritage & Endangered Species Program. Accessible at: https://www.mass.gov/doc/atlantic-sturgeon/download.

MassWildlife. (2015b). Shortnose Sturgeon (*Acipenser brevirostrum*) fact sheet. Massachusetts Division of Fish & Wildlife. Natural Heritage & Endangered Species Program. Accessible at https://www.mass.gov/doc/shortnose-sturgeon/download.

Massachusetts Department of Environmental Protection. (MA DEP). (2021). Eelgrass Mapping Project Online Viewer. http://maps.massgis.state.ma.us/images/dep/eelgrass/eelgrass_map.htm.

Massachusetts Division of Marine Fisheries. (2020). Shellfish suitability area figure layer. Retrieved October 2020 from: https://docs.digital.mass.gov/dataset/massgis-data-shellfish-suitability-areas.

Massachusetts Office of Coastal Zone Management. (MA CZM). (2015). *2015 Massachusetts Ocean Management Plan. Volume 1: Management and Administration.* Report by Massachusetts Office of Coastal Zone Management for the Executive Office of Environmental Affairs.

Matthiessen, P. & Law, R. J. (2002). Contaminants and their effects on estuarine and coastal organisms in the United Kingdom in the late twentieth century. *Environ. Poll.*, 120:739-57.

Mattocks, S., Hall, C. J., and Jordaan, A. (2017). Damming, Lost Connectivity, and the Historical Role of Anadromous Fish in Freshwater Ecosystem Dynamics. *BioScience*, 67(8).

McGee, S., Piorkowski, R., and Ruiz, G. (2006). Analysis of recent vessel arrivals and ballast water discharge in Alaska: Toward assessing ship-mediated invasion risk. Marine Pollution Bulletin, 52(12): 1634-1645. https://doi.org/10.1016/j.marpolbul.2006.06.005.

Mercer, J. (2013). *Following the quahog through time and space*. 12th Annual Ronald C. Baird Sea Grant Science Symposium. November 2013. Rhode Island Sea Grant.

Morgan, R.P. II, V.J. Rasin Jr., and L.A. Noe. (1983). Sediment Effects on Eggs and Larvae of Striped Bass and White Perch. *Transactions of the American Fisheries Society*, 112(2A): 220-224.

Mueller-Blenkle, C., P.K. McGregor, A.B. Gill, M.H. Anderson, J. Metcalfe, V. Bendall, P. Sigray, D.T. Wood, and F. Thomsen. (2010). Effects of pile-driving noise on the behaviour of marine fish. *COWRIE Ref: Fish 06-08*, Technical Report.

Murphy, B.R. and D. Erkan. (2006). *Survey of the northern quahog, Mercenaria mercenaria, in Narragansett Bay, Rhode Island*. Rhode Island Department of Environmental Management, Division of Fish and Wildlife, Jamestown, RI. 54 pp

Musick, J. A., Burgess, G., Cailliet, G., Camhi, M. and Fordham, S. (2000). Management of Sharks and Their Relatives (Elasmobranchii), *Fisheries*, 25(3): 9-13. Available online: https://doi.org/10.1577/1548-8446(2000)025<0009:MOSATR>2.0.CO;2.

Muxika I., Borja, A., Bonne, W. (2005). The suitability of the marine biotic index (AMBI) to new impact sources along European coasts*. Ecol Ind*., 5:19-31.

New England Fishery Management Council and National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS). (2017). *Final Omnibus Essential Fish Habitat Amendment 2*. New England Fishery Management Council, Newburyport, and National Marine Fisheries Service, Gloucester, Massachusetts, USA. Updated October 25, 2017.

Newbold, S. C., & Iovanna, R. (2007). Ecological Effects of Density-Independent Mortality: Application to Cooling-Water Withdrawals. *Ecological Applications, 17*(2), 390-406. doi: https://doi.org/10.1890/06-0070

NMFS. (2020). Recommendations for Mapping Fish Habitat. National Oceanic and Atmospheric Administration, National Marine Fisheries Service GARFO Habitat Conservation and Ecosystem Services Division, January 2020.

NMFS. (2009). *Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat.* National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. pp. 395.

NMFS. (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts* (pp. 167). Washington, DC: U.S. Department of Commerce.

National Oceanic and Atmospheric Administration. NOAA. (2020a). Species directory: Atlantic Sturgeon. Available on-line at: https://www.fisheries.noaa.gov/species/atlantic-sturgeon.

NOAA. (2020b). Species directory: Shortnose Sturgeon. Available on-line at: https://www.fisheries.noaa.gov/species/shortnose-sturgeon.

NOAA. (2020c). Essential Habitat Mapper. Retrieved October 2020 from: https://www.habitat.noaa.gov/protection/efh/efhmapper/.

NOAA. (2020d). Individual species information accessed from main directory. Fisheries management species documentation. Retrieved October 2020 from: https://www.fisheries.noaa.gov/species-directory.

NOAA. (2020e). Atlantic Mackerel, Squid and Butterfish Management Plan. Retrieved October 2020 from: https://www.fisheries.noaa.gov/management-plan/atlantic-mackerel-squid-and-butterfish-management-plan.

NOAA. (2020f). Summer Flounder, Scup, and Black Sea Bass Management Plan. Retrieved October 2020 from: https://www.fisheries.noaa.gov/management-plan/summer-flounder-scup-and-black-sea-bass-management-plan.

NOAA. (2020g). Spiny Dogfish Management Plan. Retrieved October 2020 from: https://www.fisheries.noaa.gov/management-plan/spiny-dogfish-management-plan.

NOAA. (2020h). Atlantic Surfclam and Ocean Quahog Management Plan. Retrieved October 2020 from: https://www.fisheries.noaa.gov/management-plan/atlantic-surfclam-and-ocean-quahog-management-plan.

NOAA. (2020i). Atlantic Sea Scallop Management Plan. Retrieved October 2020 from: https://www.fisheries.noaa.gov/management-plan/atlantic-sea-scallop-management-plan.

NOAA. (2020j). Northeast Skate Complex Management Plan. Retrieved October 2020 from: https://www.fisheries.noaa.gov/management-plan/northeast-skate-complex-management-plan.

NOAA. (2004). Highly Migratory Species Fishery Management Plan. Retrieved October 2020 from: https://swfsc.noaa.gov/uploadedFiles/Events/Meetings/Meeting_2014/.

National Oceanic and Atmospheric Administration National Geophysical Data Center. (NOAA NGDC). (1999). U.S. Coastal Relief Model Vol.1- Northeast Atlantic. NOAA National Centers for Environmental Information. https://doi.org/10.7289/V5MS3QNZ.

NOAA NGDC. (2008). Nantucket, Massachusetts 1/3 arc-second MHW Coastal Digital Elevation Model. NOAA National Centers for Environmental Information.

Narragansett Bay Estuary Program, NBEP. (2017). *The State of Narragansett Bay and Its Watershed: Technical Report*.

National Science Foundation & U.S. Geological Survey. (2011). *Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research* funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Accessed April 2020 at: https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

Nightingale, B., Longcore, T. & Simenstad, C.A. (2006). *Artificial night lighting and fishes*. In *Ecological consequences of artificial night lighting*. C. Rich and T. Longcore, (eds.) Washington, DC: Island Press. pp. 257–276.

Normandeau Associates, Inc. (2012). *Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities.* A Workshop Report for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 72 pp. plus Appendices.

Normandeau Associates, Inc. (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranch and Other Marine Species*. OCS Study BOEMRE 2011-09. Camarillo, CA: U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region.

NEFSC. (2020a). Northeast Region Stock Assessment Support Materials. Retrieved October 2020 from: https://www.fisheries.noaa.gov/resource/data/northeast-region-stock-assessment-support-materials.

NEFSC. (2020b). *Ecology of the Northeast U.S. Continental Shelf*. Available online at: https://www.nefsc.noaa.gov/ecosys/ecosystem-ecology/physical.html. Accessed on June 20, 2020 to obtain information on the physical setting of the Project Area.

NEFSC. (1999a). Essential fish habitat source document. Windowpane, Scophthalmus aquosus, life history and habitat characteristics. Retrieved from https://repository.library.noaa.gov/view/noaa/3127

NEFSC. (1999b). Essential fish habitat source document. Witch flounder, Glyptocephalus cynoglossus, life history and habitat characteristics. Retrieved from https://repository.library.noaa.gov/view/noaa/3136

NEFSC. (2017). *2017 Whiting Stock Assessment Update Report*. Retrieved October 2020 from: http://s3.amazonaws.com/nefmc.org/2017-Whiting-Stock-Assessment-Draft-Report_v1.pdf.

Northeast Gateway Energy Bridge, L. P. (Northeast Gateway) (2012). Environmental Impact Assessment for the Northeast Gateway Deepwater Port. Prepared by Tetra Tech, Inc., 129.

Northeast Regional Ocean Council. (2020). Northeast Ocean Data Portal. Online database and interactive maps. Retrieved October 2020 from: https://www.northeastoceandata.org/.

Orr, T.L., Herz, S. & D. Oakley. (2013). *Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments*. OCS Study. BOEM 2013-0116.

Perry, E., Seegert, G., Vondruska, J., Lohner, T., & Lewis, R. (2002). Modeling possible cooling-water intake system impacts on Ohio River fish populations. *The Scientific World Journal, 2*, 58-80.

Phipps, G. (2001). Signal maintenance shapes salmon solution. *Northwest Region Bulletin*. p. 2.

Picciulin, M., Sebastianutto, L., Codarin, A., Farina, A. & Ferrero, E.A. (2010). In situ behavioural responses to boat noise exposure of *Gobius cruentatus* (Gmelin, 1789; fam. *Gobiidae*) and *Chromis* (Linnaeus, 1758; fam. *Pomacentridae*) living in a marine protected area. *Journal of Experimental Marine Biology and Ecology*, 386: 125-132.

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D. A., Bartol, S., Carlson, T. J., Coombs, S., Ellison, W. T., Gentry, R. L., Halvorsen, M. B., Lokkeborg, S., Rogers, P. H., Southall, B., Zeddies, D., & Tavolga, W. A. (2014). *ASA S3/SC1. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.* New York: Springer.

Popper, A.N., Fay, R.R. & J.F. Webb. (2008). *Chapter 1: Introduction to Fish Bioacoustics*. In *Fish bioacoustics*. Springer Handbook of Auditory Research. J.F. Webb, R.R. Fay, and A.N. Popper, eds. 32(2008):1-15.

Price, E.B., Kabengi, N., & S.T. Goldstein. (2019). Effects of heavy-metal contaminants (Cd, Pb, Zn) on benthic foraminiferal assemblages grown from propagules, Sapelo Island, Georgia (USA). *Marine Micropaleontology*, 147: 1-11.

Purser, J., & A.N. Radford. (2011). Acoustic noise induces attention shifts and reduces foraging performance in three-spined sticklebacks (Gasterosteus aculeatus). PLOS One, 6(2):1-8.

Puvanendran, V., Falk-Petersen, I., Lysne, H., Tveiten, H., Toften, H., Peruzzi, S. (2015). Effects of different step-wise temperature increment regimes during egg incubation of Atlantic cod on egg viability and newly hatched larval quality. *Aquaculture Research*. 46(1), 226-235.

Rhode Island Coastal Resources Management Council. (CRMC). (2016). Web-based map of 2016 *submerged aquatic vegetation in Narragansett Bay, RI Coastal Ponds and Block Island*. https://edc.maps.arcgis.com/apps/View/index.html?appid=db52bb689c1e44259c06e11fd24895f8.

CRMC. (2010). *Rhode Island Ocean Special Area Management Plan: Ocean SAMP – Volumes 1 and 2.* Report by Rhode Island Coastal Resources Management Council.

Rhode Island Sea Grant. (2018). The Murder Mystery of Narragansett Bay's Winter Flounder. Available online at: http://seagrant.gso.uri.edu/murder-mystery-narragansett-bays-winter-flounder/.

Schtickzelle, N. and Quinn, T. P. (2007). A metapopulation perspective for salmon and other anadromous fish. *Fish and Fisheries*, 8(4): 297-314. https://doi.org/10.1111/j.1467-2979.2007.00256.x.

Sebastianutto, L., Picciulin, M., Costantini, M. & Ferrero, E.A. (2011). How boat noise affects an ecologically crucial behavior: The case of territoriality in *Gobius cruentatus* (*Gobiidae*). *Environmental Biology of Fishes*, 92: 207-215.

Skomal, G. B. (2007*). Shark nursery areas in the coastal waters of Massachusetts*. In *American Fisheries Society Symposium* (Vol. 50, p. 17). American Fisheries Society.

Slavik, K., Lemmen, C., Zhang, W., Kerimoglu, O., Klingbeil, K. & Wirtz, K. (2019). The large scale impact of offshore windfarm structures on pelagic primary production in the southern North Sea. *Hydrobiologia*, 845. 10.1007/s10750-018-3653-5.

Spiga, I., Caldwell, G. & Bruintjes, R. (2016). Influence of Pile Driving on the Clearance Rate of the Blue Mussel, *Mytilus edulis* (L.). *Proceedings of Meetings on Acoustics*. 27. DOI:040005. 10.1121/2.0000277.

Stein, A. B., Friedland, K. D., & Sutherland, M. (2004). Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. *Transactions of the American Fisheries Society*, 133(3), 527-537.

Stokesbury, K.D.E. (2014). *Final Report: SMAST video survey of Western portion of the offshore Windfarm area.* School for Marine Science and Technology, University of Massachusetts Dartmouth.

Stokesbury, K.D.E. (2012). *Final Report: SMAST video survey of Western portion of the offshore Windfarm area*. School for Marine Science and Technology, University of Massachusetts Dartmouth.

Sulak, K.J., R.E. Edwards, G.W. Hill and M.T. Randall. (2002). Why do sturgeons jump? Insights from acoustic investigations of the Gulf sturgeon in the Suwannee River, Florida, USA. *Journal of Applied Ichthyology*. Vol. 18, pp. 617-620.

Thomsen, F, K. Lüdemann, R. Kafemann & W. Piper. (2006). *Effects of Offshore Wind Farm Noise on Marine Mammals and Fish*. Cowrie, Ltd.

Tougaard, J. and Henriksen, O. D. (2009). Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. *The Journal of the Acoustical Society of America* 125, 3766 (2009). Available online: https://doi.org/10.1121/1.3117444.

USCG. (2015). Navigation Rules and Regulations Handbook. Retrieved December 2020 from: https://www.navcen.uscg.gov/pdf/navrules/cg_nrhb_20151231.pdf.

US DOC/NOAA/NMFS Northeast Fisheries Science Center. 2019. Zooplankton and ichthyoplankton abundance and distribution in the North Atlantic collected by the Ecosystem Monitoring (EcoMon) Project from 1977-02-13 to 2019-11-11 (NCEI Accession 0187513). Version 2.2. NOAA National Centers for Environmental Information. Data set. https://www.ncei.noaa.gov/archive/accession/0187513. Accessed 7/20/2022

Vasconcelos, R.O., Amorim, M.P. & F. Ladich. (2007). Effects of ship noise on the detectability of communication signals in the Lusitania toadfish. *Journal of Experimental Biology*, 210: 2104-2112.

Wang, V. H., Zapfe, C. R., & Hernandez, F. J. (2021). Assemblage Structure of Larval Fishes in Epipelagic and Mesopelagic Waters of the Northern Gulf of Mexico. *Frontiers in Marine Science, 8*. doi:10.3389/fmars.2021.766369

White, J. W., Nickols, K. J., Clarke, L., & Largier, J. L. (2010). Larval entrainment in cooling water intakes: spatially explicit models reveal effects on benthic metapopulations and shortcomings of traditional assessments. *Canadian Journal of Fisheries and Aquatic Sciences, 67*(12), 2014-2031. doi:10.1139/f10-108

Wilber, D.H. & D.G. Clarke. (2001). Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. *North American Journal of Fisheries Management,* 21(4): 855-875.

Wilkens, J.L., & B.C. Suedel. (2017). A method for simulating sedimentation of fish eggs to generate biological effects data for assessing dredging impacts. Environmental Laboratory (US).

Williams, S.J., M.A. Arsenault, B.J. Buczkowski, J.A. Reid, J. Flocks, M.A. Kulp, S. Penland, & C.J. Jenkins. (2006). *Surficial sediment character of the Louisiana offshore Continental Shelf region: a GIS Compilation.* U.S. Geological Survey Open-File Report 2006-1195.

Zemeckis, D. R., Martins, D., Kerr, L. A., & Cadrin, S. X. (2014). Stock identification of Atlantic cod (*Gadus morhua*) in US waters: an interdisciplinary approach. *ICES Journal of Marine Science, 71*(6), 1490-1506. doi:10.1093/icesjms/fsu032

Zemeckis, D. (2016). Spawning dynamics, seasonal movements, and population structure of Atlantic cod (*Gadus morhua*) in the Gulf of Maine.

SECTION 6.8 MARINE MAMMALS

81 FR 62259. (2016). Endangered and threatened species; Identification of 14 distinct population segments of the humpback whale (*Megaptera novaengliae*) and revision of species-wide listing. September 8, 2016.

A.I.S. Inc. (2020). *AIS Protected Species Observer Report*, Mayflower Wind – BOEM Lease OCS-A 0521, 2019 Geotechnical Survey.

Albouy, C., Delattre, V., Donati, G. et al. (2020). Global vulnerability of marine mammals to global warming. *Sci Rep* 10 (548). https://doi.org/10.1038/s41598-019-57280-3.

Bailey, H., Booker, K. L., & Thompson, P. M. (2014). Assessing environmental impacts of offshore wind farms: lessons learned and recommendations for the future. *Aquatic Biosystems* 10:8.

Bailey, H., Seniora, B., Simmons, D., Rusin, J., Picken, G., & P.M. Thompson. (2010). Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. *Marine Pollution Bulletin*, 60 (6), 888–897.

Benjamins, S., Harnois, V., Smith, H. C. M., Johanning, L., Greenhill, L., Carter, C. & Wilson, B. (2014). Understanding the potential for marine megafauna entanglement risk from renewable marine energy developments. *Scottish Natural Heritage Commissioned Report* No. 791.

Bergström, L., Kautsky, L., Malm, T., Rosenberg, R., Wahlberg, M., Capetillo, N.Å. & D. Wilhelmsson. (2014). Effects of offshore wind farms on marine wildlife—a generalized impact assessment. *Environmental Research Letters* 9(3). https://doi.org/10.1088/1748-9326/9/3/034012.

Betke, K., Schultz-von Glahn, M., & R. Matuschek. (2004). Underwater noise emissions from offshore wind turbines. Proceedings of CFA/DAGA'04, Strasburg, 2 pp., Accessed June 2020 at http://www.conforg.fr/cfadaga2004/master_cd/cd1/articles/000516.pdf.

Brandt, M., Diederichs, A., Betke, K., Matuschek, R., & Nehls, G. (2011). Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. *Marine Ecology Progress Series*. 421, 205-216. 10.3354/meps08888.

Broker, K.C. (2019). An Overview of Potential Impacts of Hydrocarbon Exploration and Production on Marine Mammals and Associated Monitoring and Mitigation Measures. *Aquatic Mammals* 2019, 45(6), 576-611, DOI 10.1578/AM.45.6.2019.576.

Brown, M. W. & Marx, M. K. (2000). *Surveillance, monitoring and management of North Atlantic right whales, Eubalaena glacialis, in Cape Cod Bay, Massachusetts: January to Mid-May, 2000*. Final report. Division of Marine Fisheries, Commonwealth of Massachusetts. https://www.mass.gov/files/documents/2016/08/uw/rwhale00.pdf.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*, Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

BOEM. (2016). *Guidelines for Information Requirements for a Renewable Energy Construction and Operations Plan (COP)*. Version 3.0: April 7, 2016. Retrieved from: https://www.boem.gov/sites/default/files/renewable-energy-program/COP-Guidelines.pdf.

BOEM. (2013). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts Revised Environmental Assessment*. BOEM 2014-603. 674 pp. https://www.boem.gov/Revised-MA-EA-2014/.

Carrillo, M. S. and Ritter, F. (2010). Increasing numbers of ship strikes in the Canary Islands: proposals for immediate action to reduce risk of vessel-whale collisions. *Journal of Cetacean Research and Management* 11:131–138.

Carroll, A.G., Przeslawski, R., Duncan, A., Gunning, M & B. Bruce. (2017). A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. *Marine Pollution Bulletin* 114(1): 9-24. https://doi.org/ 10.1016 /j.marpolbul.2016.11.038.

Castellote, M., Clark, C. & Lammers, M. (2012). Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. *Biological Conservation*, 147(1), 115–122.

Cetacean and Turtle Assessment Program. (CETAP). (1982). *A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf*. University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Clark, C.W. & Ellison, W.T. (2004). Potential use of low-frequency sounds by baleen whales for probing the environment: Evidence from models and empirical measurements. In: Thomas JA, Moss CF, Vater M, editors. *Echolocation in bats and dolphins*. Chicago: The University of Chicago Press. pp. 564–589.

Conn, P. B. & G.K. Silber. (2013). Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. *Ecosphere* 4(4):43.

Constantine, R., Johnson, M., Riekkola, L. & Jervis, S. (2015). Mitigation of vessel-strike mortality of endangered Bryde's whales in the Hauraki Gulf, New Zealand. *Biol Conserv* 186: 149−157.

Cranford, T.W. & Krysl, P. (2015*). Fin Whale Sound Reception Mechanisms: Skull Vibration Enables Low-Frequency Hearing*. *PLOS ONE* 10(1): e0116222. https://doi.org/10.1371/journal.pone.0116222.

Curtice, C., Cleary, J., Schumchenia, E., Halpin, P. (2019). *Marine-life Data and Analysis Team (MDAT) technical report on the methods and development of marine-life data to support regional ocean* *planning and management*. Prepared on behalf of the Marine-life Data Analysis Team (MDAT). Accessed at: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf. 81 pp.

Dahl, P., de Jong, C., & A. Popper. (2015). The Underwater Sound Field from Impact Pile Driving and Its Potential Effects on Marine Life. *Acoustics Today*, 11(2).

Dähne, M., Tougaard, J., Carstensen, J., Rose, A. & J. Nabe-Nielsen. (2017). Bubble curtains attenuate noise from offshore wind farm construction and reduce temporary habitat loss for harbour porpoises. *Mar Ecol Prog Ser* 580: 221-237. https://doi.org/10.3354/meps12257

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., & U. Sieber. (2013). Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. *Environmental Research Letters*, 8(2), 025002. https://doi.org/10.1088/1748-9326/8/2/025002.

David, J. (2006). Likely sensitivity of bottlenose dolphins to pile-driving noise. *Water and Environment Journal*, 20: 48-54. https://doi.org/10.1111/j.1747-6593.2005.00023.x.

Edren, S. M. C., Andersen, S., Teilmann, J., Carstensen, J., Harders, P., Dietz, R. & Miller, L. (2010). The effect of a large Danish offshore wind farm on harbor and gray seal haul-out behavior. *Marine Mammal Science*. 26. 614-634.

Ellison, W. T., Southall, B. L., Clark, C. W. & Frankel A. S. (2012). A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds, *Conserv Biol.* 26(1):21-8. doi:10.1111/j.1523-1739.2011.01803.x.

EPA. (2017) *Statutes and Regulations Affecting Marine Debris*. https://www.epa.gov/trash-free-waters/statutes-and-regulations-affecting-marine-debris#:~:text=Because%20marine%20debris%20typically%20harbors,implementing%20regulations%2C%20found%20at%20the.

Erbe, C., Marley, S. A., Schoeman, R. P., Smith, J. N., Trigg, L. E. & Embling, C. B. (2019). The Effects of Ship Noise on Marine Mammals–A Review. *Frontiers in Marine Science* 6. 606 pp. doi:10.3389/fmars.2019.00606.

Erbe, C., Dunlop, R. & Dolman, S. (2018). Effects of noise on marine mammals. In *Effects of Anthropogenic Noise on Animals*, eds H. Slabbekoorn, R. J. Dooling, A. N. Popper & R.R. Fay (New York, NY: Springer), 277–309. doi:10.1007/978-1-4939-8574-6_10.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. & R. Dooling. (2016). Communication masking in marine mammals: A review and research strategy. *Marine Pollution Bulletin* 103 (1–2): 15-38.

Erbe, C. (2002a). Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. *Marine Mammal Science.* 18. 394-418.

Erbe, C. (2002b). Hearing abilities of Baleen Whales. Defence Research and Development Canada. Contractor Report DRDC Atlantic CR 2002-065. Retrieved July 2020 from: https://cradpdf.drdc-rddc.gc.ca/PDFS/unc09/p519661.pdf.

Executive Office of Energy and Environmental Affairs. (2009). *Massachusetts Ocean Management Plan, Volume 2, Baseline Assessment and Science Framework*. 205 pp.

Finneran, J.J. (2016). *Auditory weighting functions and TTS/PTS exposure functions for cetaceans and marine carnivores*. May 2016. San Diego, California: SPAWAR Systems Center Pacific.

Finneran, J.J. (2015). Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015, *J. Acoust. Soc. Am*. 138, 1702-1726.

Ford, B., Jiang, J., Todd, V.L. & I.B. Todd. (2017). *Measurements of Underwater Piling Noise during Nearshore Windfarm Construction in the UK: Potential Impact on Marine Mammals in Compliance with German UBA Limit*. In: 24th international congress on sound and vibration, London, UK. 1–21.

Gomez, C., Lawson, J. W., Wright, A. J., Buren, A. D., Tollit, D. & V. Lesage. (2016). A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy. *Canadian Journal of Zoology.* 94:801–819.

Graham, I.M., Merchant, N.D., Farcas, A., Barton, T.R., Cheney, B., Bono, S. & Thompson, P.M. (2019). Harbour porpoise responses to pile-driving diminish over time. *R Soc Open Sci.* 6(6): https://doi.org/10.1098/rsos.190335.

Graham, I.M., Pirotta, E., Merchant, N.D., Farcas, A., Barton, T.R., Cheney, B., Hastie, G.D., & P.M. Thompson. (2017). Responses of bottlenose dolphins and harbor porpoises to impact and vibration piling noise during harbor construction. *Ecosphere* 8(5): https://doi.org/10.1002/ecs2.1793.

Hain, J.H.W., Ratnaswamy, M.J., Kenney, R.D. & H.E. Winn. (1992). The fin whale, Balaenoptera physalus, in waters of the northeastern United States continental shelf. *Reports of the International Whaling Commission* 42: 653-669.

Hain, J.H.W., Hyman, M.A.M., Kenney, R.D. & H.E. Winn. (1985). The role of cetaceans in the shelf-edge region of the northeastern United States. *Marine Fisheries Review* 47:13-17.

Harris, D.E., Lelli, B. & G. Jakush. (2002). Harp seal records from the southern Gulf of Maine: 1997-2001. *Northeastern Naturalist* 9(3): 331-340.

Harwood, J. (2001). Marine Mammals and their Environment in the Twenty-First Century. *Journal of Mammalogy* 82(3): 630–640. Available online: https://doi.org/10.1644/1545-1542(2001)082<0630:MMATEI>2.0.CO;2.

Hayes, S.A., Josephson, E., Maze-Foley, K., Rosel, P.E. (2020). U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2019. Published July 2020. NOAA Tech Memo NMFS-NE-264.

Hayes, S.A., Josephson, E., Maze-Foley, K., Rosel, P.E., Byrd, B., Chavez-Rosales, S., Col, T. V. N., Engleby, L., Garrison, L.P., Hatch, J., Henry, A., Horstman, S.C., Litz, J., Lyssikatos, M.C., Mullin, K.D., Orphanides, C., Pace, R.M., Palka, D.L., Soldevilla, M., and Wenzel, F.W. (2018). TM 245 *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2017*. NOAA Tech Memo NMFS NE-245; 371 p.

Hayes, S.A., E. Josephson, K. Maze-Foley & P.E. Rosel (eds.). (2017). U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2016. NOAA Technical Memorandum NOAA-NE-241. Available online at: https://repository.library.noaa.gov/view/noaa/14864.

Jelinski, D.E., Krueger, C.C. & D.A. Duffusc. (2002). Geostatistical analyses of interactions between killer whales (Orcinus orca) and recreational whale-watching boats. *Applied Geography* 22(4),393-411.

Kastak, D., & Schusterman, R.J. (1998). Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology, *Journal of the Acoustical Society of America.* 103, 2216–2228. doi: 10.1121/1.421367.

Kastelein, R., Hoek, L. & R. Gransier. (2013). Hearing thresholds of two harbor seals (Phoca vitulina) for playbacks of multiple pile driving strike sounds. The *Journal of the Acoustical Society of America* 134, 2307. https://doi.org/10.1121/1.4817889.

Kastelein , R., Wensveen, P., Hoek, L. & J. Terhune. (2009). Underwater hearing sensitivity of harbor seals (Phoca vitulina) for narrow noise bands between 0.2 and 80 kHz. The *Journal of the Acoustical Society of America*. 126. 476-83. https://doi.org/10.1121/1.3132522.

Katona, S.K. & J. Beard. (1990). Population size, migrations, and feeding aggregations of the humpback whale (Megaptera novaeangliae) in the western North Atlantic Ocean. *Rep. Int. Whal. Comm.* (Special Issue) 12:295–306.

Kenney, R. (2019). Marine Mammals of Rhode Island, Part 12, Humpback Whales. Rhode Island Natural history Survey (RINHS). http://rinhs.org/animals/marine-mammals-of-rhode-island-part-12-humpback-whale/.

Kenney, R.D. & Vigness-Raposa, K.J. (2010). *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 plan.* Technical report no. 10. Coastal Resources Management Council, Wakefield, p 337. http://seagrant.gso.uri.edu/oceansamp/pdf/appendix/10-Kenney-MM&T.pdf.

Kenney, R.D., Scott, G.P., Thompson, T.J. and Winn, H.E. (1997). Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. J. *Northw. Atl. Fish*. Sci. 22:155–171.

Ketten, D.R. (2000). Cetacean ears. In *Hearing by whales and dolphins* (eds Au WWL, Popper AN, Fay RR), pp. 43–108. New York, NY: Springer.

Kraus, S.D., Kenney, R.D. & Thomas, L. (2019). *A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles*. Report prepared for the Massachusetts Clean Energy Center, Boston, MA 02110, and the Bureau of Ocean Energy Management.

Kraus, S.D., Leiter, S., Stone, K., Wikgren, B., Mayo, C., Hughes, P., Kenney, R.D., Clark, C.W., Rice, A.N., Estabrook, B. & J. Tielens. (2016). *Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. 117 pp. + appendices.

LaBrecque, E., Curtice, C., Harrison, J., Van Parijs, S. & P. Halpin. (2015). Biologically Important Areas for Cetaceans Within U.S. Waters – East Coast Region. *Aquatic Mammals*. 41. 17-29. 10.1578/AM.41.1.2015.17.

Laist, D., Knowlton, A., Mead, J., Avenue, C., Collet, A. & Podestà, M. (2001). Collisions between ships and whales. *Marine Mammal Science*. 35-75. 10.1111/j.1748-7692.2001.tb00980.x.

Leaper, R. (2019). The Role of Slower Vessel Speeds in Reducing Greenhouse Gas Emissions, Underwater Noise and Collision Risk to Whales. *Frontiers in Marine Science* 6. 505 pp. doi: 10.3389/fmars.2019.00505.

Madsen, P.T., Wahlberg, M., Tougaard, J., Lucke, K. & Tyack, P. (2006). Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. *Marine Ecology Progress Series*, 309, 279–295.

Marine Debris Research, Prevention, and Reduction Act of 2006, 33 U.S.C. §§1951 et seq. (2006).

Massachusetts Clean Energy Center. (MCEC). (n.d.). Offshore Wind Marine Wildlife Surveys. Retrieved January 2021 from: https://www.masscec.com/offshore-wind-marine-wildlife-surveys.

Matuschek, R. & K. Betke. (2009). Measurements of Construction Noise During Pile Driving of Offshore Research Platforms and Wind Farms. Proc. NAG/DAGA Int. Conference on Acoustics. https://tethys.pnnl.gov/sites/default/files/publications/Matuschek_and_Betke_2009.pdf.

Mayflower-APEM. (2020a). Lease Area OCS-A 0521 Monthly Survey Report: S1_November 2019. *Scientific Monthly Report* P00003850. 11 pp.

Mayflower-APEM. (2020b.) Lease Area OCS-A 0521 Monthly Survey Report: S2_December 2019. *Scientific Monthly Report* P00003850. 10 pp.

Mayflower-APEM (2020c). Lease Area OCS-A 0521 Monthly Survey Report: S3_January 2020. *Scientific Monthly Report* P00003850. Mayflower, 28/02/2020, 10 pp.

Mayflower-APEM (2020d). Lease Area OCS-A 0521 Monthly Survey Report: S4_February 2020. *Scientific Monthly Report* P00003850. Mayflower, 19/02/2020, 10 pp.

Mayflower-APEM (2020e). Lease Area OCS-A 0521 Monthly Survey Report: S5_March 2020. *Scientific Monthly Report* P00003850. Mayflower, 09/03/2020, 10 pp.

Mayflower-APEM (2020f). Lease Area OCS-A 0521 Monthly Survey Report: S7_April_(02) 2020. *Scientific Monthly Report* P00003850. Mayflower, 03/08/2020, 10 pp.

Mayflower-APEM (2020g). Lease Area OCS-A 0521 Monthly Survey Report: S9_May_(02) 2020. *Scientific Monthly Report* P00003850. Mayflower, 09/09/2020, 9 pp.

Mayflower-APEM (2020h). Lease Area OCS-A 0521 Monthly Survey Report: S10_June_ 2020. *Scientific Monthly Report* P00003850. Mayflower, 28/09/2020, 9 pp.

Mayflower-APEM (2020i). Lease Area OCS-A 0521 Monthly Survey Report: S11_July 2020. *Scientific Monthly Report* P00003850. Mayflower, 26/10/2020, 15 pp.

Mayflower-APEM (2020j). Lease Area OCS-A 0521 Monthly Survey Report: S12_August (01) 2020. *Scientific Monthly Report* P00003850. Mayflower, 07/12/2020, 12 pp.

Mayflower-APEM (2020k). Lease Area OCS-A 0521 Monthly Survey Report: S13_August_02 2020. *Scientific Monthly Report* P00003850. Mayflower, 07/12/2020, 12 pp.

Mayflower-APEM (2020l). Lease Area OCS-A 0521 Monthly Survey Report: S14_September 2020. *Scientific Monthly Report* P00003850. Mayflower, 07/12/2020, 12 pp.

Mayflower-APEM (2020m). Lease Area OCS-A 0521 Survey Results [Excel spreadsheet]. Mayflower, 10/09/2020.

Mayflower Wind Energy LLC, APEM Inc., Normandeau Associates, RPS Group. (2020). Mayflower Quarterly Survey Report: November 2019 - January 2020. *Scientific Quarterly Report* P00003850. 24 pp.

Mayo, C.A. & M.K. Marx. (1990). Surface foraging behaviour of the North Atlantic right whale, Eubalaena glacialis, and associated zooplankton characteristics. *Can. J. Zool.* 68:2214–2220.

Mcgillivary, P., Schwehr, K. & K. Fall. (2009). Enhancing AIS to improve whale-ship collision avoidance and maritime security. *Oceans*: 1 - 8.

McKenna, M.F., Calambokidis, J., Oleson, E.M., Laist, D.W., Goldbogen, J.A. (2015). Simultaneous tracking of blue whales and large ships demonstrates limited behavioural responses for avoiding collision. *Endang Species Res 27:* 219−232.

McKenna, M., Wiggins, S. & Hildebrand, J. (2013). Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions. *Sci Rep 3*. https://doi.org/10.1038/srep01760.

Mehta, S. (2000). SPECIAL REPORT * As their ocean-fed cooling systems kill off seals, sea lions and other creatures, coastal power plants are accused of operating. *Los Angeles Times*. January 9. Retrieved from https://www.latimes.com/archives/la-xpm-2000-jan-09-me-52347-story.html

Mikkelsen, L., Johnson, M., Wisniewska, D.M., van Neer, A., Siebert, U., Madsen, P.T., et al. (2019). Long-term sound and movement recording tags to study natural behavior and reaction to ship noise of seals. *Ecol. Evol.* 9, 2588–2601. doi:10.1002/ece3.4923.

Morandi, A., Berkman, S., Rowe, J., Balouskus, R., Etkin, D.S., Moelter, C. & D. Reich. (2018). *Environmental Sensitivity and Associated Risk to Habitats and Species on the Pacific West Coast and Hawaii with Offshore Floating Wind Technologies; Volume 1: Final Report*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, Camarillo, CA. OCS Study BOEM 2018-031. 100 p.

Nabe-Nielsen, J., van Beest, F.M., Grimm, V., Sibly, R.M., Teilmann, J., & Thompson, P.M. (2018). Predicting the impacts of anthropogenic disturbances on marine populations. *Conservation Letters 11: e12563*. https://doi.org/10.1111/conl.12563.

Nachtigall, P.E., Supin, A.Y., Pacini, A.F., Kastelein, R. A. (2018). Four odontocete species change hearing levels when warned of impending loud sound. *Integr Zool.* 13(2):160-165. doi:10.1111/1749-4877.12286.

Nachtigall, P.E. & A.Y. Supin. (2008). A false killer whale adjusts its hearing when it echolocates. *J. Exp. Biol.* 211, 1714-1718. doi:10.1242/jeb.013862.

National Academy of Sciences. (2003). *Ocean Noise and Marine Mammals*. ISBN: 0-309-50694-0. 204 pp.

NMFS. (2020). *Fin Whale Balaenoptera physalus Species Page.* Accessed April 2020 from: https://www.fisheries.noaa.gov/species/fin-whale.

NMFS. (2019). *Draft U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2019. NOAA Technical Memorandum NMFS.* 399 pp. Accessed from: https://www.fisheries.noaa.gov/national/marine-mammal-protection/draft-marine-mammal-stock-assessment-reports.

NMFS. (2018). 2018 Revisions to: Technical Guidance for Assessing the *Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

NOAA. (2019). New England, Mid-Atlantic Species Directory. Website accessed April 2020 from: https://www.fisheries.noaa.gov/species-directory.

NOAA. (2018). National Weather Service: *What is a Hurricane?* https://oceanservice.noaa.gov/facts/hurricane.html.

NOAA. (2017). *2016–2020 Humpback Whale Unusual Mortality Event Along the Atlantic Coast.* Website accessed April 2020 from: https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2020-humpback-whale-unusual-mortality-event-along-atlantic-coast.

North Atlantic Energy Service Corporation (North Atlantic). (n.d.). Seabrook Station Offshore Intake Seal Deterrent Barrier Design. In (pp. 12).

NSF & USGS. (2011). Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Accessed April 2020 online at: https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

Nedwell, J. R., Parvin, S. J., Edwards, B., Workman, R., Brooker, A. G. & Kynoch, J. E. (2007) Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters. *Subacoustech Report* No. 544R0738 to COWRIE; ISBN: 978-09554279-5-4.

Nedwell, J. D., Langworthy, J. & D. Howell. (2003). Assessment of subsea acoustic noise and vibration from offshore wind turbines and its impact on marine life. *Cowrie Rep* 544 R 0424:1–68.

New England Aquarium. (2020a). Aerial Survey: June 25, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020b). Aerial Survey: July 5, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020c). Aerial Survey: July 25, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020d). Aerial Survey: August 19, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020e). Aerial Survey: August 23, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020f). Aerial Survey: September 17, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020g). Aerial Survey: September 24, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020h). Aerial Survey: October 4, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020i). Aerial Survey: November 19, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020j). Aerial Survey: November 29, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020k). Aerial Survey: December 14, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020l). Aerial Survey: December 19, 2020, RI/MA Wind Energy Areas.

New England Aquarium. (2020m). Aerial Survey: January 8, 2021, RI/MA Wind Energy Areas.

Norro, A. & S. Degraer. (2016). Quantification and characterisation of Belgian offshore wind farm operational sound emission at low wind speeds. In: Degraer, S. et al. (Ed.) *Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Environmental impact monitoring reloaded*. Pp. 25-35.

Northeast Fisheries Science Center & Southeast Fisheries Science Center. (2011-2017). Annual reports for 2010, 2011, 2012, 2013, 2014, 2015, and 2016 work conducted under AMAPPS. Available online at https://www.nefsc.noaa.gov/psb/AMAPPS/.

Northeast Fisheries Science Center & Southeast Fisheries Science Center. (2018). Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. waters of the Western North Atlantic Ocean – AMAPPS II. Available online at: https://www.nefsc.noaa.gov/psb/AMAPPS/.

Northeast Gateway Energy Bridge, L. P. (Northeast Gateway) (2012). Environmental Impact Assessment for the Northeast Gateway Deepwater Port. Prepared by Tetra Tech, Inc., 129.

Nowacek, D.P., Clark, C.W., Mann, D., Miller, P.J.O., Rosenbaum, H.C., Golden, J. S., Jasny, M., Kraska, J. & Southall, B. L. (2015). Marine seismic surveys and ocean noise: time for coordinated and prudent planning. *Front. Ecol. Environ.* 13:378–386.

Nowacek, D.P., Johnson, M.P. & P.L. Tyack. (2004). North Atlantic right whales (Eubalaena glacialis) ignore ships but respond to alerting stimuli. *Proc. R. Soc. Lond. Ser. B Biol.* Sci. 271, 227–231. doi: 10.1098/rspb.2003.2570.

O’Brien, O, McKenna, K, Hodge, B, Pendleton, D, Baumgartner, M, and Redfern, J. (2021). Megafauna aerial surveys in the wind energy areas of Massachusetts and Rhode Island with emphasis on large whales: Summary Report Campaign 5, 2018-2019. OCS Study BOEM 2021-033. 83 p.

Pace, R.M., Corkeron, P.J. & S.D. Kraus. (2017). State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecol Evol.* 7: 8730– 8741. https://doi.org/10.1002/ece3.3406.

Palka, D. L., Chavez-Rosales, S., Josephson, E., Cholewiak, D., Haas, H. L., Garrison, L., Jones, M., Sigourney, D., Waring, G. & C. Orphanides. (2017). *Atlantic Marine Assessment Program for Protected Species: 2010-2014*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2017-071. 211 pp.

Palsbøll, P. J., Allen, J., Berube, M., Clapham, P., Feddersen, T., Hammond, P., Hudson, R., Jorgensen, H., Katona, S., Larsen, A.H. & N. Oien. (1997). Genetic tagging of humpback whales. *Nature* 388:767–769.

Pangerc, T., Robinson, S., Theobald, P. & L. Galley. (2016). Underwater sound measurement data during diamond wire cutting: First description of radiated noise. *Proceedings of Meetings on Acoustics*, 27(1), 40012. https://doi.org/10.1121/2.0000322.

Parks, S.E., Johnson, M., Nowacek, D. & Tyack, P.L. (2011). Individual right whales call louder in increased environmental noise. *Biol Lett.* 7(1):33-5. doi:10.1098/rsbl.2010.0451.

Parks, S., Ketten, D., Malley, J., Arruda, J. & O'Malley, J. (2007). Anatomical predictions of hearing in the North Atlantic Right Whale. The Anatomical Record: *Advances in Integrative Anatomy and Evolutionary Biology*. 290. 734 - 744. doi:10.1002/ar.20527.

Payne, P. M., Wiley, D. N., Young, S. B., Pittman, S., Clapham, P. J., & Jossi, J. W. (1990). Recent Fluctuations in the Abundance of Baleen Whales in the Southern Gulf of Maine in Relation to Changes in Selected Prey. *Fishery Bulletin, 88*(4), 687-696.

Payne, K. & Payne, R. (2010). Large Scale Changes over 19 Years in Songs of Humpback Whales in Bermuda. Zeitschrift für Tierpsychologie. 68. 89 - 114. 10.1111/j.1439-0310.1985.tb00118.x.

Pine, M. K., Hannay, D. E., Insley, S. J., Halliday, W. D. & F. Juanes. (2018). Assessing vessel slowdown for reducing auditory masking for marine mammals and fish of the western Canadian Arctic. *Marine Pollution Bulletin 135*: 290-302. https://doi.org/10.1016/j.marpolbul.2018.07.031.

Pirotta, E., Milor, R., Quick, N., Moretti, D., Di Marzio, N., Tyack, P., et al. (2012). Vessel noise affects beaked whale behavior: results of a dedicated acoustic response study. *PLoS One 7*:e42535. doi:10.1371/journal.pone.0042535.

Redfern, J., Hatch, L. T., Caldow, C., Deangelis, M., Gedamke, J., Hastings, S., Henderson, L., McKenna, M., Moore, T. J. & Porter, M. B. (2016). Assessing the risk of chronic shipping noise to baleen whales off Southern California, USA. *Endangered Species Research* 32. 10.3354/esr00797.

Reine, K. J., Clarke, D. G. & Dickerson, C. (2012). Characterization of underwater sounds produced by a hydraulic cutterhead dredge fracturing limestone rock. DOER Technical Notes Collection (ERDC TN-DOERE-34). Vicksburg, MS: U.S. Army Engineer Research and Development Center. www.wes.army.mil/el/dots/doer.

Richardson, W. J., Greene, C. R., Malme, C. I. &. Thomson, D. H. (1995). Chapter 8 - Marine Mammal Hearing, *Marine Mammals and Noise*, Academic Press. 35 pp. doi:10.1016/B978-0-08-057303-8.50011-2.

Roberts, J.J., L. Mannocci, R.S. Schick, and P.N. Halpin. (2018). *Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2).*

Document version 1.0. Report prepared for Naval Facilities Engineering Command, Atlantic, by the Duke University Marine Geospatial Ecology Lab, Durham, NC. http://seamap.env.duke.edu/resources/dsm/references/USECGOM/AFTT_Update_2017_2018_Final_Report_v1.2_excerpt.pdf.

Roberts J.J., Best, B.D, Mannocci, L., Fujioka., E., Halpin, P.N., Palka, D.L., Garrison, L.P., Mullin, K.D., Cole, T.V.N. & G.G. Lockhart. (2016). Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. *Scientific Reports* 6: 22615. doi:10.1038/srep22615.

Rolland, R.M., Parks, S.E., Hunt, K.E., Castellote, M., Corkeron, P.J., Nowacek, D.P., Wasser, S. K. & S.D. Kraus. (2012). Evidence that ship noise increases stress in right whales. *Proc. R. Soc.B.,* 279: 2363–2368. https://doi.org/10.1098/rspb.2011.2429.

RPS. (2019). Protected Species Observer Report, on behalf of Shell and Mayflower Wind Energy LLC.

Russell, D.J., Hastie, G.D., Thompson, D., Janik, V.M., Hammond, P.S., Scott-Hayward, L.A., Matthiopoulos, J., Jones, E. L. & McConnell, B. J. (2016). Avoidance of wind farms by harbour seals is limited to pile driving activities. *J Appl Ecol*, 53: 1642-1652. doi:10.1111/1365-2664.12678.

Russell, D., Brasseur, S., Thompson, D., Hastie, G., Janik, V., Aarts, G., Mcclintock, B., Matthiopoulos, J., Moss, S. & B. McConnell. (2014). Marine mammals trace anthropogenic structures at sea. *Current Biology* 24. R638–R639. 10.1016/j.cub.2014.06.033.

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J. & Reijnders, P. (2011). Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea Environ. *Res. Lett.* 6 025102 6.

Schoeman R. P., Patterson-Abrolat, C. & Plön, S. (2020). A Global Review of Vessel Collisions With Marine Animals. *Frontiers in Marine Science* 7: 292pp. Doi: 10.3389/fmars.2020.00292.

Schwartz. (2021). Chapter 8. Estuarine Habitat of Narragansett Bay. *An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve.* https://coast.noaa.gov/data/docs/nerrs/Reserves_NAR_SiteProfile_Ch8-13.pdf.

Sears, R., Wenzel, F. & J.M. Williamson. (1987). The blue whale: a catalog of individuals from the western North Atlantic (Gulf of St. Lawrence). Mingan Island Cetacean Study, St. Lambert, Quebec, Canada. 27 pp.

Sergeant, D.E. (1977). Stocks of fin whales Balaenoptera physalus L. in the North Atlantic Ocean. *Rep. Int. Whal. Comm.* 27: 460–473.

Smith, L., Link, J., Cadrin, S. & D. Palka. (2015). Consumption by marine mammals on the Northeast U.S. continental shelf. *Ecological Applications* 25: 373-389. 10.1890/13-1656.1.

Sorochan, K. A., Plourde, S., Baumgartner, M. F., & Johnson, C. L. (2021). Availability, supply, and aggregation of prey (Calanus spp.) in foraging areas of the North Atlantic right whale (Eubalaena glacialis). *ICES Journal of Marine Science, 78*(10), 3498-3520. doi:10.1093/icesjms/fsab200

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. & P.L. Tyack. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2), 125-232, doi: 10.1578/AM.45.2.2019.125.

Southall, B.L., Nowacek, D.P., Miller, P.J.O. & P.L. Tyack. (2016). Experimental Field Studies to Measure Behavioral Responses of Cetaceans to Sonar. *Endangered Species Research* 31:293–315.

Southall, B.L., Bowles, A.E., Ellison, W. & Finneran, J.J. (2007). Marine mammal noise-exposure criteria: initial scientific recommendations. *Aquat Mamm.* 33. 411-522.

Staudinger, M. D., Goyert, H., Suca, J. J., et al. (2020) The role of sand lances (*Ammodytes sp.*) in the Northwest Atlantic Ecosystem: A synthesis of current knowledge with implications for conservation and management. *Fish Fish.* 21: 522– 556. https://doi.org/10.1111/faf.12445.

Stone, K.M., Leiter, S.M., Kenney, R.D., Wikgren, B. C., Thompson, J. L., Taylor, J. K. D. & Kraus, S. D. (2017). Distribution and abundance of cetaceans in a wind energy development area offshore of Massachusetts and Rhode Island. *J Coast Conserv* 21: 527–543. Doi: 10.1007/s11852-017-0526-4.

Southwest Fisheries Science Center (SWFSC). (2017). *Annual Report under Section 101(a)(S)(A) of the MMPA*. Retrieved from: https://media.fisheries.noaa.gov/dam-migration/swfsc_2015loa_monrep_2017_opr1.pdf

Swingle, W. M., Barco, S. G., Pitchford, T. D., McLellan, W. A & Pabst, D. A. (1993). Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. *Mar. Mamm. Sci.* 9:309–315.

TerraSond Ltd. (2019a). *Archaeological Assessment in Support of Site Assessment Plan (Metocean LIDAR Buoy), Mayflower Wind Energy LLC Offshore Windfarm, BOEM Renewable Energy Lease Number OCS-A 0521 (2019-016).* Houston TX. November 22, 2019.

TerraSond Ltd. (2019b). *Geohazard Site Assessment Plan (Metocean LIDAR Buoy Placement), Mayflower Wind Energy Offshore Windfarm, BOEM Renewable Energy Lease Number OCS-A 0521 – Block 6181 (2019-016).* Houston TX. October 22, 2019.

Thomsen, F.; Gill, A.; Kosecka, M.; Andersson, M.; André, M.; Degraer, S.; Folegot, T.; Gabriel, J.; Judd, A.; Neumann, T.; Norro, A.; Risch, D.; Sigray, P.; Wood, D.; & Wilson, B. (2015). *MaRVEN - Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy* (Report No. RTD-K3-2012-MRE). Report by Danish Hydraulic Institute (DHI). Report for European Commission.

Todd, V.L.G. Todd, I.B. Gardiner J.C., Morrin, E.C.N. MacPherson, N.A. DiMarzio, N.A. & F. Thomsen. (2014). A review of impacts of marine dredging activities on marine mammals. *ICES Journal of Marine Science* 72 (2): 328–340. https://doi.org/10.1093/icesjms/fsu187.

Todd, V.L.G., Pearse, W.D., Tregenza, N.C., Lepper, P.A. & I. B. Todd. (2009). Diel echolocation activity of harbour porpoises (*Phocoena phocoena*) around North Sea offshore gas installations. Ices J. Marine Sci. 66, 734–745.

Tougaard, J. & O.D. Henriksen. (2009). Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. *The Journal of the Acoustical Society of America* 125, 3766 (2009). Available online: https://doi.org/10.1121/1.3117444.

Tsujii, K., Akamatsu, T., Okamoto, R., Mori, K., Mitani, Y., and Umeda, N. (2018). Change in singing behavior of humpback whales caused by shipping noise. *PLOS One* 13:e0204112. Doi: 10.1371/journal.pone.0204112.

URI Coastal Resources Center. (2014). *Rhode Island Shellfish Management Plan Version II: November 2014.* Available online at: http://www.rismp.org/wp-content/uploads/2014/04/smp_version_2_11.18.pdf.

Vanderlaan, A. S. M. & Taggart, C. T. (2007). Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Mar Mamm Sci* 23: 144–156.

Van Renterghem, T., Dekoninck, L., & Botteldooren, D. (2014). Propagation distance-of-concern for offshore wind turbine airborne sound during piling and normal operation. Proceedings of *Forum Acusticum 2014*. Presented at the Forum Acusticum 2014.

Whitehead, H. (2002). *Sperm whales: Social evolution in the ocean*. University of Chicago Press, Chicago, Illinois. 431 pp.

Wiley, D., Asmutis, R. A., Pitchford, T. D. & Gannon, D. P. (1995). Stranding and mortality of humpback whales, Megaptera novaeangliae, in the mid-Atlantic and southeast United States, 1985-1992. *Fishery Bulletin*- National Oceanic and Atmospheric Administration. 93. 196-205.

Wu, C., Wang, W., Hsu, Y., Liu, D., Chen, C., Hu, W., Chen, N., Lin, S., Hwang, W., Huang, Y., Li, W. (2017). Underwater Noise Measurement and Simulation for Offshore Wind Farm in Taiwan. *IEEE Underwater Technology* (UT), Busan. pp. 1-7. doi: 10.1109/UT.2017.7890320.

SECTION 6.9 SEA TURTLES

81 FR 20058. (2016). *Endangered and Threatened Wildlife and Plants*; Final Rule to List Eleven Distinct Population Segments of the Green Sea Turtle (*Chelonia mydas*) as Endangered or Threatened and Revision of Current Listings Under the Endangered Species Act.

A.I.S. Inc. (2020). *AIS Protected Species Observer Report*, Mayflower Wind – BOEM Lease OCS-A 0521, 2019 Geotechnical Survey.

Anton, Y., Sunardi, S., Din, J., Syed, A. & Hassan, R. (2010). Turtle Hearing Capability Based on ABR Signal assessment. *TELKOMNIKA* 8. doi:10.12928/telkomnika.v8i2.620.

Arendt, M. D., Segars, A. L., Byrd, J. I., Boynton, J., Whitaker, J. D., Parker, L., Owens, D. W., Blanvillain, G., Quattro, J. M. & Roberts, M. A. (2012). Seasonal distribution patterns of juvenile loggerhead sea turtles (*Caretta caretta*) following capture from a shipping channel in the Northwest Atlantic Ocean. *Marine Biology* 159:127–139.

Bailey, H., Brookes, K. L. & Thompson, P. M. (2014). Assessing Environmental Impacts of Offshore Wind Farms: Lessons Learned and recommendations for the Future. *Aquatic Biosystems*, 10:8. doi:10.1186/2046-9063-10-8.

Bartol, S.M. & Musick, J.A. (2003). Sensory biology of sea turtles. *The biology of sea turtles*, 2, 79-102.

Bartol, S.M., Musick, J.A. & Lenhardt, M.L. (1999). Auditory evoked potentials of the loggerhead turtle (*Caretta caretta*). *Copeia*, 836-840.

Benjamins, S., Harnois, V., Smith, H. C. M., Johanning, L., Greenhill, L., Carter, C. & Wilson, B. (2014). Understanding the potential for marine megafauna entanglement risk from renewable marine energy developments. *Scottish Natural Heritage Commissioned Report* No. 791.

Betke, K., Schultz-von Glahn, M., & Matuschek, R. (2004). *Underwater noise emissions from offshore wind turbines.* Proceedings of CFA/DAGA'04, Strasburg, 2 pp., Accessed June 2020 at http://www.conforg.fr/cfadaga2004/master_cd/cd1/articles/000516.pdf.

Bevan, E., Wibbels, T., Najera, B. M. Z., Sarti, L., Martinez, F. I., Cuevas, J. M., Gallaway, B. J., Pena, L. J. & Burchfield, P. M. (2016). Estimating the historic size and current status of the Kemp's ridley sea turtle (*Lepidochelys kempii*) population. *Ecosphere* 7(3): e01244.

Bjorndal, K.A., Schroeder, B. A., Foley, A. M. et al. (2013). Temporal, spatial, and body size effects on growth rates of loggerhead sea turtles (*Caretta caretta*) in the Northwest Atlantic. *Marine Biology.* 160, 2711–2721 https://doi.org/10.1007/s00227-013-2264-y.

Bjorndal, K.A. (1997). Foraging Ecology and Nutrition of Sea Turtles. In: Lutz, P.L. and Musick J.A., Eds., *The Biology of Sea Turtles*, CRC Press, Boca Raton, FL, 199-231.

Bleakney, J.S. (1955). Four records of the Atlantic ridley turtle, *Lepidochelys kempi*, from Nova Scotia. *Copeia* 2:137.

Bolten, A.B., Crowder, L. B., Dodd, M. G., MacPherson, S. L., Musick, J. A., Schroeder, B. A., Witherington, B. E., Long, K. J., Snover, M. L. (2011). Quantifying multiple threats to endangered species: an example from loggerhead sea turtles. *Front Ecol Environ* 9: 295–301.

Bowen, B. W., Bass, A. L., Chow, S. M., Bostrom, M., Bjorndal, K. A., Bolten, A. B., Okuyama, T., Bolker, B. M., Epperly, S., LaCasella, E., Shaver, D., Dodd, M., Hopkins-Murphy… & Dutton, P. H. (2004). Natal homing in juvenile loggerhead turtles (*Caretta caretta*). *Mol. Ecol.* 13:3797–3808.

Brazner, J.C. & McMillan, J. (2008). Loggerhead turtle (*Caretta caretta*) bycatch in Canadian pelagic longline fisheries: relative importance in the western North Atlantic and opportunities for mitigation. *Fish Res* 91: 310–324.

BOEM. (n.d.). Clean Water Act (CWA). Retrieved July 2020 from: https://www.boem.gov/environment/environmental-assessment/clean-water-act-cwa#.

BOEM. (2020a). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP),* Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2020b). *Environmental Studies Electromagnetic Fields (EMF) & Marine Life*. https://www.boem.gov/sites/default/files/documents/renewable-energy/mapping-and-data/Electromagnetic-Fields-Marine-Life.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs., Sterling, VA. OCS Study 2019- 036.

BOEM. (2014). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts Revised Environmental Assessment*. BOEM 2014-603. 674 pp. https://www.boem.gov/Revised-MA-EA-2014/.

Burke, V.J., Standora, E.A. & Morreale, S.J. (1991). Factors affecting strandings of cold-stunned juvenile Kemp's ridley and loggerhead sea turtles in Long Island, New York. *Copeia*, 4:1136–1138.

Camisa, M., Manfredi, V., Szymanski, M., & Glenn, R. (2020). *2019 Annual Performance Report.* Massachusetts Division of Marine Fisheries, Boston, MA. FA Grant Agreement: F-56-R. 67pp.

Caretta, J.V., Price, T., Petersen, D. & Read, R. (2004). Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996–2002. *Marine Fisheries Review*, 66(2), pp. 21-30.

Ceriani, S. A., Casale, P., Brost, M., Leone, E. H., & B.E. Witherington. (2019). Conservation implications of sea turtle nesting trends: elusive recovery of a globally important loggerhead population. *Ecosphere* 10(11):e02936. 10.1002/ecs2.2936.

Cetacean and Turtle Assessment Program.(CETAP). (1982). *A Characterization of Marine Mammals and Turtles in the Mid and North Atlantic Areas of the U.S. Outer Continental Shelf* (Report No. AA551-CT8-48). Report by University of Rhode Island. Report for U.S. Department of the Interior (DOI).

Constantino, M. & M. Salmon. (2003). Role of chemical and visual cues in food recognition by leatherback posthatchlings (*Dermochelys coriacea L*). *Zoology*, 106 3, 173-81.

Cook, S.L. & Forrest, T.G. (2005). Sounds Produced by Nesting Leatherback Sea Turtles (*Dermochelys coriacea*). *Herpetological Review* 36(4):387–390.

Copping, A., Sather, N., Hanna, L., Whiting, J., Zydlewski, G., Staines, G., Gill, A., Hutchison, I., O'Hagan, A. & E. Masden. (2016). *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*. 199 pp.

Crear, D. P., Lawson, D. D., Seminoff, J. A., Eguchi, T., LeRoux, R. A., & Lowe, C. G. (2016). Seasonal shifts in the movement and distribution of green sea turtles Chelonia mydas in response to anthropogenically altered water temperatures. *Marine Ecology Progress Series*, 548, 219-232. doi:10.3354/meps11696

Denkinger, J., Parra, M., Muñoz, J. P., Carrasco, C., Murillo, J. C., Espinosa, E., Rubianes, F. & Koch, V. (2013). Are boat strikes a threat to sea turtles in the Galapagos Marine Reserve?. *Ocean & Coastal Management,* 80:29-35. Doi:/10.1016/j.ocecoaman.2013.03.005.

Department of the Navy. (2007). Navy OPEREA Density Estimates (NODE) for the Southeast OPAREAS: VACAPES, CHPT, JAX/CHASN, and Southeastern Florida & AUTEC-Andros. Naval Facilities

Engineering Command, Atlantic; Norfolk, Virginia. Contract N62470-02-D-9997, Task Order 0060. Prepared by Geo-Marine, Inc., Hampton, Virginia.

Dodge, K. L., Galuardi, B., Miller, T. J. & Lutcavage, M. E. (2014). Leatherback Turtle Movements, Dive Behavior, and Habitat Characteristics in Ecoregions of the Northwest Atlantic Ocean. *PLOS One* 9(3): e91726. https://doi.org/10.1371/journal.pone.0091726.

Douglas-Westwood, LLC. (2013). *Assessment of Vessel Requirements for the U.S. Offshore Wind Sector. U.S. Department of the Interior*. Retrieved June 2020 from: https://www.energy.gov/eere/wind/downloads/assessment-vessel-requirements-us-offshore-wind-sector.

Eckert, S. A. (1989). Diving and foraging behavior of the leatherback sea turtle, *Dermochelys coriacea*. *PhD dissertation*. University of Georgia, Athens, GA, USA. 111pp.

Eguchi, T., Seminoff, J. A., LeRoux, R. A., Prosperi, D., Dutton, D. L., & Dutton, P. H. (2012). Morphology and Growth Rates of the Green Sea Turtle (Chelonia mydas) in a Northern-most Temperate Foraging Ground. *Herpetologica*, 68(1), 76-87. doi:10.1655/herpetologica-d-11-00050.1

Endres, C.S. & Lohmann, K.J. (2012). Perception of dimethyl sulfide (DMS) by loggerhead sea turtles: a possible mechanism for locating high-productivity oceanic regions for foraging. *The Journal of Experimental Biology*, 215(Pt 20), 3535–3538. https://doi.org/10.1242/jeb.073221.

Ferrara, C.R., Vogt, R.C., & Sousa-Lima, R.S. (2013) Turtle vocalizations as the first evidence of post-hatching parental care in chelonians. *Journal of Comparative Psychology* 127(1): 24-32.

Fish and Wildlife Research Institute. (2006). Florida's index nesting beach survey data. Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission.

Florida Power and Light. (1995). *Assessment of the Impacts of the St. Lucie Nuclear Generating Plant on Sea Turtle Species Found in the Nearshore Waters of Florida*. Retrieved from https://www.nrc.gov/docs/ML1722/ML17228B332.pdf

Florida Power Corporation. (n.d.). *Biological Assessment of Impact to Sea Turtles at Florida Power Corporation's Crystal River Energy Complex*. Retrieved from https://www.nrc.gov/docs/ML0300/ML030070232.pdf

Foley, A. M., Stacy, B. A., Hardy, R. F., Shea, C. P., Minch, K. E., & Schroeder, B. A. (2019). Characterizing watercraft-related mortality of sea turtles in Florida. *Jour. Wild. Mgmt.* 83:1057-1072. doi:10.1002/ jwmg.21665.

Fuentes, Mariana. M.P.B., et al. (2016). Conservation hotspots for marine turtle nesting in the United States based on coastal development. *Ecological Applications* 26:2706–2717.

Gill, A.B., & M. Desender. (2020). Risk to Animals from Electro-magnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices. In A.E. Copping and L.G. Hemery (Eds.), OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World. Report for Ocean Energy Systems (OES). (pp. 86-10). DOI: 10.2172/1633088.

Goodale, M.W. & A. Milman. (2016). Cumulative adverse effects of offshore wind energy development on wildlife, *Journal of Environmental Planning and Management*, 59(1):1-21. DOI: 10.1080/09640568.2014.973483.

Griffin, L.P., Griffin, C R., Finn, J.T., Prescott, R.L., Faherty, M., Still, B.M., et al. (2019). Warming seas increase cold-stunning events for Kemp's ridley sea turtles in the northwest Atlantic. *PLOS One* 14 (1): e0211503. https://doi.org/10.1371/journal.pone.0211503.

Haas, H.L. (2010). Using observed interactions between sea turtles and commercial bottom-trawling vessels to evaluate the conservation value of trawl gear modifications. *Mar Coast Fish* 2(1): 263–276.

Hart, K.M., Mooreside, P. & Crowder, L.B. (2006). Interpreting the spatio-temporal patterns of sea turtle strandings: Going with the flow. *Biol Conserv.* 129: 283–290.

Hays, G.C., Adams, C.R., Broderick, A.C., Godley, B.J., Lucas, D.J., Metcalfe, J.D. & Prior, A.A. (2000). The diving behaviour of green turtles at Ascension island. *Anim. Behav.* 59, 577–586.

Hazel, J., Lawler, I.R., & Marsh, H. (2007). Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research*, 3(2):105–113. Accessed from: https://www.int-res.com/abstracts/esr/v3/n2/p105-113/.

Heppell, S.S., Burchfield, P.M. & L.J. Peña. (2007). Kemp's ridley recovery: how far have we come, and where are we headed? In: Plotkin PT (ed) *Biology and conservation of ridley sea turtles*. Johns Hopkins University Press, Baltimore, MD, p 325–335.

Hildebrand, H.H. (1963). Hallazgo del area de anidacion de la tortuga marina "lora", *Lepidochelys kempi* (Garman), en la costa occidental del Golfo de Mexico*. Ciencia (Mexico)* 22:105–112.

Hopkins-Murphy, S.R., Owens, D.W., & Murphy, T.M. (2003). Ecology of immature loggerheads on foraging grounds and adults in interesting habitat in the eastern United States. In: Bolten AB, Witherington BE (eds) *Loggerhead sea turtles*. Smithsonian Institution Press, Washington, pp 79–92.

Kenney, R.D. & Vigness-Raposa, K.J. (2010). *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 Plan*. Technical report no. 10. Wakefield (RI): Coastal Resources Management Council.

Ketten, D.R., & Bartol, S.M. (2005). *Functional Measures of Sea Turtle Hearing*. Woods Hole Oceanographic Institution: ONR Award No: N00014-02-1-0510.

Kraus, S.D., Kenney, R.D. & Thomas, L. (2019). *A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles*. Report prepared for the Massachusetts Clean Energy Center, Boston, MA 02110, and the Bureau of Ocean Energy Management.

Kraus, S.D., Leiter, S., Stone, K., Wikgren, B., Mayo, C., Hughes, P., Kenney, R.D., Clark, C.W., Rice, A.N., Estabrook, B. & Tielens, J. (2016). *Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles*. U.S. Department of the Interior, Bureau of

Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-054. 117 pp. + appendices.

Lanyon, J.M., Limpus, C.J. & Marsh, H. (1989). Dugongs and turtles: grazers in the seagrass system. In Biology of seagrasses. A treatise on the biology of seagrasses with special reference to the Australian region. *Aquatic plant studies* 2: 610-634.

Lavender, A.L., Bartol, S.M. & Bartol, I.K. (2014). Ontogenetic investigation of underwater hearing capabilities in loggerhead sea turtles (*Caretta caretta*) using a dual testing approach. *Journal of Experimental Biology* 217: 2580-2589. doi:10.1242/jeb.096651.

Lazell, J. (1980). New England Waters: Critical Habitat for Marine Turtles. *Copeia*, 2: 290-295. doi:10.2307/1444006.

Liu, X., Manning, J., Prescott, R., Page, F., Zou, H., et al. (2019). On simulating cold-stunned sea turtle strandings on Cape Cod, Massachusetts. *PLOS One* 14(12): e0204717. https://doi.org/10.1371/journal.pone.0204717.

Lohmann, K.J., Putman, N. F. & Lohmann, C.M.F. (2012). The magnetic map of hatchling loggerhead sea turtles. *Current Opinion in Neurobiology* 22(2):336-342. https://doi.org/10.1016/j.conb.2011.11.005.

Lohmann, K.J., Cain, S.D., Dodge, S.A. & Lohmann, C.M.F. (2001). Regional magnetic fields as navigational markers for sea turtles. *Science* 294:364-366.

Lutcavage, M.E., Plotkin, P., Witherington, B. & Lutz, P.L. (1997). Human impacts on sea turtle survival. In: *The Biology of Sea Turtles, Vol. I*, P. L. Lutz and J. Musick, eds. CRC Press. Boca Raton, Fla. pp. 387–410.

Lutz, P.L. &. Musick, J.A. (1997). *The Biology of Sea Turtles*. Boca Raton, Florida: CRC Press.

Mansfield, K. L., Saba, V. S., Keinath, J. A., & Musick, J. A. (2009). Satellite tracking reveals a dichotomy in migration strategies among juvenile loggerhead turtles in the Northwest Atlantic. *Mar. Biol.* 156:2555–2570.

Mayflower Wind Energy, LLC, APEM Inc., Normandeau Associates, & RPS Group. (2020). *Quarterly Avian Report*. 30/10/2020, 35 pp.

Mayflower-APEM. (2020). Lease Area OCS-A 0521 Monthly Survey Report: S11_July 2020. *Scientific Monthly Report* P00003850. Mayflower, 26/10/2020, 15 pp.

McKenna L.N., Paladino F.V., Tomillo, P.S. & N.J. Robinson. (2019). Do Sea Turtles Vocalize to Synchronize Hatching or Nest Emergence?. *Copeia* 107(1):120-123.

Moein, S.E., et al. (1995). *Evaluation of seismic sources for repelling sea turtles from hopper dredges, in Sea Turtle Research Program: Summary Report*, Hales, L.Z., Ed., Prepared for U.S. Army Engineer Division, South Atlantic, Atlanta, GA, and U.S. Naval Submarine Base, Kings Bay, GA, Technical Report CERC-95-31.

Morreale & Standora. (1992) Annual Occurrence and Winter Mortality of Marine Turtles in New York Waters. *Journal of Herpetology*, 26(3), 301-308. doi:10.2307/15648851989.

Mrosovsky, N. (1972). Spectrographs of the Sounds of Leatherback Turtles. *Herpetologica* 28(3): 256-258.

Murray, K.T., & C.D. Orphanides. (2013). Estimating the risk of loggerhead turtle *Caretta caretta* bycatch in the U.S. mid-Atlantic using fishery-independent and -dependent data. *Mar Ecol Prog Ser* 477: 259–270.

Narazaki T., Sato, K., Abernathy, K.J., Marshall, G.J. & N. Miyazaki. (2013). Loggerhead Turtles (*Caretta caretta*) Use Vision to Forage on Gelatinous Prey in Mid-Water. *PLOS ONE* 8(6): e66043. https://doi.org/10.1371/journal.pone.0066043.

NMFS & USFWS. (2007). Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) 5-Year Review: Summary and Evaluation. National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD and U.S. Fish and Wildlife Service, Southeast Region, Jacksonville Ecological Service Field Office, Jacksonville, FL. 50 pp.

NMFS & USFWS. (1993). Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico National Marine Fisheries Service, St. Petersburg, Florida.

NMFS. (2020a). Loggerhead Turtle *Caretta caretta* Species Page. Accessed May 2020 from: https://www.fisheries.noaa.gov/species/loggerhead-turtle.

NMFS. (2020b). Green Turtle *Chelonia mydas* Species Page. Accessed May 2020 from: https://www.fisheries.noaa.gov/species/green-turtle.

NMFS. (2020c). Leatherback Turtle D*ermochelys coriacea* Species Page. Accessed May 2020 from: https://www.fisheries.noaa.gov/species/leatherback-turtle.

NMFS. (2020d). Kemp's Ridley Turtle *Lepidochelys kempii* Species Page. Accessed May 2020 from: https://www.fisheries.noaa.gov/species/leatherback-turtle.

NMFS. (2020e). Biological Opinion on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico. Tracking No: FPR-2017-9234. Accessed July 2020 from: https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico.

NMFS. (2018). *2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts*. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

NMFS. (2018). 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

National Research Council Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. (2003). Effects of Noise on Marine Mammals. *Ocean Noise and Marine Mammals 3*. Washington (DC): National Academies Press (US). Accessed June 2020 from: https://www.ncbi.nlm.nih.gov/books/NBK221255/.

NSF & USGS. (2011). *Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey*. Accessed April 2020 online at: https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf.

Nedwell, J. D., Langworthy, J. & D. Howell. (2003). Assessment of subsea acoustic noise and vibration from offshore wind turbines and its impact on marine life. *Cowrie Rep* 544 R 0424:1–68.

Nelms, S.E., Piniak, W.E.D., Weir, C.R., & B.J. Godley. (2016). Seismic surveys and marine turtles: An underestimated global threat? *Biological Conservation*, 193:49-65. https://doi.org/10.1016/j.biocon.2015.10.020.

Normandeau Associates, Inc., Exponent, Inc., Tricas, T. & Gill, A. (2011). *Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, CA. OCS Study BOEMRE 2011-09.

Northeast Fisheries Science Center & Southeast Fisheries Science Center. (NFSC & SEFSC). (2018). *2018 Annual Report of a Comprehensive Assessment of Marine Mammal, Marine Turtle, and Seabird Abundance and Spatial Distribution in U.S. waters of the Western North Atlantic Ocean – AMAPPS II*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. 119 pp.

NEFSC. (2011). *Preliminary summer 2010 regional abundance estimate of loggerhead turtles (Caretta caretta) in northwestern Atlantic Ocean continental shelf waters*. U.S. Department of Commerce, Northeast Fish Sci Cent Ref Doc. 11-03; 33 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at: http://www.nefsc.noaa.gov/nefsc/publications/.

O'Brien, O., McKenna, K., Hodge, B., Pendleton, D., Baumgartner, M. & J. Redfern. (2021). *Megafauna aerial surveys in the wind energy areas of Massachusetts and Rhode Island with emphasis on large whales:* Summary Report Campaign 5, 2018-2019. OCS Study BOEM 2021-033. 83 p.

Palka, D.L., Chavez-Rosales, S., Josephson, E., Cholewiak, D., Haas, H. L., Garrison, L., Jones, M., Sigourney, Waring, & et al. (2017). *Atlantic Marine Assessment Program for Protected Species: 2010-2014*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2017-071. 211 pp.

Pangerc, T., Theobald, P., Wang, L., Robinson, S., & Lepper, Paul. (2016). Measurement and characterisation of radiated underwater sound from a 3.6 MW monopile wind turbine. *The Journal of the Acoustical Society of America*. 140. Pp 2913-2922. https://doi.org/10.1121/1.4964824.

Piniak, W.E.D, Mann, D.A., Harms, C.A., Jones, T.T. & S.A. Eckert. (2016). Hearing in the Juvenile Green Sea Turtle (*Chelonia mydas*): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. *PLOS ONE* 11(10): e0159711. https://doi.org/10.1371/journal.pone.0159711.

Piniak, W.E.D., Eckert, S.A., Harms, C.A. & E.M. Stringer. (2012). Underwater hearing sensitivity of the leatherback sea turtle (*Dermochelys coriacea*): Assessing the potential effect of anthropogenic noise. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2012-01156. 35pp.Plotkin, P.T. & A.F. Amos. (1990). *Effects of Anthropogenic Debris on Sea Turtles in the Northwestern Gulf of Mexico*. In: Shomura, R. S., Godfrey, M. L. (eds) Conference on Marine Debris. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-SWFSC-154, Honolulu, Hawaii.

Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Lokkeborg, S., Rogers, P.H., Southall, B., Zeddies, D., and Tavolga, W.A. (2014). ASA S3/SC1. 4 TR-2014 *Sound Exposure Guidelines for Fishes and Sea Turtles*: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI (Springer, New York).

Rees, A.F., et al. (2016). Are we working towards global research priorities for management and conservation of sea turtles? *Endangered Species Research* 31:337–382.

Richards, P., Epperly, S. P., Heppell, S., King, R. T., Sasso, C. R., Moncada, F., Nodarse, G., Shaver, D., Medina, Y., & Zurita, J. (2011). Sea turtle population estimates incorporating uncertainty: A new approach applied to western North Atlantic loggerheads *Caretta caretta*. *Endangered Species Research*. 15:151-158. Doi: 10.3354/esr00379.

Ridgway, S.H. Wever, E.G. McCormick, J.G., Palin, & J.H. Anderson. (1969). Hearing in the Sea Turtle, *Chelonia mydas*. *PNAS* 64 (3) 884-890. https://doi.org/10.1073/pnas.64.3.884.

Samuel-Rhoads, Y., Morreale, S., Clark, C., Greene, C. & Richmond, M. (2005). Underwater, low-frequency noise in a coastal sea turtle habitat. *The Journal of the Acoustical Society of America*. 117. 1465-72. 10.1121/1.1847993.

Schoeman R.P., Patterson-Abrolat, C. & Plön, S. (2020). A Global Review of Vessel Collisions with Marine Animals. *Frontiers in Marine Science* 7: 292pp. Doi: 10.3389/fmars.2020.00292.

Schwartz, F.J. (1978). Behavioral and tolerance responses to cold water temperatures by three species of sea turtles (*Reptilia, Chelonidae*) in North Carolina. *Fla Mar Res Publ*. 33:16–18.

Schwartz, M.L. (2021). Chapter 8. Estuarine Habitat of Narragansett Bay In *An Ecological Profile of the Narragansett Bay National Estuarine Research Reserve*. https://coast.noaa.gov/data/docs/nerrs/Reserves_NAR_SiteProfile_Ch8-13.pdf

Shimada, T., Limpus, C., Jones, R. & Hamann, M. (2017). Aligning habitat use with management zoning to reduce vessel strike of sea turtles. *Ocean & Coastal Management* 142:163-172. 10.1016/ j.ocecoaman.2017.03.028.

Shoop, C. R., & Kenney, R. D. (1992). Distributions and abundances of loggerhead and leatherback sea turtles in northeastern United States waters. *Herpetological Monographs* 6: 43–67.

Southeast Fisheries Science Center. (SEFSC). (2020). *Sea Turtle Stranding Narrative Report*. Accessed June 2020 from: https://grunt.sefsc.noaa.gov/stssnrep/SeaTurtleReportII.do?action=reportIIqueryp.

Still, B.M., Griffin, C. R. & R. Prescott. (2005). Climatic and oceanographic factors affecting daily patterns of juvenile sea turtle cold-stunning in Cape Cod Bay, Massachusetts. *Chelonian Conserv Biol.* 4:883–890.

Thomsen, F.; Gill, A.; Kosecka, M.; Andersson, M.; André, M.; Degraer, S.; Folegot, T.; Gabriel, J.; Judd, A.; Neumann, T.; Norro, A.; Risch, D.; Sigray, P.; Wood, D.; & Wilson, B. (2015). *MaRVEN - Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewable Energy* (Report No. RTD-K3-2012-MRE). Report by Danish Hydraulic Institute (DHI). Report for European Commission.

Turner-Tomaszewicz, C., & Seminoff, J. A. (2012). Turning Off the Heat: Impacts of Power Plant Decommissioning on Green Turtle Research in San Diego Bay. *Coastal Management, 40*(1), 73-87. doi:10.1080/08920753.2012.640267

Turtle Expert Working Group. (TEWG). (2000). *Assessment Update for the Kemp's Ridley and Loggerhead Sea Turtle Populations in the Western North Atlantic*. NOAA Technical Memorandum NMFS-SEFSC-444. National Marine Fisheries Service, Miami, FL. 155 pp.

TEWG. (2007). *An Assessment of the Leatherback Turtle Population in the Atlantic Ocean*. NOAA Technical Memorandum NMFS=SEFSE-FFF. 116 pp.

Tyson, R.B., Piniak, W.E.D., Domit, C., Mann, D., Hall, M., Nowacek, D.P. & Fuentes, M.M.P.B. (2017). Novel Bio-Logging Tool for Studying Fine-Scale Behaviors of Marine Turtles in Response to Sound. *Frontiers in Marine Science* 4:219. doi:10.3389/fmars.2017.00219.

Von Holle, B., J.L. Irish, A. Spivy, J.H. Weishampel, A. Meylan, M.H. Godfrey, et al. (2019). Effects of future sea level rise on coastal habitat. *Journal of Wildlife Management* 83:694–704.

Wallace, B.P., Kot, C.Y., Dimatteo, A.D., Lee, T., Crowder, L.B & Lewison R.L. (2013). Impacts of fisheries bycatch on marine turtle populations worldwide: toward conservation and research priorities. *Ecosphere* 4:40.

Warchol, M.E. (2011). Sensory regeneration in the vertebrate inner ear: Differences at the levels of cells and species. *Hearing Research* 273:72-79.

Whelchel, A. & M. Clark, (2010). Chapter 11 – *Sea Turtle, from the Northwest Atlantic Marine Ecoregional Assessment: Species, Habitats and Ecosystems*. Phase One. The Nature Conservancy, Eastern U.S. Division, Boston, MA.

Wibbels, T. & E. Bevan. (2019). *Lepidochelys kempii* (errata version published in 2019). The IUCN Red List of Threatened Species 2019: e.T11533A155057916. https://dx.doi.org/10.2305/IUCN.UK.2019-2.RLTS.T11533A155057916.en. Downloaded on 09 May 2020.

SECTION 7.1 MARINE ARCHAEOLOGY

BOEM. (2020a). *Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Retrieved January 2021 from:

https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf.

BOEM. (2020b). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

National Environmental Policy Act of 1969. 42 USC. 4321 et seq. (NEPA, 1969). Retrieved January 2021 from: https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Environ-Cultural/nepa_statute.pdf.

SECTION 7.2 TERRESTRIAL ARCHAEOLOGY

BOEM. (2020a). Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf.

BOEM. (2020b). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

Robinson, D.S., B. Ford, H. Herbster, and J.N. Walker, Jr. (2004) Marine Archaeological Reconnaissance Survey, Cape Wind Energy Project, Nantucket Sound, Massachusetts. Prepared for Cape Wind Associates, LLC.

Town of Somerset. (2021). Official Zoning Map. https://www.townofsomerset.org/sites/g/files/vyhlif3821/f/uploads/officialzoning_map_march_2018.pdf.

SECTION 7.3 ABOVE-GROUND HISTORIC PROPERTIES

BOEM. (2020a). Guidelines for Providing Archaeological and Historical Property Information Pursuant to 30 CFR Part 585. United States Department of the Interior. Washington, D.C. Available online at: https://www.boem.gov/sites/default/files/documents/about-boem/Archaeology%20and%20Historic%20Property%20Guidelines.pdf.

BOEM. (2020b). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

National Park Service. (NPS). (1990). How to Apply the National Register of Historic Places Criteria for Evaluation. National Register Bulletin No. 15. National Register Branch, National Park Service, United States Department of the Interior, Washington, D.C. http://www.nps.gov/nr/publications/bulletins/pdfs/nrb15.pdf.

Sullivan RG. 2021. Methodology for Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States. Washington (DC): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-032.78 p https://www.boem.gov/sites/default/files/documents/environment/environmentalstudies/BOEM2021032.pdf?fbclid=IwAR007XbMRp22z6TOY_cW6aaGDg7cgdP68N0E5zTL7bPxWiLsJjkF7oth1ol

SECTION 8.0 VISUAL RESOURCES

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs Accessed from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

U.S. Bureau of Land Management. (BLM). (1986). Visual Resource Management System. Retrieved April 2020 from: http://blmwyomingvisual.anl.gov/vr-overview/blm/.

Sullivan RG. (2021). Methodology for Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States. Washington (DC): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-032.78 p https://www.boem.gov/sites/default/files/documents/environment/environmentalstudies/BOEM2021032.pdf?fbclid=IwAR007XbMRp22z6TOY_cW6aaGDg7cgdP68N0E5zTL7bPxWiLsJjkF7oth1ol

Sullivan, R. G., L. B. Kirchler, J. Cothren, and S. L. Winters. (2013). Offshore Wind Turbine Visibility and Visual Impact Threshold Distances. Environmental Practice, 15:1, 33-49.

Section 9.1 In-Air Acoustics

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs Accessed from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

Cowan, J.P. (1994). *Handbook of Environmental Acoustics*. New York: Wiley.

Federal Transit Administration (FTA). (2018). *Transit Noise and Vibration Impact Assessment Manual* (Report Number 0123). FTA, Washington, DC.

International Organization for Standardization (ISO). (1996). *Acoustics- Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation*. ISO, Geneva, Switzerland.

MassDEP Noise Pollution Policy, DAQC Policy 90-001. (1990). https://www.mass.gov/doc/massdep-noise-policy/download.

World Health Organization. (WHO). (2018). *Environmental Noise Guidelines for the European Region*. p.1

Section 9.2 Underwater Acoustics

Bellmann, M.A., A. May, T. Wendt, S. Gerlach, P. Remmers & J. Brinkmann. (2020). *Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values*. 128 p.

Betke, K. (2008). *Measurement of Wind Turbine Construction Noise at Horns Rev II*. Report Number 1256-08-a-KB. Technical report by Institut für technische und angewandte Physik GmbH (ITAP) for BioConsultSH, Husun, Germany. 30 p. https://tethys.pnnl.gov/sites/default/files/publications/Betke-2008.pdf.

Betke, K., Schultz-von Glahn, M. & R. Matuschek. (2004). Underwater noise emissions from offshore wind turbines. https://tethys.pnnl.gov/sites/default/files/publications/Betke-2004.pdf.

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs Accessed from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

BOEM. (2014). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts: Revised Environmental Assessment*. Document Number 2014-603. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs.

Leggat, L.J., H.M. Merklinger & J.L. Kennedy. (1981). *LNG Carrier Underwater Noise Study for Baffin Bay*. Defence Research Establishment Atlantic, Dartmouth, NS, Canada. 32 p.

MacGillivray, A.O. (2014). *A model for underwater sound levels generated by marine impact pile driving.* Proceedings of Meetings on Acoustics 20(1). https://doi.org/10.1121/2.0000030.

NMFS. (2009). *Non-Competitive Leases for Wind Resource Data Collection on the Northeast Outer Continental Shelf*, *May 14, 2009*. Letter to Dr. James Kendall, Chief, Environmental Division, Minerals Management Service, and Mr. Frank Cianfrani, Chief – Philadelphia District, U.S. Army Corps of Engineers.

Pile Dynamics, Inc. (2010). What is a Refined Wave Equation (GRLWEAP) Analysis? https://www.pile.com/.

Reiser, C.M., D.W. Funk, R. Rodrigues & D.E. Hannay. (2011). *Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July-October 2010: 90-day report*. Report Number P1171E-1. Report by LGL Alaska Research Associates Inc. and JASCO Applied Sciences for Shell Offshore Inc, National Marine Fishery Services, and U.S. Fish and Wildlife Services. 240 + appendices p.

Reiser, C.M., D.W. Funk, R. Rodrigues & D.E. Hannay. (2010). *Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore, Inc. in the Alaskan Chukchi Sea, July-October 2009: 90-day report*. Report Number P1112-1. Technical report by LGL Alaska Research Associates Inc. and JASCO Research Ltd. for Shell Offshore Inc, National Marine Fisheries Service, and U.S. Fish and Wildlife Services. 104 pp, plus appendices.

Tetra Tech. (2014). *Hydroacoustic Survey Report of Geotechnical Activities Virginia Offshore Wind Technology Advancement Project (VOWTAP)*.

Section 10.1 Demographics and Employment, and Economics

BOEM. (2020a). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs Accessed June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2020b). Vineyard Wind 1 Offshore Wind Energy Project, Supplemental to the Draft Environmental Impact Statement. BOEM 2020-025. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. June 2020.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, BVG Associates Ltd. (2017). U.S. Job Creation in Offshore Wind. A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind. NYSERDA Report 17-22. October 2017.

Epsilon Associates, Inc. (2020). Vineyard Wind, Final Construction and Operations Plan, Volume III, 22 October 2018. Updated June 3, 2020. Accessed from: https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-construction-and-operations-plan-volume-iii.

Rhode Island Statewide Planning Program. (2013). Rhode Island Population Projections 2010-2040. Rhode Island Statewide Planning Program. April 2013. Accessed from: http://www.planning.ri.gov/documents/census/tp162.pdf.

Strate, S. (2015). University of Massachusetts, Amherst, Long-term Population Projections for Massachusetts Regions and Municipalities, Prepared for the Office of the Secretary of the Commonwealth of Massachusetts, March 2015.

U.S. Bureau of Economic Analysis. (USBEA). (2018). Regional Data, GDP and Personal Income Mapping, CAGDP1 Gross domestic product (GDP) by county and metropolitan area. Accessed from: https://apps.bea.gov/iTable/iTable.cfm?reqid=99&step=1&acrdn=6.

U.S. Census Bureau. (USCB). (2018). DP03: Selected Economic Characteristics, 2018: ACS 5-Year Estimates Data Profiles. Accessed from: https://data.census.gov/cedsci/table?g=0400000US25_0500000US25001,25005,25007,25019,25023&y=2018&d=ACS%205-Year%20Estimates%20Data%20Profiles&tid=ACSDP5Y2018.DP03&hidePreview=false&moe=false&vintage=2018&layer=VT_2018_050_00_PY_D1&cid=DP03_0001E.

USCB. (2019a). QuickFacts Plymouth County, Massachusetts; Rhode Island; Massachusetts; Dukes County, Massachusetts; Bristol County, Massachusetts; Barnstable County, Massachusetts. Accessed from: https://www.census.gov/quickfacts/fact/table/plymouthcountymassachusetts,RI,MA,dukescountymassachusetts,bristolcountymassachusetts,barnstablecountymassachusetts/PST045219.

USCB. (2019b). U.S. Census Bureau, Population Estimates Program (PEP). Quick Facts – Massachusetts; Barnstable County, Massachusetts; Bristol County, Massachusetts; Dukes County, Massachusetts; Nantucket County, Massachusetts; Plymouth County, Massachusetts. Accessed from: https://www.census.gov/quickfacts/fact/table/MA,plymouthcountymassachusetts,nantucketcountymassachusetts,dukescountymassachusetts,bristolcountymassachusetts,barnstablecountymassachusetts/INC910218#INC910218.

Section 10.2 Environmental Justice and Minority and Lower Income Groups

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs Accessed June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. U.S. Dept.

of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

Council on Environmental Quality. (CEQ). (1997). *Environmental Justice – Guidance Under the national Environmental policy Act.* Executive Office of the President. Washington D.C. Accessed from: https://www.epa.gov/sites/production/files/2015-02/documents/ej_guidance_nepa_ceq1297.pdf.

Executive Order (EO) No. 12898. (1994). *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.* Federal Register Vol. 59, No. 32, Title 3. Accessed from: https://www.archives.gov/files/federal-register/executive-orders/pdf/12898.pdf.

Federal Interagency Workgroup on Environmental Justice & NEPA Committee. (EPA). (2016). *Promising Practices for EJ Methodologies in NEPA Reviews*. Report of the Federal Interagency Working Group on Environmental Justice & NEPA Committee. Accessed from: https://www.epa.gov/sites/production/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.

MassGIS. (2021). MassGIS Data: 2020 U.S. Census Environmental Justice Populations. June. Accessed from: https://www.mass.gov/info-details/massgis-data-2020-us-census-environmental-justice-populations#overview-.

Massachusetts Executive Office of Energy and Environmental Affairs. (EEA). (2017). *Environmental Justice Policy of the Executive Office of Energy and Environmental Affairs*. Constitution of the Commonwealth of Massachusetts, Article 97.

Rhode Island Department of Environmental Management. (RIDEM). (2021). *Environmental Resource Map.* Accessed from: http://www.dem.ri.gov/maps/.

Rhode Island Department of Environmental Management. (RIDEM). (2009). *Policy for Considering Environmental Justice in the Review of Investigation and Remediation of Contaminated Properties.* SOP Number BEP-AWC-1 Effective Date 6/26/09. Revision 1. Accessed from: http://www.dem.ri.gov/envequity/pdf/ejfinal.pdf.

USCB. (2021a). *B03002 ACS Hispanic or Latino Origin by Race.* 5-Year Estimates. U.S. Census Bureau. Accessed from: https://data.census.gov/cedsci/.

USCB. (2021b). *B19013 Median Household Income in the Past 12 Months (in 2019 Inflation-Adjusted Dollars). 5-Year Estimates.* 2015-2019. U.S. Census Bureau. Accessed from: https://data.census.gov/cedsci/.

USCB. (2021c). *C17002 Ratio of Income to Poverty Level in the Past 12 Months.* 5-Year Estimates. 2015-2019. U.S. Census Bureau. Accessed from: https://data.census.gov/cedsci/.

USCB. (2019a). U.S. Census Bureau, Population Estimates Program (PEP). Quick Facts – Massachusetts; Barnstable County, Massachusetts; Bristol County, Massachusetts; Dukes County, Massachusetts; Nantucket County, Massachusetts; Plymouth County, Massachusetts. https://www.census.gov/quickfacts/fact/table/MA,plymouthcountymassachusetts,nantucketco untymassachusetts,dukescountymassachusetts,bristolcountymassachusetts,barnstablecountymassachusetts/INC910218#INC910218.

SECTION 10.3 RECREATION AND TOURISM

Brittanica. (2013). *Bristol county, Massachusetts, United States.* States & Other Subdivisions. Accessed from: https://www.britannica.com/place/Bristol-county-Massachusetts.

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036.

BOEM. (2012). Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts: Environmental Assessment.

Carr-Harris A., & C. Lang. (2019). *Sustainability and tourism: the effect of the United States' first offshore wind farm on the vacation rental market.* Department of Environmental and Natural Resource Economics, University of Rhode Island, United States. Resource and Energy Economics, Volume 57, August 2019, Pages 51-67.

Cape Cod Commission. (CCC). (2019). Cape Cod Regional Policy Plan - Barnstable County Ordinance#19-01. Accessed from: https://www.capecodcommission.org/resource-library/file/?url=/dept/commission/team/Website_Resources/RPP/Cape_Cod_Regional_Policy_Plan_Effective_02-22-2019.pdf.

Epsilon Associates, Inc. (2020). *Vineyard Wind, Final Construction and Operations Plan, Volume III, 22 October 2018. Updated June 3, 2020.* Accessed from: https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-construction-and-operations-plan-volume-iii.

Kirkpatrick, A.J., S. Benjamin, G.S. DePiper, T. Murphy, S. Steinback, and C. Demarest. (2017). *Socio-Economic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic. Volume I—Report Narrative*. U.S Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, D.C. OCS Study BOEM 2017-012. 150 pp.

Lilley M.B., Firestone J., & W. Kempton. (2010). The Effect of Wind Power Installations on Coastal Tourism. Energies 2010, 3, 1-22; doi:10.3390/en3010001

Martha's Vineyard Commission. (2020). *Open Space Protection*. Retrieved from: https://www.mvcommission.org/open-space-protection.

Massachusetts Office of Travel & Tourism. (2020). Explore Massachusetts. Accessed from: https://www.massvacation.com/explore/.

Montaup Country Club. (n.d.). Home. Accessed from: https://www.montaupcc.com/.

National Parks Service. (NPS). (2020). Annual Park Recreation Visits (1964 - Last Calendar Year) - Cape Cod NS. Accessed from: https://irma.nps.gov/STATS/Reports/Park/CACO.

Rhode Island Commerce Corporation. (2021). *Newport County, Rhode Island.* Accessed from: https://www.visitrhodeisland.com/plan/regions/newport-county/.

Southeastern Massachusetts Visitors Bureau. (2021). *Things to do: Outdoor Adventures*. Accessed from: http://visitsemass.com/outdoors/.

Starbuck K, & A. Lipsky. (2013). *2012 Northeast Recreational Boater Survey: A Socioeconomic and Spatial Characterization of Recreational Boating in Coastal and Ocean Waters of the Northeast United States.* Technical Report Dec 2013. Boston (MA): Doc #121.13.10, p.105

USCB. (2021). *DP04 Selected Housing Characteristics. 5-Year Estimates. 2015-2019*. U.S. Census Bureau. Accessed from: https://data.census.gov/cedsci/table?d=ACS%205-Year%20Estimates%20Data%20Profiles&tid=ACSDP5Y2019.DP04.

USFWS. (2017). *Nomans Land Island: National Wildlife Refuge, Massachusetts*. Retrieved from: https://www.fws.gov/refuge/Nomans_Land_Island/about.html.

Section 11.0 Commercial and Recreational Fisheries and Fishing Activity

ACCSP. (Atlantic Coastal Cooperative Statistics Program). (2021). *Comprehensive, species-specific landings database*. https://www.accsp.org.

Atlantic States Marine Fisheries Commission. (ASFMC). (2021a). *Jonah Crab*. http://www.asmfc.org/species/jonah-crab.

ASFMC. (2021b). *Black Sea Bass*. http://www.asmfc.org/species/black-sea-bass.

ASMFC. (2019a). *American Lobster*. Available online: http://www.asmfc.org/species/american-lobster.

ASMFC. (2019b). *Jonah Crab*. Available at: http://www.asmfc.org/species/jonah-crab.

ASFMC. (2017). *2017 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for: Jonah Crab* (*Cancer borealis*). http://www.asmfc.org/uploads/file/59f0fcf0JonahCrabFMP_Review_2017.pdf. Benjamin, S., Lee, M.Y. & G. DePiper. (2018). Visualizing fishing data as rasters. *NEFSC Ref Doc 18-12.* Retrieved November 2020, from: https://repository.library.noaa.gov/view/noaa/23030.

BOEM. (2020a). *Guidelines for Providing Information on Fisheries Social and Economic Conditions for Renewable Energy Development on the Atlantic Outer Continental Shelf Pursuant to 30 CFR Part 585.* Retrieved December 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/Social%20%26amp%3B%20Econ%20Fishing%20Guidelines.pdf.

BOEM. (2020b). *Environmental Studies Electromagnetic Fields (EMF) & Marine Life. Available online at:* https://www.boem.gov/sites/default/files/documents/renewable-energy/mapping-and-data/Electromagnetic-Fields-Marine-Life.pdf.

BOEM. (2020c). Commercial Wind Leasing Offshore Rhode Island And Massachusetts. Available online at: https://www.boem.gov/renewable-energy/state-activities/commercial-wind-leasing-offshore-rhode-island-and-massachusetts.

BOEM. (2014). *Development of Mitigation Measures to Address Potential Use Conflicts between Commercial Wind Energy Lessees/Grantees and Commercial Fishermen on the Atlantic Outer Continental Shelf.* Available online at: https://www.boem.gov/sites/default/files/renewable-energy-program/Fishing-BMP-Final-Report-July-2014.pdf.

BOEM. (2013). *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts.* Available online at: https://www.boem.gov/sites/default/files/uploadedFiles/BOEM/Renewable_Energy_Program/State_Activities/BOEM%20RI_MA_Revised%20EA_22May2013.pdf.

Commercial Fisheries Center of Rhode Island. (CFCRI). (2021). Who We Are. https://www.cfcri.org/about.html.

Degraer, S., R. Brabant, B. Rumes, & L. Vigin. (2016). Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Environmental impact monitoring reloaded. *Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management Section: Brussels*. Available online at: http://www.vliz.be/en/catalogue?module=ref&refid=282994&printversion=1&dropIMIStitle=1.

DePiper, G.S. (2014). Statistically assessing the precision of self-reported VTR fishing locations. NOAA technical memorandum NMFS-NE-229*. Doi: 10.7289/V53F4MJN.*

Edmonds, N., C. Firmin, D. Goldsmith, R. Faulkner & D. Wood. (2016). A review of crustacean sensitivity to high amplitude underwater noise: Data needs for effective risk assessment in relation to UK commercial species*. Marine Pollution Bulletin*, 108:5-11. Available online at: https://doi.org/10.1016/j.marpolbul.2016.05.006.

Equinor Wind US, Eversource Energy, Mayflower Wind, Orsted North America, and Vineyard Wind LLC. (2019). *Letter to Mr. Michael Emerson, RE: Proposal for a uniform 1 x 1 NM wind turbine layout for New England Offshore Wind*, 1 November 2019. Available online at: https://static1.squarespace.com/static/5a2eae32be42d64ed467f9d1/t/5dd3d3e476d4226b2a83db25/1574163438896/Proposed+1x1+layout+from+RI-MA+Leaseholders+1+Nov+19+%281%29.pdf.

Giannini, C. and P. Howell. (2010). *Connecticut Lobster (Homarus americanus) Population Studies*. NOAA - NMFS, Northeast Region, New London, Connecticut.

Gilkinson, K. Fader, G.B.K. Gordon, D.C. & R. Charron. (2003). Immediate and longer-term impacts of hydraulic clam dredging on an offshore sandy seabed: Effects on physical habitat and processes of recovery. *Continental Shelf Research 23:1315-1336.* Available online: https://doi.org/10.1016/S0278-4343(03)00123-7.

Gill, A. & M. Desender. (2020). *State of the Science Report – Chapter 5: Risks to Animals from Electromagnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices.* In. A. Copping and L. Hemery (eds.), OES-Environmental 2020 State of the Science Report:

Environmental Effects of Marine Renewable Energy Development Around the World. Report for Ocean Energy Systems. Available online at: https://tethys.pnnl.gov/publications/state-of-the-science-2020-chapter-5-electromagnetic-fields.

Gomez-Chiarri, M. & J.S. Cobb. (2012). Shell Disease in the American Lobster, Homarus americanos: A Synthesis of Research from the New England Lobster Research Initiative: Lobster Shell Disease. *Journal of Shellfish Research*, 31(2) : 583-590. https://bioone.org/journals/journal-of-shellfish-research/volume-31/issue-2/035.031.0219/Shell-Disease-in-the-American-Lobster-iHomarus-americanus-i/10.2983/035.031.0219.pdf.

Google. (2021). Rhode Island Rec Fishing Spots. https://www.google.com/maps/d/viewer?mid=1WSyUlmF186poGIJfDHf_C_lpwh62bpdh&ll=41.5427073398297%2C-71.45751485&z=10.

Greater Atlantic Regional Fisheries Office. (GARFO). (2020). *Vessel Logbook Database*. Retrieved from: https://www.fisheries.noaa.gov/inport/item/11489.

Guida, V.A, Drohan, H., Welch, J., McHenry. D., Johnson, V., Kentner, J., Brink, D., Timmons, J., Pessutti, S., Fromm, E., & Estela-Gomez. (2017). *Habitat Mapping and Assessment of Northeast Wind Energy Areas.* https://espis.boem.gov/final%20reports/5647.pdf.

HDR. (2019). *Benthic Monitoring During Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island—Year 2*. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2019-019. 318 pp. Available online at: https://espis.boem.gov/final%20reports/BOEM_2019-019.pdf.

Holland, S.C, Oh. S., Larkin & A. Hodges. (2012). *The Operations and Economics of the For-Hire Fishing Fleets of the South Atlantic States and the Atlantic Coast of Florida.* https://fred.ifas.ufl.edu/pdf/Holland.pdf.

Hutchison, Z.L., P. Sigray, H. He, A.B. Gill, J. King & C. Gibson. (2018). *Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables.* Sterling (VA): U.S. Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-003.

Itano, D. & K. Holland (2000). Movement and vulnerability of bigeye (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) in relation to FADs and natural aggregation points. *Aquatic Living Resources, Volume 13, Issue 4, 2000, Pages 213-223.*https://doi.org/10.1016/S0990-7440(00)01062-7.

Kirkpatrick, A.S. (2017). *SocioEconomic Impact of Outer Continental Shelf Wind Energy Development on Fisheries in the U.S. Atlantic.* Washington, DC: U.S Dept. of the Interior, Bureau of Ocean Energy Management. Retrieved from: https://tethys.pnnl.gov/sites/default/files/publications/Kirkpatrick-et-al-2017-BOEM-Vol2.pdf.

Liberman, Ellen. (2017). Squid fishing is a boon to the local economy*. Rhode Island Monthly. May 30, 2017.* Available online: https://www.rimonthly.com/squid-fishing-boon-local-economy/.

Maine Sea Grant. (n.d.). *Maine Seafood Guide – Crab.* https://seagrant.umaine.edu/maine-seafood-guide/crab/.

Massachusetts Division of Marine Fisheries. (MA DMF). (2021a). *Whelks and Whelk Management.* https://www.mass.gov/service-details/whelks-and-whelk-management.

MA DMF. (2021b). *Recreational saltwater fishing regulations*. https://www.mass.gov/service-details/recreational-saltwater-fishing-regulations.

MA DMF. (2020). *Characterization of the Massachusetts Spring Longfin Squid Fishery.* https://www.mass.gov/doc/2020-longfin-squid-trawl-fishery-report/download.

MA DMF. (2018a). *Annual Report.* 102 pp. Retrieved from: https://www.mass.gov/doc/2018-dmf-annual-report/download.

MA DMF. (2018b). *A Stock Assessment of Channeled Whelk (Busycotypus canaliculatus) in Nantucket Sound, Massachusetts.* https://www.researchgate.net/publication/324058768_A_Stock_Assessment_of_Channeled_Whelk_Busycotypus_canaliculatus_in_Nantucket_Sound_Massachusetts.

Massachusetts Office of Coastal Zone Management. (CZM). (2015). *Massachusetts Ocean Management Plan.* 197 pp. Retrieved from: https://www.mass.gov/service-details/massachusetts-ocean-management-plan.

Massachusetts Saltwater E-Regulation. (2020). *Commonly Caught Species.* Retrieved from: http://www.eregulations.com/massachusetts/fishing/saltwater/commonly-caught-species/.

MAFMC. (2021a). Mid-Atlantic Fishery Management Council. Overview. *Mackerel, Squid, and Butterfish.* https://www.mafmc.org/msb.

MARCO. (n.d.). Mid-Atlantic Region Council on the Ocean. *Mid-Atlantic Ocean Data Portal.* Retrieved from: http://portal.midatlanticocean.org/.

Minerals Management Service. (2009). *U.S. Coast Guard Assessment of Potential Impacts to Marine Radar as it relates to Marine Navigation Safety from the Nantucket Sound Wind Farm as Proposed by Cape Wind, LLC.* Available online at: https://users.ece.utexas.edu/~ling/US2%20USCGRADARfindingsandrecommendationsFINAL.pdf.

Moore, K. (2020). Recreational fishermen wade into offshore wind. *National Fishermen.* Feb 11, 2020. Available online at: https://www.nationalfisherman.com/mid-atlantic/recreational-anglers-wade-into-offshore-wind.

MLA. (2021). Massachusetts Lobsterman's Association Mission Statement. https://lobstermen.com/about/mission-statement/.

NASCA. (2019). North American Submarine Cable Association. *Cable Burial Experience on the Northeast Coast of the United States.* Available online at: https://www.n-a-s-ca.org/app/download/6817691613/NASCA+Cable+Burial+Experience+Northeast+Coast+of+the+United+States.pdf?t=1567615190.

NEFMC. (2021). New England Fishery Management Council. *Small-mesh Multispecies FMP. Plan Overview.* https://www.nefmc.org/management-plans/small-mesh-multispecies.

NOAA. (2016). *The Economic Contribution of Marine Angler Expenditures on Durable Goods in the United States, 2014*. Sabrina J. Lovell, J. Hilger, S. Steinback, and C. Hutt. Available online at: https://www.st.nmfs.noaa.gov/Assets/economics/durable-expenditures/documents/TM165_Durable_Goods_2014.pdf.

NOAA Fisheries. (NMFS). (2021a). NOAA Fisheries Landing Queries. Retrieved from: https://foss.nmfs.noaa.gov/apexfoss/f?p=215:200.

NMFS. (2021b). *Fisheries of the United States 2019*. https://media.fisheries.noaa.gov/2021-05/FUS2019-FINAL-webready-2.3.pdf?null=.

NMFS. (2020a). *Socioeconomic Impacts of Atlantic Offshore Wind Development.* Retrieved November 2020, from: https://www.fisheries.noaa.gov/resource/data/socioeconomic-impacts-atlantic-offshore-wind-development.

NMFS. (2020b). *Fisheries of the United States, 2018*. Silver Spring, MD: U.S. Dept. of Commerce, NOAA Tech. https://www.fisheries.noaa.gov/feature-story/fisheries-united-states-2018.

NMFS. (2020c). *Saltwater Recreational Fishing in the Greater Atlantic Region.* Retrieved November 2020 from: https://www.fisheries.noaa.gov/new-england-mid-atlantic/recreational-fishing/saltwater-recreational-fishing-greater-atlantic.

NMFS. (2019a). *Recreational Fishing Data and Statistics Queries*. Accessed from NOAA Fisheries Recreational Fishing Data: https://www.fisheries.noaa.gov/recreational-fishing-data/recreational-fishing-data-and-statistics-queries.

NMFS. (2019b). *Fishing Gear: Bottom Trawls.* https://www.fisheries.noaa.gov/national/bycatch/fishing-gear-bottom-trawls.

NMFS. (2019c). *Fishing Gear: Traps and Pots.* https://www.fisheries.noaa.gov/national/bycatch/fishing-gear-traps-and-pots.

NMFS. (2019e). *Fishing Gear: Gillnets.* https://www.fisheries.noaa.gov/national/bycatch/fishing-gear-gillnets.

NMFS. (2016). *Fisheries Economics of the United States 2016.* Silver Spring, MD: U.S. Dept. of Commerce, NOAA Tech. Published November 07, 2018. https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-2016-infographics.

NMFS. (n.d.). Regional Vessel Monitoring Information. Vessel monitoring system (VMS) requirements information according to each region. https://www.fisheries.noaa.gov/national/enforcement/regional-vessel-monitoring-information.

Northeast Regional Ocean Council. (NROC). (2018). *Vessel Monitoring Systems (VMS) Commercial Fishing Density, Northeast and Mid-Atlantic Regions.* Data download: https://services.northeastoceandata.org/arcgis1/rest/services/OceanUses.

NYSERDA (New York State Energy Research and Development Authority). (2017). *NYS Offshore Wind Master Plan.* Available online: https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Offshore-Wind-in-New-York-State-Overview/NYS-Offshore-Wind-Master-Plan.

Orsted. (2020). Lobster populations remain healthy as wind farm study results are published. Holderness Fishing Industry Group. *Orsted Press Release.* https://orsted.co.uk/media/newsroom/news/2020/07/lobster-populations-remain-healthy-as-wind-farm-study-results-are-published.

Rawson, A. & E. Rogers. (2015). Assessing the impacts to vessel traffic from offshore wind farms in the Thames Estuary. *Scientific Journals of the Maritime University of Szczecin.* 43. 99-107. https://www.researchgate.net/publication/316460284_Assessing_the_impacts_to_vessel_traffic_from_offshore_wind_farms_in_the_Thames_Estuary.

Reubens, J.T, S. Degraer & M. Vincx. (2011). Aggregation and feeding behaviour of pouting (Trisopterus luscus) at wind turbines in the Belgian part of the North Sea. Journal of Fisheries Research. Volume 108, Issue 1, 2011, pp. 223-227. https://doi.org/10.1016/j.fishres.2010.11.025.

Rhode Island Coastal Resources Management Council. (CRMC). (2018). CRMC *Federal Consistency Manual*. http://www.crmc.ri.gov/regulations/Fed_Consistency.pdf.

CRMC. (2010). *Rhode Island Ocean SAMP*. https://seagrant.gso.uri.edu/oceansamp/pdf/samp_crmc_revised/RI_Ocean_SAMP.pdf.

RIDEM. (2021a). *Marine Fisheries Minimum Sizes and Possession Limits*. http://www.dem.ri.gov/programs/marine-fisheries/mfsizes.php#recre.

RIDEM. (2021b) *RIDEM Marine Fisheries Maps*. https://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=8beb98d758f14265a84d69758d96742f.

RIDEM. (2021c). *Recreational Fishing*. http://www.dem.ri.gov/programs/marine-fisheries/recreational-fishing.php.

Rhode Island Department of State. (RI DOS). (n.d.). *General Equipment Provisions*. https://rules.sos.ri.gov/regulations/part/250-90-00-6.

Roberts, L., H. Harding, I. Voellmy, R. Bruintjes, S. Simpson, A. Radford, T. Breithaupt & M. Elliot. (2016). *Exposure of benthic invertebrates to sediment vibration: From laboratory experiments to outdoor simulated pile-driving.* Proceedings of Meetings on Acoustics: Fourth International Conference on the Effects of Noise on Aquatic Life, 27:1-10. Available online at: https://doi.org/10.1121/2.0000324.

Steinback, S. & A. Brinson. (2013). *The Economics of the Recreational For-hire Fishing Industry in the Northeast United States,* 2nd ed. Northeast Fisheries Science Center Social Sciences Branch, NOAA Fisheries. Woods Hole, MA. https://www.savingseafood.org/images/recreational_econ.pdf.

The Port of New Bedford. (2021). *The New Bedford Port Authority.* https://portofnewbedford.org/the-new-bedford-port-authority/.

USCG. (2020). *The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study.* Final, USCG-2019-0131, dated 14 May 2020, published 27 May 2020. https://www.federalregister.gov/documents/2020/05/27/2020-11262/port-access-route-study-the-areas-offshore-of-massachusetts-and-rhode-island.

van der Stap, R & J. Coolen. (2016). Marine Fouling Assemblages on Offshore Gas Platforms in the Southern North Sea: Effects of Depth and Distance from Shore on Biodiversity. *PLoS ONE 11(1): e0146324.* https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0146324.

van Hal, R., Griffioen, A.B. & O.A. van Keeken. (2017). Changes in fish communities on a small spatial scale, an effect of increased habitat complexity be an offshore wind farm. *Journal of Marine Environmental Research. Volume 126*. Available online at: https://pubmed.ncbi.nlm.nih.gov/28231443/.

Wilber, D., Carey, D. & M. Griffin. (2018). Flatfish habitat use near North America's first offshore wind farm. *Journal of Sea Research*, 139:24-32. Available online at: https://doi.org/10.1016/j.seares.2018.06.004.

Wilhelmsson, D., Malm, T. & M. Öhman. (2006). The influence of offshore wind power on demersal fish. *ICES Journal of Marine Science*, 63(5):775-784. Available online at: https://doi.org/10.1016/j.icesjms.2006.02.001.

SECTION 12.0 ZONING AND LAND USE

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0*. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). *National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf*. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study 2019- 036. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/IPFs-in-the-Offshore-Wind-Cumulative-Impacts-Scenario-on-the-N-OCS.pdf.

Falmouth, Massachusetts. (2020). Beach Department. Accessed from Beach Department: http://www.falmouthmass.us/152/Beach-Parking-Stickers.

Massachusetts Government (Mass.gov.). (2020). *Massachusetts Law About Zoning*. Accessed from Mass.gov: https://www.mass.gov/info-details/massachusetts-law-about-zoning.

Massachusetts Office of Coastal Zone Management. (CZM). (2020). *About CZM*. Accessed from Mass.gov: https://www.mass.gov/orgs/massachusetts-office-of-coastal-zone-management.

Rhode Island Coastal Resources Management Council. (CRMC). (n.d.). Strategic Planning. Available online at: http://www.crmc.ri.gov/strategicplanning.html.

Rhode Island. State of Rhode Island. (2014). Statewide Planning Program. http://www.planning.ri.gov/documents/local/RIGeneral_Laws_Land_Use%20_Planning.pdf.

Town of Falmouth, Massachusetts. (2020). Zoning Bylaw. https://www.falmouthma.gov/DocumentCenter/View/8559/Falmouth-Zoning-Bylaw-Recodification-Clean-Copy-for-April-2021-Town-Meeting.

Town of Falmouth, Massachusetts. (2021). Falmouth Zoning Map. https://www.falmouthma.gov/DocumentCenter/View/802/Falmouth-Zoning-Map-PDF.

Town of Portsmouth, Rhode Island. (2002). Portsmouth Official Zoning Map. https://www.portsmouthri.com/DocumentCenter/View/3157/Map-6---Portsmouth-Official-Zoning-Map.

Town of Portsmouth, Rhode Island. (2012). Zoning Ordinance. https://www.portsmouthri.com/DocumentCenter/View/39/Zoning-Ordinance-.

Town of Somerset, Massachusetts. (2020). Zoning Bylaw. https://www.townofsomerset.org/sites/g/files/vyhlif3821/f/uploads/zoning_by_law_amended_atm_8.20.20.pdf.

Town of Somerset, Massachusetts. (2021). Official Zoning Map. https://www.townofsomerset.org/sites/g/files/vyhlif3821/f/uploads/current_officialzoning_july_2021.pdf.

SECTION 13.0 NAVIGATION AND VESSEL TRAFFIC

BOEM. (2021). *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development.* https://www.boem.gov/sites/default/files/documents/renewable-energy/2021-Lighting-and-Marking-Guidelines.pdf.

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). Draft Proposed Guidelines for Providing Information on Lighting and Marking of Structures Supporting Renewable Energy Development, United States Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, October 2019. https://www.boem.gov/sites/default/files/documents/renewable-energy/Lighting-and-Marking-Guidelines.pdf. Accessed 30 September 2020.

International Civil Aviation Organization. (ICAO). (2013). *Annex 14: Aerodromes, Volume 1 Aerodrome Design and Operations,* Sixth Ed., July 2013.

International Association of Lighthouse Authorities. (IALA). (2013). *IALA Recommendation O-139 on the Marking of Man-Made Offshore Structures*, Ed. 2, December 2013.

IALA. (2017). *IALA Recommendation R1001 – The IALA Maritime Buoyage System*, Ed. 1.0, June 2017.

International Maritime Organization. (IMO). (1972). *Convention on the International Regulations for Preventing Collisions at Sea* (COLREGS), Adoption: 20 October 1972; Entry into force: 15 July 1977.

IMO. (2019). International Maritime Organization: Ships' Routing (webpage): http://www.imo.org/en/OurWork/Safety/Navigation/Pages/ShipsRouteing.aspx.

MarineTraffic. (2020). *Automatic Identification System data acquired from MarineTraffic*, Historical AIS-T and AIS-S data for TIMESTAMP between '2019-01-01 00:00' and '2019-12-31 23:59' UTC, for LAT between 40.24432 and 41.2633 and LON between -71.1037 and -69.7495 and for LAT between 41.25375 and 41.68632 and LON between -70.6774 and -70.1139, July 2020.

NOAA. (2020). United States Coast Pilot Volume 2. *Atlantic Coast: Cape Cod, Massachusetts to Sandy Hook, New Jersey* – 50th Edition, 2020. https://nauticalcharts.noaa.gov/publications/coast-pilot/files/cp2/CPB2_WEB.pdf.

USCG. (2020a). *The Areas Offshore of Massachusetts and Rhode Island Port Access Route Study*, Final, USCG-2019-0131, dated 14 May 2020, published 27 May 2020.

USCG. (2020b). *ME, NH, MA, RI, CT, NY, NJ-ATLANTIC OCEAN-OFFSHORE STRUCTURE PATON MARKING GUIDANCE-Revised*, First District Local Notice to Mariners, District: 1, Week: 44/20, 05 November 2020. https://www.navcen.uscg.gov/pdf/lnms/lnm01442020.pdf.

SECTION 14.0 OTHER MARINE USES

AECOM. (2020). *Mayflower Wind, Military Activity Study*.

BOEM. (2021). *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development.* https://www.boem.gov/sites/default/files/documents/renewable-energy/2021-Lighting-and-Marking-Guidelines.pdf.

BOEM. (2020a). Commercial Leases OCS-A 0520, 0521, and 0522. https://www.boem.gov/renewable-energy/state-activities/commercial-leases-ocs-0520-0521-and-0522.

BOEM. (2020b). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2020c). *Vineyard Wind 1 Offshore Wind Energy Project, Supplement to the Draft Environmental Impact Statement.* https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-1-Supplement-to-EIS.pdf.

BOEM. (2019). National Environmental Policy Act Documentation for Impact-Producing Factors in the Offshore Wind Cumulative Impacts Scenario on the North Atlantic Continental Shelf. OCS Study 2019- 036.

BOEM. (2013). Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts, Revised Environmental Assessment. Office of Renewable Energy Programs. OCS EIS/EA. BOEM 2013-1131. https://www.boem.gov/renewable-energy/state-activities/commercial-wind-leasing-offshore-rhode-island-and-massachusetts.

Capitol Airspace Group. (CAG). (2020a). Obstruction Evaluation & Airspace Analysis. Mayflower Offshore Wind Project. Offshore Nantucket, Massachusetts.

CAG. (2020c). *Aircraft Detection Lighting System (ADLS) Efficacy Analysis.* Mayflower Offshore Wind Project, Offshore Nantucket, Massachusetts.

Ecology and Environment, Inc. (E&E). (2016). *Military Range Complex*. Environmental Common Operating Picture (COP) GIS metadata. Prepared for Naval Facilities Engineering Command (NAVFAC) Atlantic. https://www.northeastoceandata.org/files/metadata/Themes/Security/NEMilitaryRangeComplex.pdf.

Martha's Vineyard Airport. (MVY). (2019). Airlines. Retrieved from: https://mvyairport.com/airlines/.

Nantucket Memorial Airport. (NMA). (2020). Airlines and Destinations. Retrieved from: https://www.nantucket-ma.gov/618/Airlines-and-Destinations.

Rhode Island Coastal Resources Management Council. (CRMC). (2010). Rhode Island Ocean, *Special Area Management Plan*. Adopted by the RI CRMC on October 19, 2010. http://seagrant.gso.uri.edu/oceansamp/documents.html.

USACE. (2019). FUDS (Formerly Used Defense Sites Program) *Annual Report to Congress—2019*. https://ags02.sec.usace.army.mil/portal/apps/webappviewer/index.html?id=afacf8394c8a43c5b960eb1cf9145738.

FAA. (2019). Order 7400.2M 5-1-4(a). Procedures for Handling Airspace Matters. https://www.faa.gov/documentLibrary/media/Order/7400.2M_Bsc_w_Chg_1_2_3_dtd_12_31_20_For_Post.pdf.

FAA. (2020). Advisory Circular No. AC 70/7460-1M. Obstruction Marking and Lighting. Retrieved from: https://www.faa.gov/documentLibrary/media/Advisory_Circular/Advisory_Circular_70_7460_1M.pdf.

Westslope Consulting, LLC. (2020). *Radar and Navigational Aid Screening Study*. Mayflower Offshore Wind Project.

SECTION 15.0 PUBLIC HEALTH AND SAFETY

BOEM. (2020). *Information Guidelines for a Renewable Energy Construction and Operations Plan (COP)*, Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.

BOEM. (2019). Department of the Interior Policy Statement on Regulating

BSEE. (2019). *Renewable Energy Policy Statement*. https://www.bsee.gov/what-we-do/renewable-energy/renewable-energy-policy-statement.

Etkin, Dagmar Schmidt, PhD. (2006). *Oil Spill Probability Analysis for the Cape Wind Energy Project in Nantucket Sound*. Environmental Research Consulting. Cortlandt Manor, NY. https://www.boem.gov/sites/default/files/renewable-energy-program/Studies/CWfiles/SL-ERC2006OilSpillProbability.pdf.

Transportation Research Board of the National Academies. (TRBNA). (2013). Worker Health and Safety *on Offshore Wind Farms.* Special Report 310. TAP 686aa. ISBN 978-0-309-26326-9. https://www.bsee.gov/sites/bsee.gov/files/tap-technical-assessment-program//686aa.pdf.

Section 16.0 Summary of Avoidance, Minimization and Mitigation Measures

BOEM. (2020). Information Guidelines for a Renewable Energy Construction and Operations Plan (COP), Version 4.0. Retrieved June 2020 from: https://www.boem.gov/sites/default/files/documents/about-boem/COP%20Guidelines.pdf.