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VINEYARD WIND

Draft
Construction and Operations Plan

Volume III
Text

Vineyard Wind Project

June 3, 2020

Submitted by
Vineyard Wind LLC
700 Pleasant Street, Suite 510
New Bedford, Massachusetts 02740

Submitted to
Bureau of Ocean Energy Management
45600 Woodland Road
Sterling, Virginia 20166

Prepared by
Epsilon Associates, Inc.
3 Mill & Main Place, Suite 250
Maynard, Massachusetts 01754

Epsilon
ASSOCIATES INC.

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In Association with:

Baird & Associates
Biodiversity Research Institute
C2Wind
Capitol Air Space Group
Clarendon Hill Consulting
Ecology and Environment
Foley Hoag
Geo SubSea LLC
Gray & Pape
JASCO Applied Sciences
Morgan, Lewis & Bockius LLP
Public Archaeology Laboratory, Inc.
RPS
Saratoga Associates
Swanson Environmental Associates
Wood Thilsted Partners Ltd
WSP

June 3, 2020

Section 6.0

Biological Resources

6.0 BIOLOGICAL RESOURCES

6.1 Terrestrial Fauna Including Inland Birds

This section addresses impacts to terrestrial wildlife species, including inland birds, associated with the Project's onshore facilities. These facilities, which include a duct bank, splice vaults, and an onshore substation, are described in detail in Section 2.2.1 and are located between the potential Landfall Sites in Barnstable or Yarmouth and the Project's utility interconnection point in Barnstable.

Coastal and marine birds are discussed in Section 6.2 and bats are discussed in Section 6.3. Coastal habitats are discussed in Section 6.4.

6.1.1 Description of the Affected Environment

The terrestrial areas impacted by the Project include those along the Onshore Export Cable Route, the Project's onshore substation, and utility interconnection point at the Barnstable Switching Station or West Barnstable Substation. Coastal areas and habitat impacted by the Project's horizontal directional drilling ("HDD") Landfall Site are discussed in Section 6.4, below.

6.1.1.1 Terrestrial Habitats

Onshore Export Cable Route

As described in Section 3.0 of Volume I and as shown on Figure 2.2-1 in Volume I, the Project Envelope includes two main Onshore Export Cable Routes: one from the Covell's Beach Landfall Site to the onshore substation (the Western Onshore Export Cable Route) and a second from either the New Hampshire Avenue to the onshore substation (the Eastern Onshore Export Cable Route). For both Onshore Export Cable Routes, the majority of each route is located beneath paved roadways that pass through residential and commercial areas and have sufficiently wide shoulders to avoid impacts to terrestrial wildlife habitat.

The segments of the Onshore Export Cable Routes that are not located beneath paved roadways follow other previously disturbed corridors, such as railroad and electric transmission rights-of-way ("ROW"), thereby minimizing potential impacts to terrestrial wildlife. A description of the two potential Onshore Export Cable Routes is included below.

Western Onshore Export Cable Route from Covell's Beach Landfall Site

- Approximately 2.6 kilometers ("km") (1.6 miles ["mi"]) of the Western Onshore Export Cable Route is located off-road and along a utility ROW. This route crosses active sand and gravel mining and processing facility, several commercial properties, and an area controlled by the Town of Barnstable and subject to a conservation restriction. Outside of the active industrial and commercial areas, the ROW is managed by the utility to exclude incompatible vegetation, including most trees and all tall-growing plant species. As a result of these management practices, the habitat within the utility ROW is predominantly grass and scrubland.

Eastern Onshore Export Cable Route from New Hampshire Avenue

- Approximately 0.8 km (0.5 mi) of the Eastern Onshore Export Cable Route is located along a railroad corridor owned and operated by the Massachusetts Department of Transportation. Within this segment, the duct bank would be installed beneath the existing rail bed, requiring temporary removal of the rails and ties. This work would take place during the winter months when the railroad is not in service. The rail bed would then be restored to preconstruction condition. The duct bank installation for this segment can be completed entirely within a previously disturbed area thereby minimizing direct disturbance to any adjacent wildlife habitat.

- Approximately 1.9 km (1.2 mi) of the Eastern Onshore Export Cable Route is located off-road and along a utility ROW. This route traverses a rolling landscape that is actively managed by the utility to exclude incompatible vegetation, including most trees and all tall-growing plant species. As a result of these management practices, the habitat within the utility ROW is predominantly grass and scrubland with graminoids, goldenrods (*Solidago* spp.), asters (Asteraceae), and various forbs. Low-growing shrubs include Scrub Oak (*Quercus ilicifolia*), Sweet Fern (*Comptonia peregrina*), Bayberry (*Morella pensylvanica*), Southern Arrowwood (*Viburnum dentatum*), Northern Arrowwood (*V. recognitum*), Green Briar (*Smilax rotundifolia*), Highbush Blueberry (*Vaccinum corymbosum*), Lowbush Blueberry (*V. angustifolium*), and Huckleberry (*Gaylussacia baccata*).

  The Project is also evaluating a route variant that would follow a proposed bike path approximately 2.1 km (1.3 mi) through the Hyannis Ponds Wildlife Management Area ("HPWMA") as an alternative to the preferred routing within the utility ROW. The HPWMA is predominately a Pine-Oak forest community. Vegetation is comprised primarily of Pitch Pine *(Pinus rigida)* and Scarlet Oak *(Quercus coccinea)* in the tree layer with Black Huckleberry *(Gaylussacia baccata)* and Lowbush Blueberry *(Vaccinium angustifolium)* dominant in the understory. Bracken Fern *(Pteridium aquilinum)* and Teaberry *(Gaultheria procumbens)* are common ground covers. The HPWMA is managed by the Massachusetts Division of Fisheries and Wildlife ("MassDFW") for both hunting and passive recreation purposes.

> Approximately 0.6 km (0.4 mi) of the Eastern Onshore Export Cable Route is located along an unimproved dirt access road that leads from Mary Dunn Road to the utility ROW and Barnstable Switching Station. This access road varies in width from 3.7 to 6.1 meters ("m") (12 to 20 feet ["ft"]) and is located directly south of the Route 6 highway layout. Duct bank installation in this segment would require clearing of approximately 740 square meters ("m^2") (8,000 square feet ["ft^2"]) of vegetation, primarily Pitch Pine and Oak saplings, along the more narrow sections of the access road.

Along the portion of either Onshore Export Cable Route, no areas of rare species habitats have been mapped by the MassDFW, Natural Heritage and Endangered Species Program ("NHESP"). Coastal rare species habitat associated with the Landfall Sites are discussed in Section 6.4.

Additionally, no segment of any Onshore Export Cable Route crosses wetlands. However, the Onshore Export Cable Route from the New Hampshire Avenue Landfall Sites crosses over a culvert that carries Thornton Brook beneath Higgins Crowell Road in Yarmouth (see Figure 6.1-1). For this route, there are also two wetland areas adjacent to the utility ROW: one on the north side of the corridor just west of the railroad in Yarmouth (see Figure 6.1-1) and another along the south side of the corridor and just west of Mary Dunn Road (see Figure 6.1-2). At both of these locations, the Onshore Export Cable Route is more than 30 m (100 ft) from these wetland areas and they will not be impacted by the Project. There are no other wetland areas within 30 m (100 ft) of the Project's onshore facilities.

Onshore Substation Site

The Project's onshore substation is located on the eastern portion of a previously developed site within the Independence Park commercial/industrial area in Barnstable, as shown in Figures 6.1-1 and 6.1-2. The site consists of approximately 0.03 km^2 (8.55 acres) of mostly wooded land, but the site also includes previously disturbed land, portions of an existing building (the Cape Cod Times Production Center), a small building on the northern portion of the site, paved circulation roads, landscaped dividers, and parking lots for the former Cape Cod Times Production Center. The topography of the site is moderately hilly with elevations ranging from a low of approximately 18 m (60 ft) (NAVD88) in the southern portion to approximately 30 m (100 ft) along the northern boundary (Town of Barnstable GIS).

The site vegetation is comprised primarily of Pitch Pine and Scarlet Oak in the tree layer with Black Huckleberry and Lowbush Blueberry dominant in the understory. Bracken Fern and Teaberry are present as ground covers. These types of Pitch Pine-Oak forests are very common on Cape Cod, often developing in sandy areas that have been subjected to repeated burnings (DeGraaf and Yamasaki, 2001).

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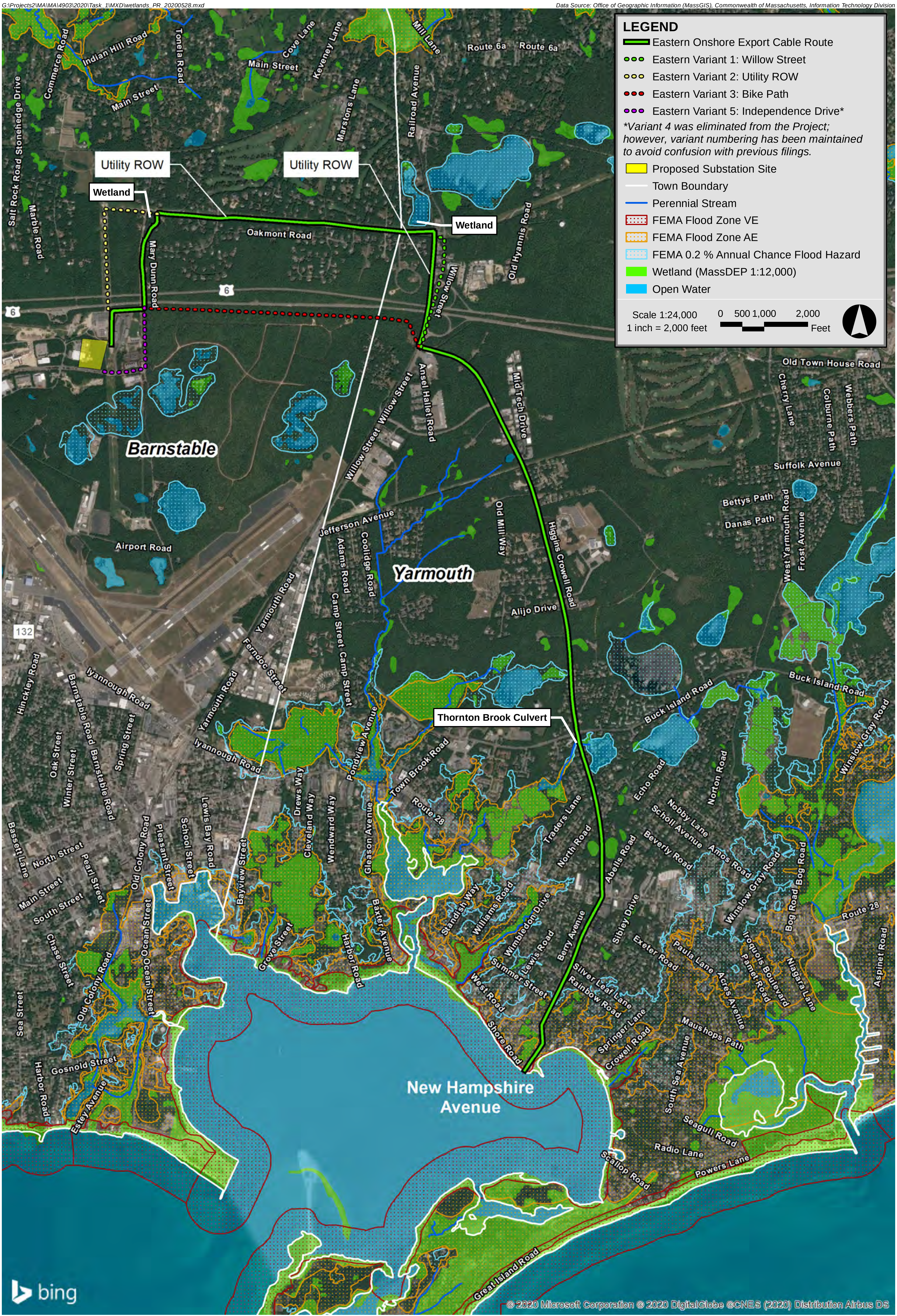
Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes. Map Projection: NAD83 UTM Zone 19

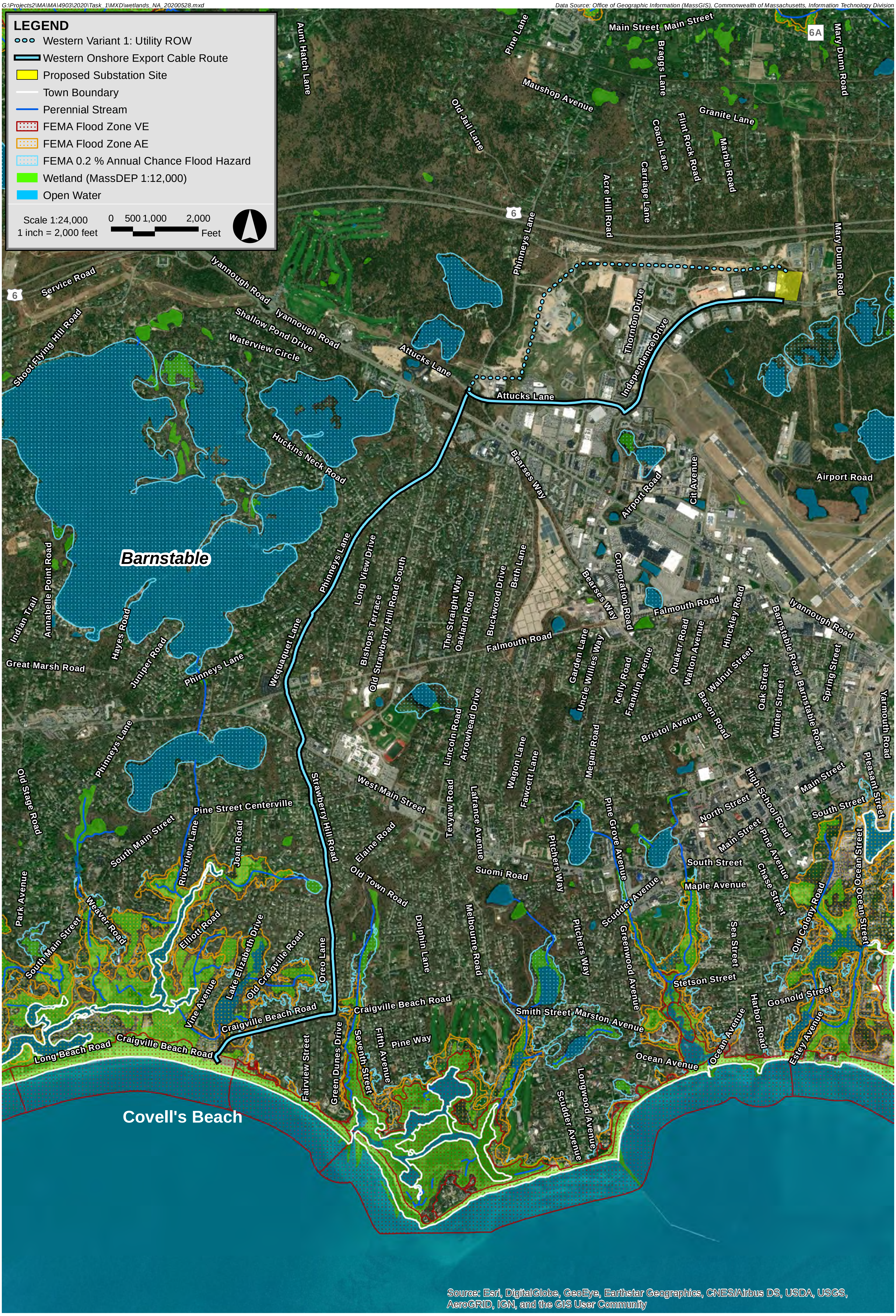
Vineyard Wind Project

VINEYARD WIND

Figure 6.1-1

Wetlands Proximate to the Onshore Export Cable Route (New Hampshire Avenue)

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 6.1-2

Wetlands Proximate to the Onshore Export Cable Route (Covell's Beach Landfall)

As the site lacks any available water source, it does not provide suitable habitat for amphibians or other non-avian animal species with limited home range. However, some small ponds are located within 430 m (1,400 ft) of the site, which is well within the range of several mammal species commonly found on Cape Cod (see Section 6.1.1.2).

6.1.1.2 Terrestrial Fauna including Inland Birds

Massachusetts hosts a diversity of wildlife habitats. Species distribution across the state is reflective of this diversity. However, many specialized wildlife species that are known to occur in other parts of the state are virtually absent from Cape Cod, where Pitch Pine-Oak forests and scrub-shrub habitats predominate. Conversely, the coastal areas of the Project Area are favored by many species that are not present in appreciable numbers farther inland (Natural Heritage & Endangered Species Program, 2016). The species that are mentioned in this section are known to commonly occur in areas that are affected by the portion of the onshore export cable installation and onshore substation construction. Refer to Section 6.4 for a discussion of wildlife species that are known to commonly occur along the coast and are likely present at or near the cable Landfall Sites.

Wildlife expected to be present along the Onshore Export Cable Route or at the onshore substation include species known to inhabit Pine-Oak forests, which is the dominant forest type found on Cape Cod and southeastern Massachusetts. Mammals known to occur in this type of habitat include, but are not limited to: White-tailed Deer (*Odocoileus virginianus*), Coyote (*Canis latrans*), Red Fox (*Vulpes vulpes*), Virginia Opossum (*Didelphis virginiana*), Woodchuck (*Marmota monax*), Striped Skunk (*Mephitis mephitis*), Common Raccoon (*Procyon lotor*), White-footed Mouse *(Peromyscus maniculatus),* and other small rodents. (DeGraaf and Yamasaki, 2001)

Reptiles and amphibians at the site include, but are not limited to: Northern Redback Salamander *(Plethodon cinereus)*, AmericanToad *(Bufo americanus)*, Spring Peeper *(Hyla crucifer)*, Wood Frog *(Rana sylvatica)*, Leopard Frog *(Rana pipiens)*, Green Frog *(Rana clamitans)*, Snapping Turtle *(Chelydra serpentina)*, Garter Snake *(Thamnophis sirtalis)*, and Black Racer *(Coluber constricta)* (DeGraaf and Yamasaki, 2001).

Birds that may be present include: 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)*, Whip-poor-will *(Caprimulgus vociferous)*, 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 Thush *(Catharus guttatus)*, Ovenbird *(Seiurus aurcopillus)*, Eastern Towhee *(Pipilo erythro-phtalmus),* Yellow-rumped Warbler *(Setophaga coronate),* Eastern Phoebe *(Sayornis phoebe),* and Chipping Sparrow *(Spizella passerine).* (DeGraaf and Yamasaki, 2001)

Representative wildlife species lists developed by the US Fish and Wildlife Service for a Pine-Oak forest at the Massasoit National Wildlife Refuge in nearby Plymouth, Massachusetts are provided in Table 6.1-1 through 6.1-4 below (USFWS, 2018). While this list was developed specifically for Plymouth, many, if not all, of these species are also anticipated to be present in the Pine-Oak forest near the proposed onshore substation or along the Onshore Export Cable Route.

Table 6.1-1 Amphibians and Reptiles Confirmed on Massasoit Wildlife Refuge, Plymouth, MA

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]
Plethodontidae Family						
Red-backed Salamander	*Plethodon cinereus cinereus*	-	-	*G5*	-	-
Salamandridae Family						
Red-spotted Newt	*Notophthalmus viridescens*	-	-	*G5*	-	-
Ranidae Family						
American Bullfrog	*Lithobates catesbeianus*	-	-	*G5*	-	-
Green Frog	*Lithobates clamitans*	-	-	*G5*	-	-
Northern Leopard Frog	*Lithobates pipiens*	-	-	*G5*	*S4*	-
Wood Frog	*Lithobates sylvaticus*	-	-	*G5*	-	*NNE, SNE, MAt*
Bufonidae Family						
American Toad	*Anaxyrus americanus*	-	-	*G5*	-	-
Fowler's Toad	*Anaxyrus fowleri*	-	-	*G5*	-	-
Hylidae Family						
Northern Spring Peeper	*Pseudacris crucifer*	-	-	G5	-	-

Table 6.1-1 Amphibians and Reptiles Confirmed on Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	Atlantic LCC Representative Species[5]
Hylidae Family						
Gray Treefrog	*Hyla versicolor*	-	-	*G5*	-	-
Colubridae Family						
Eastern Hognose Snake	*Heterodon platirhinos*	-	-	G5	S4	SNE, MAt
Eastern Ribbon Snake	*Thamnophis sauritus*	-	-	G5	S5	-
Milk Snake	*Lampropeltis triangulum*	-	-	G5	-	-
Emydidae Family						
Painted Turtle	*Chrysemys picta*	-	-	G5	-	MAt
Northern Red-Bellied Cooter	*Pseudemys rubriventris*	E	E	G5T2Q	S1	-
Chelydridae Family						
Snapping Turtle	***Chelydra serpentina***	**-**	**-**	**G5**	**-**	**-**
Kinosternidae Family						
Common Musk Turtle	*Sternotherus odoratus*	-	-	G5	-	-

Source: USFWS, 2018

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from http://explorer.natureserve.org/ where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid; "-"=not listed.

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Gaviidae Family (Loons)									
Common Loon	*Gavia immer*	-	SC	G5	S1	NNE, SNE	-	-	-
Ardeidae Family (Wading Birds)									
Great Blue Heron	*Ardea herodias*	-	-	G5	-	-	-	-	V
Black-crowned Night Heron	*Nycticorax nycticorax*	-	-	G5	S2	-	-	M	V
Anatidae Family (Swans, Geese, Ducks)									
Mute Swan	*Cygnus olor*	-	-	G5	-	-	-	-	-
Canada Goose	*Branta canadensis*	-	-	G5	-	-	-	HH	-
Wood Duck	*Aix sponsa*	-	-	G5	-	MAt	-	-	-
Mallard	*Anas platyrhynchos*	-	-	G5	-	-	-	H	-

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Anatidae Family (Swans, Geese, Ducks)									
American Black Duck	*Anas rubripes*	-	-	G5	S4	NNE, SNE, MAt	-	HH	IIC
Blue-winged Teal	*Anas discors*	-	-	G5	-	-	-	-	-
Anatidae Family (Swans, Geese, Ducks)									
Green-winged Teal	*Anas crecca*	-	-	G5	-	-	-	M	-
Cathartidae, Accipitridae, and Pandionidae Families (Diurnal Raptors and Osprey)									
Turkey Vulture	*Cathartes aura*	-	-	G5	-	-	-	-	-
Red-shouldered Hawk	*Buteo lineatus*	-	-	G5	-	MAt	-	-	V
Red-tailed Hawk	*Buteo jamaicensis*	-	-	G5	-	-	-	-	-
Bald Eagle	*Haliaeetus leucocephalus*	-	T	G5	S1	-	Y	M	-
Osprey	*Pandion haliaetus*	-	-	G5	-	-	-	-	V

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

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Phasianidae and Odontophoridae Families (Upland Game Birds)									
Northern Bobwhite	*Colinus virginianus*	-	-	G5	S5	-	-	H	-
Ruffed Grouse	*Bonasa umbellus*	-	-	G5	S5	NNE	-	-	-
Wild Turkey	*Meleagris gallopavo*	-	-	G5	-	-	-	-	-
Columbidae Family (Pigeons and Doves)									
Mourning Dove	*Zenaida macroura*	-	-	G5	-	-	-	-	-
Cuculidae Family (Cuckoos and Allies)									
Yellow-billed Cuckoo	*Coccyzus americanus*	-	-	G5	-	-	-	-	-
Black-billed Cuckoo	*Coccyzus erythropthalmus*	-	-	G5	-	-	-	-	IA
Caprimulgidae Family (Goatsuckers)									
Whip-poor-will	*Caprimulgus vociferous*	-	SC	G5	S4	MAt	Y	H	-
Alcedinidae Family (Kingfishers)									
Belted Kingfisher	*Megaceryle alcyon*	-	-	G5	-	-	-	-	-

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

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Picidae Family (Woodpeckers)-									
Red-bellied Woodpecker	*Melanerpes carolinus*	-	-	G5	-	-	-	-	-
Yellow-bellied Sapsucker	*Sphyrapicus varius*	-	-	G5	-	-	-	-	-
Picidae Family (Woodpeckers)-									
Downy Woodpecker	*Picoides pubescens*	-	-	G5	-	-	-	-	-
Hairy Woodpecker	*Picoides villosus*	-	-	G5	-	-	-	-	IIA
Northern Flicker	*Colaptes auratus*	-	-	G5	-	-	-	H	-
Tyrannidae Family (Tyrant Flycatchers)									
Eastern Wood-Pewee	*Contopus virens*	-	-	G5	-	MAt	-	-	IIA
Eastern Phoebe	*Sayornis phoebe*	-	-	G5	-	-	-	-	-
Great Crested Flycatcher	*Myiarchus crinitus*	-	-	G5	-	-	-	H	-

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Tyrannidae Family (Tyrant Flycatchers)									
Eastern Kingbird	*Tyrannus tyrannus*	-	-	G5	-	-	-	H	-
Vireonidae Family (Vireos)									
Red-eyed Vireo	*Vireo olivaceus*	-	-	G5	-	-	-	-	-
Corvidae Family (Crows and Jays)									
Blue Jay	*Cyanocitta cristata*	-	-	G5	-	-	-	-	-
American Crow	*Corvus brachyrhynchos*	-	-	G5	-	-	-	-	-
Fish Crow	*Corvus ossifragus*	-	-	G5	-	-	-	-	-
Hirundinidae Family (Swallows)									
Barn Swallow	*Hirundo rustica*	-	-	G5	-	-	-	-	-
Tree Swallow	*Tachycineta bicolor*	-	-	G5	-	-	-	-	-
Paridae Family (Chickadees and Titmice)									
Tufted Titmouse	*Baeolophus bicolor*	-	-	G5	-	-	-	-	-

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

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Paridae Family (Chickadees and Titmice)									
Black-capped Chickadee	*Poecile atricapillus*	-	-	G5	-	-	-	-	-
Sittidae Family (Nuthatches)									
Red-breasted Nuthatch	*Sitta canadensis*	-	-	G5	-	-	-	-	-
White-breasted Nuthtch	*Sitta carolinensis*	-	-	G5	-	-	-	-	-
Troglodytidae Family (Wrens)									
Carolina Wren	*Thryothorus ludovicianus*	-	-	G5	-	-	-	-	-
Sylviidae Family (Gnatcatchers)									
Blue-gray Gnatcatcher	*Polioptila caerulea*	-	-	G5	-	-	-	-	-
Turdidae Family (Thrushes)									
Eastern Bluebird	*Sialia sialis*	-	-	-	-	-	-	-	-
American Robin	*Turdus migratorius*	-	-	G5	-	-	-	-	-

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Turdidae Family (Thrushes)									
Wood Thrush	*Hylocichla mustelina*	-	-	G5	S5	NNE, SNE, MAt	Y	HH	IA
Hermit Thrush	*Catharus guttatus*	-	-	G5	-	-	-	-	-
Mimidae Family (Mimids)									
Gray Catbird	*Dumetella carolinensis*	-	-	G5	-	-	-	M	-
Northern Mockingbird	*Mimus polyglottos*	-	-	G5	-	-	-	-	-
Mimidae Family (Mimids)									
Brown Thrasher	*Toxostoma rufum*	-	-	G5	S5	MAt	-	H	-
Bombycillidae Family (Waxwings)									
Cedar Waxwing	*Bombycilla cedrorum*	-	-	G5	-	-	-	-	-
Parulidae Family (Wood Warblers)									
Yellow Warbler	*Dendroica petechia*	-	-	G5	-	-	-	-	-
Prairie Warbler	*Dendroica discolor*	-	-	G5	S5	SNE, MAt	Y	HH	IA

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

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Parulidae Family (Wood Warblers)									
Palm Warbler	*Dendroica palmarum*	-	-	G5	-	NNE	-	-	-
Pine Warbler	*Dendroica pinus*	-	-	G5	-	-	-	-	-
Blackpoll Warbler	*Dendroica striata*	-	SC	G5	S1	NNE	-	-	-
Black-and-white Warbler	*Mniotilta varia*	-	-	G5	-	MAt	-	H	IIA
Ovenbird	*Seiurus aurocapilla*	-	-	G5	-	NNE, SNE, MAt	-	-	-
Parulidae Family (Wood Warblers)									
Common Yellowthroat	*Geothlypis trichas*	-	-	G5	-	-	-	-	-
Thraupidae Family (Tanagers)									
Scarlet Tanager	*Piranga olivacea*	-	-	G5	-	-	-	H	IA
Cardinalidae Family (Cardinals and Grosbeaks)									
Northern Cardinal	*Cardinalis cardinalis*	-	-	G5	-	-	-	-	-

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Cardinalidae Family (Cardinals and Grosbeaks)									
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	-	-			-	-	-	IIA
Emberizidae Family (Emberizine Sparrows and Allies)									
Eastern Towhee	*Pipilo erythrophthalmus*	-	-	G5	S5	NNE, MAt	-	H	IIA
Field Sparrow	*Spizella pusilla*	-	-	G5	S5	-	-	H	-
Chipping Sparrow	*Spizella passerina*	-	-	G5	-	-	-	-	-
Song Sparrow	*Melospiza melodia*	-	-	G5	-	-	-	-	-
Icteridae Family (Icterids)									
Brown-headed Cowbird	*Molothrus ater*	-	-	G5	-	-	-	-	-
Red-winged Blackbird	*Agelaius phoeniceus*	-	-	G5	-	-	-	-	-
Common Grackle	*Quiscalus quiscula*	-	-	G5	-	-	-	-	-
Baltimore Oriole	*Icterus galbula*	-	-	G5	-	-	-	H	IA

Table 6.1-2 Birds Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]	BCC Region 5[6]	BCR 30[7]	PIF Area 9[8]
Fringillidae Family (Finches)									
Purple Finch	*Carpodacus purpureus*	-	-	G5	-	-	-	-	IIA
House Finch	*Carpodacus mexicanus*	-	-	G5	-	-	-	-	-
American Goldfinch	*Carduelis tristis*	-	-	G5	-	-	-	-	-

Source: USFWS, 2018

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from http://explorer.natureserve.org/ where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid; "-"=not listed.

[6] U.S. Fish and Wildlife Service Division of Migratory Birds, Birds of Conservation Concern for Region 5 (Northeast) (USFWS 2008). Y=species identified as a species of conservation concern in Region 5; "-"=species not identified.

[7] Bird Conservation Region 30: New England/Mid-Atlantic Coast Conservation Priority Category: HH=highest priority; H=high priority; M=moderate priority (http://www.acjv.org/BCR_30/BCR30_June_23_2008_final.pdf).

[8] Partners in Flight Bird Conservation Plan for Southern New England: Physiographic Area 09 (Dettmers and Rosenberg 2000). IA=high continental priority and high regional responsibility; IB=high continental priority and low regional responsibility; IIA=high regional concern; IIC=high regional threats; V=additional state listed.

Table 6.1-3 Mammals Confirmed at Massasoit Wildlife Refuge, Plymouth, MA

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC	Representative Species[5]
Canidae Family							
Coyote	*Canis latrans*	-	-	*G5*	-	-	
Gray Fox	*Urocyon cinereoargenteus*	-	-	*G5*	-	-	
Red Fox	*Vulpes vulpes*	-	-	*G5*	-	-	
Procyonidae Family							
Raccoon	*Procyon lotor*	-	-	*G5*	-	-	
Mephitidae Family							
Striped Skunk	*Mephitis mephitis*	-	-	G5	-	-	
Mustelidae Family							
Fisher	*Martes pennanti*	-	-	G5	-	-	
Cervidae Family							
White-tailed Deer	*Odocoileus virginianus*	-	-	G5	-	-	
Sciuridae Family							
Red Squirrel	*Tamiasciurus hudsonicus*	-	-	G5	-	-	

Table 6.1-3 Mammals Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]	North Atlantic LCC Representative Species[5]
Vespertilionidae Family						
Big Brown Bat	*Eptesicus fuscus*	-	-	G5	-	-
Silver-haired Bat	*Lasionycteris noctivagans*	-	-	G5	SU	-
Eastern Red Bat	*Lasiurus borealis*	-	-	G5	S4	NNE, SNE, MAt
Eastern Pipistrelle	*Pipistrellus subflavus*	-	-	G3	-	MAt
Eastern Small-footed Myotis	*Myotis leibii*	-	SC	G1G3	S1	-

Source: USFWS, 2018.

[1] Federal Legal Status Codes (under Federal Endangered Species List): E=endangered; T=threatened; C=candidate; "-"=no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E=endangered; T=threatened; SC= special concern; WL=watch list; "-"=no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from http://explorer.natureserve.org/ where the conservation status of a species is designated by a number from 1 to 5 (1=critically imperiled, 2=imperiled, 3=vulnerable, 4=apparently secure, 5=secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR=unranked (global rank not yet assessed) and "?"=inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 =critically imperiled; S2=imperiled; S3=either very rare or uncommon, vulnerable; S4=widespread, abundant, apparently secure; S5=secure; SNA=not applicable; "-"=no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

[5] North Atlantic Landscape Conservation Cooperative Representative Species: NNE=northern New England; SNE = southern New England; MAt=mid; "-"=not listed.

Table 6.1-4 Invertebrates Confirmed at Massasoit Wildlife Refuge, Plymouth, MA

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]
Libellulidae Family					
Blue Dasher	*Pachydiplax longipennis*	-	-	G5	-
Calico Pennant	*Celithemis elisa*	-	-	G5	-
Common Whitetail	*Libellula lydia*	-	-	G5	-
Eastern Pondhawk	*Erythemis simplicicollis*	-	-	G5	-
Golden-Winged Skimmer	*Libella auripennis*	-	-	G5	-
Slaty Skimmer	*Libellula incesta*	-	-	G5	-
White Corporal	*Libellula exusta*	-	-	G4	-
Nymphalidae Family					
Eastern Comma	*Polygonia comma*	-	-	G5	-
Great Spangled Fritillary	*Speyeria cybele*	-	-	G5	-
Mourning Cloak	*Nymphalis antiopa*	-	-	G5	-
Red Admiral	*Vanessa atalanta*	-	-	G5	-
Red-spotted Purple	*Limenitis artemis astyanax*	-	-	G5T5	-
Lycaenidae Family					
Striped Hairstreak	*Satyrium liparops*	-	-	G5	-
Hesperiidae Family					
True Skipper sp. (tauny-orange or brown)	*Hesperia spp.*	-	-	G5	-

Table 6.1-4 Invertebrates Confirmed at Massasoit Wildlife Refuge, Plymouth, MA (Continued)

Common Name	Scientific Name	Federal Legal Status[1]	MA Legal Status[2]	Global Rarity Rank[3]	MA Rarity Rank[4]
Saturniidae Family					
Polyphemus moth	*Antheraea polyphemus*	-	-	G5	-
Carabidae Family					
Six-spotted Green Tiger Beetle	*Cicindela sexguttata*	-	-	G5	-

Source: USFWS, 2018

[1] Federal Legal Status Codes (under Federal Endangered Species List): E = endangered; T = threatened; C = candidate; "-" = no status.

[2] State Legal Status Codes (under Massachusetts Endangered Species Lists): E = endangered; T = threatened; SC = special concern; WL = watch list; "-" = no status.

[3] Global Rarity Rank: NatureServe Global Conservation Status Ranks from http://explorer.natureserve.org/ where the conservation status of a species is designated by a number from 1 to 5 (1 = critically imperiled, 2 = imperiled, 3 = vulnerable, 4 = apparently secure, 5 = secure), preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global, N = National, and S = Subnational). Additionally, GNR = unranked (global rank not yet assessed) and "?" = inexact numeric rank.

[4] Massachusetts Rarity Rank from 2005 Massachusetts Comprehensive Wildlife Conservation Strategy, Revised 2006: S1 = critically imperiled; S2 = imperiled; S3 = either very rare or uncommon, vulnerable; S4 = widespread, abundant, apparently secure; S5 = secure; SNA = not applicable; "-" = no rank given. State rarity ranks were only provided for "species in greatest need of conservation", therefore although some species were assigned a rank of S5, they are still of conservation concern in Massachusetts.

6.1.2 Potential Impacts of the Project

Impact-producing factors for the Project are described below. Short-term construction-related impacts are associated with 1) physical habitat disturbance, 2) displacement due to construction noise and vibration, or 3) direct mortality from contact with construction equipment. Permanent impacts potentially affecting wildlife are limited to habitat loss or conversion of habitat type. The sections below detail these potential impacts as well as impact avoidance and mitigation measures.

Table 6.1-5 Impact-Producing Factors for Terrestrial Wildlife

Impact-Producing Factors	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Temporary alteration of habitat	X		
Temporary disturbance due to noise and vibration-producing activities	X	X	
Direct wildlife mortality by equipment contact	X		
Permanent loss or alteration of habitat	X	X	

6.1.2.1 Construction and Installation

As already noted, the Project's onshore facilities are sited to maximize the use of existing ROWs and other previously developed lands, and minimize alteration or loss of unique or protected habitat or known habitats of rare, threatened, or special concern species. The installation of duct bank and splice vaults within existing corridors will not result in any further fragmentation of forested habitat, and construction at the onshore substation site will only affect forested wildlife habitat that is very common in southeastern Massachusetts. However, land clearing and grading associated with construction of the onshore substation has the potential to permanently displace resident wildlife or disrupt select lifecycle activities (e.g., nesting, breeding, hibernation/aestivation). The short-term and permanent impacts to terrestrial fauna are discussed below.

6.1.2.1.1 Temporary Habitat Alteration

As described earlier in this section, a portion of either Onshore Export Cable Route is located along an existing utility ROW that is currently maintained by the utility as grass and scrubland habitat. Installation of duct bank and splice vaults within the utility ROW requires clearing and grading within a corridor of sufficient width to accommodate excavation and stockpiling of soils, and to provide space for construction equipment access along the work zone. This will result in some short-term loss of forage and cover for area wildlife within the utility ROW. The work, however, is confined and will not impact similar wildlife habitat located elsewhere within the utility ROW.

Any disturbances to terrestrial habitat will be short-term, localized, and will not affect rare or protected habitat types or species. Furthermore, the utility ROW and adjacent woodlands would remain viable wildlife habitats for animals that thrive in the managed grass and scrubland and forest edge communities. Accordingly, population level impacts to wildlife resulting from temporary habitat alteration are unlikely.

6.1.2.1.2 Noise and Vibration

Construction equipment will generate noise and vibration at levels sufficient to temporarily displace nearby wildlife, particularly those in off-road areas, such as the utility ROW, that are removed from the noise generated by local traffic. Regardless of the location, any affected wildlife is expected to return to the area once construction activities are completed; therefore, this short-term impact is unlikely to have population level impacts.

6.1.2.1.3 Direct Mortality

Although the expectation is that wildlife will leave the immediate area as construction progresses along the Onshore Export Cable Route, limited direct wildlife mortality may occur as a result of the construction activities. Impacts are expected to be limited to less mobile animals of commonly occurring species.

6.1.2.1.4 Loss or Alteration of Habitat

The clearing of vegetation at the Project's onshore substation site will result in the permanent loss of approximately 6.1 acres of Pitch pine-Oak forest habitat within the Independence Park commercial/industrial area in Barnstable. It is also possible that work within the utility ROW could require some permanent removal of trees located along the edge of the utility ROW, if further surveys indicate that it has not been maintained to its full width. This limited loss of habitat, however, is unlikely to have population level impacts on wildlife for the reasons outlined below.

Forest is the dominant natural habitat in Massachusetts, with over 60% of land area in the Commonwealth currently in a forested state (MADFW, 2013). Pitch pine-Oak forests are among the most common habitat types on Cape Cod, and are not in short supply regionally or locally. One such area of nearby conservation land is the 365-acre HPWMA, located directly west of Mary Dunn Road and approximately 0.4 km (0.25 mi) east of the site. Wildlife species, including birds, mammals, and herpetiles, that may otherwise use the area proposed for the onshore substation would not be limited with regard to the availability of and access to similar habitats in the Onshore Project Area.

Further, the habitat at the onshore substation is neither undeveloped nor unfragmented. The forest area at the site is substantially affected by local development, and does not provide meaningful habitat for species, such as the Scarlet Tanager (*Piranga olivacea),* which require undisturbed land areas. Furthermore, in addition to roadways and ROWs that bound and bisect the forest in the area, the onshore substation is proximate to the Barnstable Airport and other heavy industrial uses commonly seen south of Route 6 between Barnstable and Hyannis. Finally, the habitat that would be lost is not used by any known rare, threatened, or special concern species.

For these reasons, the potential impacts associated with the loss of forested habitat at the onshore substation are unlikely to have population level impacts.

6.1.2.1.5 Avoidance, Minimization, and Mitigation Measures

As noted above, the Project's Onshore Export Cable Route is sited almost entirely within paved roadways or other previously developed corridors (aside from the route variant that would follow a proposed bike path), thereby avoiding undisturbed forest interiors and other significant wildlife habitat. Routing along roadways and other previously developed corridors also minimizes potential construction impacts to adjacent wildlife habitats. Although the development of the onshore substation will require permanent loss of habitat common to the region, its location within a developed industrial area prevents impacts to less common or more valuable habitats, and will minimize impacts to area wildlife.

At certain locations, expanded work zones and construction staging areas may be required to accommodate special construction equipment and materials. Wherever possible, these spaces will be located within previously developed areas, such as nearby parking lots, in order to avoid or minimize disturbance to naturally vegetated areas. Any previously undisturbed areas of wildlife habitat affected by expanded work zones or elsewhere along the Onshore Export Cable Route will be restored in consultation with local officials.

Siltation fencing will be installed prior to commencement of other land-disturbing activities and maintained during the construction period.

6.1.2.1.6 Summary

In summary, due to the nature and location of the Project's onshore construction activities, impacts to terrestrial wildlife will be largely short-term and localized. Permanent loss of terrestrial habitat will be minimal, affecting approximately six acres at the onshore substation. Impacts to terrestrial wildlife will be reduced further by implementing the above avoidance, minimization, and mitigation measures. Consequently, population level impacts to terrestrial wildlife including inland birds in the vicinity of the Project are unlikely.

6.1.2.2 Operations and Maintenance

Under normal circumstances, operations and maintenance of the Project will not result in further habitat alteration or involve activities expected to have a negative impact on wildlife. Onshore facilities will be monitored and controlled remotely from the Project's operations and maintenance center, which will be staffed by the necessary personnel, including managers, engineers, technicians, and support personnel. In the event monitors determine repair work is necessary, a crew would be dispatched to the identified location to complete repairs and restore normal operations. Such work would typically involve the onshore export cables, which are accessed through manholes at the installed splice vaults, or within the fenced perimeter of the onshore substation. This allows repairs to be completed within the installed transmission infrastructure and without additional impact to wildlife habitat.

6.1.2.2.1 Temporary Disturbance by Noise

Maintenance and repairs to the Project's onshore export cable or onshore substation could generate noise that temporarily displaces nearby wildlife, but this impact would be short-term and is unlikely to have population level impacts. The Project substation transformers will also generate some noise, which might affect nearby terrestrial wildlife. However, given the location of the substation within a commercial/industrial area with other noise sources nearby, any possible impact from noise will be insignificant.

6.1.2.2.2 Avoidance, Minimization, and Mitigation Measures

The design of the Onshore Export Cable Route provides for points of access at the splice vaults. Maintenance and/or repairs are expected to take place primarily within these vaults, without any disturbance to adjacent wildlife habitat. These measures will avoid or reduce any further impact to terrestrial habitat and wildlife. Consequently, onshore operations and maintenance activities associated with the Project are not anticipated to have population level impacts on terrestrial species.

6.1.3 Decommissioning

As described in Section 4.4 of Volume I, no decommissioning work is planned for the Project's onshore facilities, although removal of Project cables via existing manholes may occur if required. The splice vaults, duct bank, and onshore substation will likely remain as valuable infrastructure that would be available for future offshore wind projects developed within the Vineyard Wind Lease Area or elsewhere.

6.2 Coastal and Marine Birds

6.2.1 Description of the Affected Environment

6.2.1.1 Overview

The Wind Development Area ("WDA") is located within the Massachusetts Wind Energy Area ("MA WEA"), which is approximately 22 kilometers ("km") (13.7 miles ["mi"]) south of Martha's Vineyard. BOEM established the WEA through an intergovernmental renewable energy task force in 2012. Areas identified as important fishing areas and having "high value sea duck habitat" were excluded from the northeastern portion of the MA WEA (BOEM, 2014).

The WDA is also located within the Lease Area, and is approximately 23 km (14.3 mi) from Martha's Vineyard and Nantucket Island. More specifically, the WDA is located at a faunal break region between two Large Marine Ecosystems ("LMEs"): the Scotian Shelf (LME #8) to the north (the Gulf of Maine) and the Northeast US Continental Shelf (LME #7) to the south (the Mid-Atlantic Bight) (National Oceanic and Atmospheric Administration ["NOAA"], 2017). This region is used by a suite of breeding birds from both oceanographic regions (Nisbet et al., 2013). In addition, non-breeding summer migrants (e.g., shearwaters and storm-petrels) constitute a significant portion of the marine birds in the region (Nisbet et al., 2013). The WDA is no exception, with an influx of southern hemisphere breeders present in the area during the boreal summer/austral winter (Veit et al., 2016).

Around 450 avian species are known to occur in Massachusetts (Blodget, 2002), but many of these species are rarities and/or unlikely to occur offshore. Species of migratory, breeding, and wintering birds that may pass through the WDA include coastal birds, such as shorebirds, waterfowl, wading birds, raptors, and songbirds, and marine birds such as seabirds, and seaducks. The most likely of these to occur in the WDA are waterfowl (18 species), loons and grebes (four species), shearwaters and petrels (10 species), gannet and cormorants (three species), shorebirds (two species), gulls (11 species), terns (nine species) jaegers (three species), and auks (six species) (BOEM, 2014). Bird use of the WDA and surrounding area is well-documented, with multiple studies providing important information on avian presence and abundances at a series of useful scales (see Loring et al., 2017; NOAA, 2016j; Veit, 2015; Veit et al., 2016).

6.2.1.2 Definition of Exposure to the WDA

Exposure to offshore wind farms has spatial and temporal components. Spatially, birds are exposed on the horizontal (i.e., habitat area) and vertical (i.e., flight height) planes; temporally, bird exposure is dictated by a species' life history traits and may be limited to breeding, staging, migrating, or wintering. For the purpose of the exposure assessment, vertical exposure is considered in the impact assessment within the context of vulnerability.

The exposure assessment was conducted for coastal birds (shorebirds, waterbirds, waterfowl, wading birds, raptors, and songbirds), which are rarely found far offshore, and marine birds (loons and grebes, seaducks, shearwaters and storm-petrels, gannets and cormorants, gulls and jaegers, terns, and auks), which are more commonly found offshore. For the purposes of this assessment, "offshore" and the "offshore environment" is generally defined as beyond state waters or further than 5.6 km (3.5 mi) from shore. In addition, the exposure assessment is focused on the WDA because bird exposure to vessels installing the offshore export cable will be transitory and ephemeral (see Section 4.2.3.3 of Volume I for discussion of offshore cable installation). Coastal and marine birds may encounter a cable installation vessel, but exposure to the vessel, in any given location, will be limited to a finite temporal period and is not expected to be an impact-producing factor. As with all construction activities, the Project will reduce lighting to limit any attraction of birds to vessels at night. Federally-listed species (Roseate Tern [*Sterna dougalli*], Red Knot [*rufa* ssp.], Piping Plover [*Charadrius melodus*], and eagles) are assessed individually.

The exposure of birds to the Project was evaluated for each species or species group and categorized as insignificant, unlikely, potential, or likely based upon available literature and a quantitative assessment. Definitions of exposure levels are provided in (Table 6.2-1). For marine birds, two data sources were used to assess local and regional marine bird use of the WDA: the Massachusetts Clean Energy Center seabird surveys (Veit et al., 2016), herein referred to as "Veit survey data", and the Marine-life Data and Analysis Team ("MDAT") marine birds abundance and occurrence models (Curtice et al., 2016), herein referred to as "MDAT abundance models". Further details on each data set are available in Appendix III-C. For species where Project-specific data was not available, a determination of exposure was made by synthesizing relevant information from species accounts in the literature.

To quantitatively assess the exposure of marine birds to the WDA, both the Veit survey data and the MDAT abundance models were used to develop an annual exposure score for species groups. The species group annual exposure scores were developed from species- and seasonal-specific exposure scores and maps. A full description of the methods and the quantitative results are available in Appendix III-C.

The final exposure scores for each species and season, as well as the aggregated scores (e.g., the annual scores for each species and taxonomic group), should be interpreted as a measure of the relative importance of the WDA for a species/group, as compared to other surveyed areas in the region and in the northwest Atlantic. It does not indicate the absolute number of individuals likely to be exposed. Rather, the exposure score provides a regional and population-level context for each taxon (see Appendix III-C for further details). The following sections provide a summary of the results for each species group.

Table 6.2-1 Definition of Exposure Levels

Exposure Level	Definition[1]
Insignificant	0-2 annual exposure score AND/OR Based upon the literature, little to no evidence of use of the offshore environment for breeding, wintering, or staging, and low predicted use during migration
Unlikely	3-5 annual exposure score AND/OR Based upon the literature, low evidence of use of the offshore environment during any season
Potential	6-8 annual exposure score AND/OR Based upon the literature, moderate evidence of use of the offshore environment during any season
Likely	9-12 annual exposure score AND/OR Based upon the literature, high evidence of use of the offshore environment, and the offshore environment is primary habitat during any season

[1] The annual exposure score is the sum of all seasonal scores where seasons categorized as insignificant scores a 0, low scores a 1, medium scores a 2, and high scores a 3. Twelve is the highest possible score, which would occur if a species received a high score (3) for all four seasons (3 x 4 = 12). For further methods and annual results for each species by season see Appendix III-C.

6.2.1.3 Coastal Birds

The WDA is far enough offshore to be beyond the range of most terrestrial or coastal bird species. Coastal birds that may forage in the WDA occasionally, visit the area sporadically, or pass through on their spring and/or fall migrations, include shorebirds (e.g., sandpipers, plovers), waterbirds (e.g., cormorants, grebes), waterfowl (e.g., scoters, mergansers), wading birds (e.g., herons, egrets), raptors (e.g., falcons, eagles), and songbirds (e.g., warblers, sparrows).

6.2.1.3.1 Shorebirds

Shorebirds are coastal breeders and foragers that generally avoid straying out over deep waters during breeding. Few shorebird species breed locally on the US east coast. Most of the shorebirds that pass through the region are northern or Arctic breeders that migrate along the US east coast on their way to and from wintering areas in the Caribbean islands, Central America, and South America. Some species are clearly capable of crossing vast areas of ocean, and may traverse the WDA during migrations.

Of the shorebirds, only the phalaropes (Red Phalarope [*Phalaropus fulicarius*] and Red-necked Phalarope [*Phalaropus lobatus*]) are considered more marine than coastal (Rubega et al., 2000; Tracy et al., 2002). Very little is known regarding the migratory movements of these species, although they are known to travel well offshore during migration. Prior to the mid-1980s, millions of Red-necked Phalaropes staged in the Bay of Fundy, in the northern Gulf of Maine, during their fall migration. Since that time, these birds have completely disappeared from the area and their current fall staging area(s) is unknown (Nisbet & Veit, 2015).

Given that shorebird exposure will be primarily limited to migration and there is little evidence of shorebird use of the WDA, exposure is expected to be insignificant. See Table 6.2-1 for definition of exposure levels.

The Atlantic population of the Piping Plover, and the *rufa* subspecies of the Red Knot, are both federally- protected under the ESA, and are thus addressed in the "Federally-Listed Species" section, below.

Table 6.2-2 Shorebirds Listed in Massachusetts and their Federal Status

Common Name	Scientific Name	MA Status	Federal Status
Piping Plover	*Charadrius melodus*	T	T
Upland Sandpiper	*Bartramia longicauda*	E	

(E = Endangered; T = Threatened; SC = Special Concern).

6.2.1.3.2 Waterbirds

Waterbirds is a general term used for species associated with all manner of aquatic habitats. For the purposes of this document, this group is defined to include species that are generally restricted to freshwater or use saltmarshes, beaches, and other strictly coastal habitats, and that are not captured in other broad groupings. Given that these species spend the majority of their life in freshwater aquatic and associated terrestrial habitats, and there is little or no evidence of offshore migration in the literature or in the Veit survey data, overall exposure of this group to the WDA is expected to be insignificant.

Table 6.2-3 Waterbirds Listed in Massachusetts and their Federal Status

Common Name	Scientific Name	MA Status	Federal Status
American Bittern	*Botaurus lentiginosus*	E	
Least Bittern	*Ixobrychus exilis*	E	
King Rail	*Rallus elegans*	T	
Common Moorhen	*Gallinula chloropus*	SC	

(E = Endangered; T = Threatened; SC = Special Concern)

6.2.1.3.3 Waterfowl

Waterfowl comprises a broad group of geese and ducks, most of which spend much of the year in terrestrial or coastal wetland habitats (Baldassarre & Bolen, 2006). The diving ducks generally winter on open freshwater, as well as brackish or saltwater. Species that regularly winter on saltwater, including mergansers, scaup, and goldeneyes, usually restrict their distributions to shallow, very nearshore waters (Owen & Black, 1990). Given that coastal waterfowl spend a majority of the year in freshwater aquatic systems and near-shore marine systems, and there is little evidence of coastal waterfowl use of the WDA in the literature or the Veit survey data, overall exposure of this group to the WDA is expected to be insignificant.

A subset of the diving ducks, however, have an exceptionally strong affinity for saltwater either year-round or outside of the breeding season. These species are known as the "sea ducks" and are described separately in the Marine Bird (Section 6.2.1.4) below.

Wading Birds

Like the smaller shorebirds, long-legged wading birds, such as herons and egrets, are coastal breeders and shallow-water foragers that generally avoid straying out over deep water (Frederick, 2001). Most long-legged waders breeding along the Atlantic coast migrate south to the Gulf coast, the Caribbean islands, Central America, and South America (Heron Conservation, 2017), thus they are capable of crossing large areas of ocean, and may traverse the WDA during spring and fall migration periods. Given that long-legged wading birds spend a majority of the year in freshwater aquatic systems and coastal marine systems and there is little evidence of wading bird use of the WDA in the literature or in the Veit survey data, overall exposure of this group to the WDA is expected to be insignificant.

6.2.1.3.4 Raptors (non-eagle)

Overall, use of the WDA by most raptors is insignificant during breeding or winter seasons and will be limited to falcons and possibly Osprey [*Pandion haliaetus*] during migration. Raptor exposure to the WDA during migration will be dictated by a species' body design and general flight strategy (i.e., flapping vs. soaring). Species that use soaring flight depend upon thermals and generally do not cross large expanses of water. *Buteo* hawks (i.e., Red-tailed Hawks [*Buteo jamaicensis*], Broad-winged Hawks [*Buteo platypterus*], and Red-shouldered Hawks [*Buteo lineatus*]) that depend upon soaring flight during migration are rarely observed in offshore settings (Desorbo et al., 2012). *Accipiter* hawks (i.e., Northern Goshawks [*Accipiter gentilis*], Cooper's Hawks [*Accipiter cooperii*], and Sharp-shinned Hawks [*Accipiter striatus*]), which use a mixture of powered and soaring flight, are encountered at offshore islands but only in low numbers and they are rarely observed offshore (Desorbo et al., 2017). Most owls do not utilize the offshore environment, although there is evidence of Northern Saw-whet Owls (*Aegolius acadicus*) passing over Maine islands during migration (Desorbo et al., 2012) and Long-eared Owls (*Asio otus*) are known to migrate along the coast. The exposure of this group of raptors is expected to be insignificant to unlikely and will not be discussed further.

Falcons (e.g., American Kestrels [*Falco sparverius*], Peregrine Falcons [*Falco peregrinus*], and Merlins [*Falco columbarius*]) are the most likely raptors to be encountered offshore because their body design and use of powered flight enables them to endure large open water crossings (Kerlinger, 1985). Merlins and Peregrines are commonly observed in offshore habitats (Cochran, 1985; Desorbo et al., 2012), fly hundreds of kilometers offshore during migration (Desorbo et al., 2015), and have been observed on offshore oil platforms (Johnson et al., 2011; McGrady et al., 2006). There is little data available on falcon migration offshore in Massachusetts, but two fall migrant peregrines fitted with satellite transmitters in Maine did not fly through the WDA. Instead, the birds flew west of Cape Cod through central Massachusetts toward Narragansett Bay, Rhode Island and only flew offshore once they reached the mid-Atlantic (Desorbo et al., 2012). Nevertheless, the number of individual birds exposed to the WDA during fall migration probably represents a small proportion of the overall population.

Ospreys exhibit a wing morphology that enables open water crossings (Kerlinger, 1985); however, satellite telemetry data from Ospreys from New England and the mid-Atlantic suggest these birds generally follow coastal or inland migration routes. In some instances, individuals birds will fly offshore (Bierregaard, 2017), but exposure of Peregrine Falcons, Merlins and Ospreys is expected to be unlikely because the passage of individual birds through the WDA probably represents a relatively small proportion of the overall populations.

Bald Eagles (*Haliaeetus leucocephalus*) are federally protected under the Bald and Golden Eagle Protection Act ("BGEPA"), 16 US.C. § 668 et seqseq, and are thus addressed in the "Federally-Listed Species" section, below.

Table 6.2-4 Raptors Listed in Massachusetts and their Federal Status

Common Name	Scientific Name	MA Status	Federal Status
Bald Eagle	*Haliaeetus leucocephalus*	T	
Northern Harrier	*Circus cyaneus*	T	
Peregrine Falcon	*Falco peregrinus*	T	
Barn Owl	*Tyto alba*	SC	
Long-eared Owl	*Asio otus*	SC	
Short-eared Owl	*Asio flammeus*	E	

(E = Endangered; T = Threatened; SC = Special Concern)

6.2.1.3.5 Songbirds

Songbirds almost exclusively use terrestrial, coastal, and aquatic habitats and do not use the offshore marine system except during migration. Many North American breeding songbirds migrate to the tropical regions of Mexico, the Caribbean islands, Central America, and South America. On their migrations, these neotropical migrants mostly travel at night and at high altitudes, where favorable winds can aid them along their trip. Songbirds regularly cross large bodies of water, such as the Mediterranean Sea or the Gulf of Mexico (Bruderer & Lietchi, 1999; Gauthreaux & Belser, 1999), and there is some evidence that species migrate over the northern Atlantic as well (Drury & Keith, 1962). Some birds may briefly fly over the water while others, like the Blackpoll Warbler (*Setophaga striata*), can migrate non-stop over vast expanses of ocean (DeLuca et al., 2015; Faaborg et al., 2010).

Landbird migration may occur across broad geographic areas, rather than in narrow "flyways" as have been described for some waterbirds (Faaborg et al., 2010). Evidence for a variety of species suggests that over-water migration in the Atlantic is much more common in fall than in spring, when animals presumably migrate preferentially over land due to consistent tailwinds from the northwest (see, e.g., DeLuca et al., 2015; Hatch et al., 2013; Morris et al., 1994). Given that songbirds do not use the offshore marine system as habitat and there is little evidence of songbird use of the WDA outside of the migratory period, exposure is expected to be insignificant to unlikely.

Table 6.2-5 Songbirds Listed in Massachusetts and their Federal Status

Common Name	Scientific Name	MA Status	Federal Status
Sedge Wren	*Cistothorus platensis*	E	
Golden-winged Warbler	*Vermivora chrysoptera*	E	
Northern Parula	*Parula americana*	T	
Blackpoll Warbler	*Dendroica striata*	SC	
Mourning Warbler	*Oporornis philadelphia*	SC	
Vesper Sparrow	*Pooecetes gramineus*	T	
Grasshopper Sparrow	*Ammodramus savannarum*	T	
Eastern Whip-poor-will	*Caprimulgus vociferus*	SC	

(E = Endangered; T = Threatened; SC = Special Concern)

6.2.1.4 Marine Birds

Marine bird distributions are generally more pelagic and widespread than coastal birds. A total of 83 marine bird species are known to regularly occur off the eastern seaboard of the US (Nisbet et al., 2013). Many of these marine bird species use the WDA during multiple time periods, either seasonally or year-round, including loons and grebes, shearwaters and petrels, gannets, gulls and terns, and auks. A summary of marine birds in the region and listing status is in Table 6.2-6.

6.2.1.4.1 Loons and Grebes

Both Common Loons (*Gavia immer*) and Red-throated Loons (*Gavia stellate*) use the Atlantic outer continental shelf in winter. Analysis of satellite-tracked Red-throated Loons, captured and tagged in the mid-Atlantic area, found their winter distributions to be largely inshore of the mid-Atlantic BOEM Wind Energy Areas "WEAs", although they did overlap with the mid-Atlantic BOEM WEAs somewhat during their migration periods, particularly in spring (Gray et al., 2017). Wintering Common Loons generally show a broader and more dispersed distribution offshore in winter (Johnson et al., 2015). During migration Red-throated Loons use Nantucket Shoals, which is east of the WDA, as a stopover site (Gray et al., 2017).

The results of the recent tracking work generally align with the Veit survey data. The regional MDAT abundance models show that the birds are concentrated closer to shore and in the mid-Atlantic. The annual exposure analysis score for the loons and grebe group (three species) was insignificant. Red-necked Grebe (*Podiceps grisegena*) and Red-throated Loon are expected to have insignificant exposure during all seasons, and Common Loon has unlikely exposure during the summer and winter. Local data suggest Common Loons would have greater exposure than regional data sources, so this could be an instance of a species locally preferring a site but fairly small overall numbers are exposed.

6.2.1.4.2 Seaducks

Seaducks include the eiders, scoters, and Long-tailed Ducks (*Clangula hyemalis*), all of which are northern boreal, Gulf of Maine, or Arctic breeders that winter along the US east coast. In winter, seaducks can gather in large flocks in areas of appropriate habitat, sometimes in mixed species groups. Most seaducks forage on mussels and/or other shellfish and benthic invertebrates. They generally winter in shallower inshore waters or out over large offshore shoals, where they can access their benthic prey.

The western side of the Nantucket Shoals, approximately 25 nautical miles ("nm") to the east of the WDA, is a well-recognized important area for wintering seaducks (Meattey et al., in prep.; Silverman et al., 2013), particularly for Long-tailed Ducks (White et al., 2009), and other marine bird species (Veit et al., 2016). Long-tailed Ducks and other seaducks winter on the Nantucket Shoals in large aggregations from November to April; as much as 30% of the continental population of Long-tailed Ducks (White et al., 2009) and a significant proportion of the Atlantic population of White-winged Scoters (*Melanitta deglandi*) can spend the season in that location (Silverman et al., 2012).

Analysis of satellite-tracked Surf Scoters (*Melanitta perspicillata*), captured and tagged in the mid-Atlantic region, revealed their winter distributions to be largely well inshore of the mid-Atlantic BOEM WEAs, although they did exhibit a smaller core wintering area in Nantucket Sound (Berlin et al., 2017). Surf Scoters did overlap somewhat with the mid-Atlantic BOEM WEAs during their migration periods (Berlin et al., 2017). The regional MDAT abundance models and mid-winter aerial waterfowl surveys (Silverman et al., 2012) show that most seaducks are concentrated close to shore and between Nantucket Island, Martha's Vineyard, and Cape Cod.

The annual exposure for the seaduck group (six species) was insignificant. On a seasonal basis, Red-breasted Merganser (*Mergus serrator*), Long-tailed Duck, and Black Scoter (*Melanitta nigra)* are expected to have insignificant exposure in all seasons; Common Eiders (*Somateria mollissima*) have unlikely exposure in the winter; Surf Scoter have unlikely exposure in fall and winter; and overall, White-winged Scoter (*Melanitta fusca*) is expected to have insignificant exposure with peaks of unlikely exposure in spring and winter.

6.2.1.4.3 Shearwaters, Petrels, Storm-Petrels

Petrels and shearwaters that breed in the southern hemisphere visit the northern hemisphere during the austral winter (boreal summer) in vast numbers. These species use the US Atlantic Outer Continental Shelf ("OCS") region so heavily that, in terms of sheer numbers, they easily swamp the locally breeding species and year-round residents at this time of year (Nisbet et al., 2013). Several of these species (e.g., Great Shearwater [*Puffinus gravis*], Cory's Shearwater [*Calonectris diomedea*], and Wilson's Storm-Petrel [*Oceanites oceanicus*]) are found in high densities across the broader region (Veit et al., 2015) and within BOEM's MA WEA (Veit et al., 2016) in summer. The regional MDAT abundance models show that the birds are concentrated offshore south of Maine and Nova Scotia. The annual exposure score for the shearwater group (six species) ranged from insignificant to unlikely. Northern Fulmar (*Fulmarus glacialis*), Sooty Shearwater (*Puffinus griseus*), and Wilson's Storm-Petrel had an overall score of insignificant though the storm-petrels and shearwaters show a peak of potential in the summer. Overall, Manx Shearwater (*Puffinus puffinus*), Cory's Shearwater, and Great Shearwater are expected to have insignificant to unlikely annual exposure with peaks mainly in the summer.

6.2.1.4.4 Gannets and Cormorants

Northern Gannets (*Morus bassanus*) breed in southeastern Canada and winter along the US Atlantic OCS, particularly in the mid-Atlantic region and the Gulf of Mexico. Based on analysis of satellite-tracked Northern Gannets captured and tagged in the mid-Atlantic region, these birds show a preference for shallower, more productive waters and are mostly found inshore of the mid-Atlantic BOEM WEAs in winter (Stenhouse et al., 2017). They are opportunistic foragers, however, capable of long-distance oceanic movements, and generally migrate on a broad front, all of which may increase their exposure to offshore wind facilities, compared with species that are truly restricted to inshore habitats (Stenhouse et al., 2017). The regional MDAT abundance models show that Northern Gannets use the OCS to the south of the WDA. The annual exposure score for Northern Gannets is unlikely with exposure primarily expected during the spring, summer, and fall.

Double-crested Cormorants (*Phalacrocorax auritus*) are expected to be the most likely species of cormorant that may have limited exposure to the Project. While Great Cormorants (*Phalacrocorax carbo*) could possibly pass through the WDA during the non-breeding season, they are likely to remain in coastal waters (Hatch et al., 2000). Double-crested Cormorants tend to forage and roost close to shore. The regional MDAT abundance models show that cormorants are concentrated closer to shore and to the south. This aligns with the literature, which indicates these birds rarely use the offshore environment (Dorr et al., 2014). The annual exposure score for Double-crested Cormorant is insignificant across all seasons.

6.2.1.4.5 Gulls and Jaegers

The gulls present in the region are a large and varied group. The larger gull species (Herring Gull [*Larus argentatus*] and Great Black-backed Gull [*Larus marinus*]) are resident to the region year-round, but roam further offshore outside of the breeding season (Veit et al., 2016). While gulls tend to be coastal, they will follow fishing vessels offshore. Jaegers and skuas are highly pelagic group of dark, gull-like species. The jaegers (Pomarine Jaeger [*Stercorarius pomarinus*], Parasitic Jaeger [*Stercorarius parasiticus*], and Long-tailed Jaeger [*Stercorarius longicaudus*]) are all Arctic breeders that regularly migrate through the western North Atlantic region. Although their wintering ranges are poorly understood, they are known to occur in the Caribbean and off the coast of South America (Wiley & Lee, 1999; Wiley & Lee, 2000), or as far as southwest Africa (Long-tailed Jaeger)(Wiley & Lee, 1998). The Parasitic Jaeger is often observed closer to shore during migration than the others species (Wiley & Lee, 1999). Great Skuas (*Stercorarius skua*) are also northern breeders that may pass along the Atlantic OCS outside the breeding season. In recent decades, skuas observed in the western North Atlantic have increasingly been identified as South Polar Skuas (*Stercorarius maccormicki*) (Lee, 1989), which breed in the southern hemisphere and wander north during the austral winter. The regional MDAT abundance models show that these birds have a wide distribution ranging from near shore (gulls) to offshore (jaegers).

The annual exposure score for the gull and jaeger group (seven species) ranged from insignificant to potential. Icelandic Gull (*Larus glaucoides*) has insignificant exposure during all seasons. Pomerine Jaeger and Laughing Gull (*Larus atricilla*) are also expected to have insignificant exposure over all seasons; Pomerine Jaeger has unlikely exposure in the summer, and Laughing Gull has unlikely exposure during the fall. Over all seasons, Black-legged Kittiwake (*Rissa tridactyla*) and Bonaparte's Gull (*Larus Philadelphia*) are expected to have unlikely exposure; Black-legged Kittiwake exposure ranges from unlikely in the fall to likely in the winter, and Bonaparte's Gull is likely in the spring and insignificant in all other seasons. Overall, Herring Gull and Great Black-backed Gull are expected to have potential exposure primarily during the summer and fall, with peaks to likely exposure in the summer for Herring Gull.

6.2.1.4.6 Terns

Roseate Terns and Common Terns (*Sterna hirundo*) breed in Massachusetts, and Arctic Terns (*Sterna paradisae*) could pass through the WDA during migration. Terns, all migratory, generally restrict themselves to coastal waters during breeding, although they may pass through the WDA on their migratory journeys. This is especially true of a few tern species (Common Terns, Roseate Terns), which are known to aggregate around the Nantucket Shoals, particularly in spring (Veit et al., 2016). The regional MDAT abundance models show that terns are generally concentrated closer to shore than the WDA. The annual exposure score for the tern group (two species) was insignificant. Common Terns had insignificant exposure in all seasons.

Roseate Terns are federally-listed as well as state listed, and are thus addressed in the "Federally-Listed Species" section, below.

6.2.1.4.7 Auks

The auk species present in the region are generally northern or Arctic-breeders that winter along the US Atlantic OCS. The annual abundance and distribution of auks along the eastern seaboard in winter is erratic, however, depending upon broad climatic conditions and the availability of prey (Gaston & Jones, 1998). Recent increases in their abundances off

Table 6.2-6 Basic Ecological Traits of Marine Birds in the Region and Their Conservation Status at State, Federal, and Global Scales[1]

Species	Scientific Name	Map	Regional Presence	Distribution In/Offshore	At sea	Diet Feeds at	Feeds on	Conservation Status[2] State	Federal	Global	Global Distribution	Breeding Region
Loons & Grebes												
Common Loon	*Gavia immer*	*	winter	pelagic	dispersed	mid-water	fish, inverts	SC	.	LC	circumpolar	temperate
Red-throated Loon	*Gavia stellata*	*	winter	inshore	dispersed	mid-water	fish, inverts	.	BCC	LC	circumpolar	subArctic
Horned Grebe	*Podiceps auritus*		winter	coastal	dispersed	surf-mid	fish, inverts	.	BCC	VU	circumpolar	temp-subArc
Red-necked Grebe	*Podiceps grisegena*	*	winter	coastal	dispersed	surface	fish, inverts	.	.	LC	circumpolar	temp-subArc
Seaducks												
King Eider	*Somateria spectabilis*		winter	coastal	aggregated	benthos	inverts	.	.	LC	circumpolar	Arctic
Common Eider	*Somateria mollissima*	*	year-round	coastal	aggregated	benthos	inverts	.	.	LC	circumpolar	Arc-subArc
Surf Scoter	*Melanitta perspicillata*	*	winter	coastal	aggregated	benthos	inverts	.	.	LC	N America	subArctic
White-winged Scoter	*Melanitta fusca*	*	winter	coastal	aggregated	benthos	inverts	.	.	LC	circumpolar	subArctic
Black Scoter	*Melanitta nigra*		winter	coastal	aggregated	benthos	inverts	.	.	LC	circumpolar	subArctic
Long-tailed Duck	*Clangula hyemalis*	*	winter	coastal	aggregated	benth-mid	inverts	.	.	VU	circumpolar	Arctic
Shearwaters, Petrels & Storm-Petrels												
Northern Fulmar	*Fulmarus glacialis*	*	winter	pelagic	disp-aggreg	surface	fish, squid	.	.	LC	circumpolar	Arctic
Cory's Shearwater	*Calonectris diomedea*	*	summer	pelagic	disp-aggreg	surface	fish, inverts	.	.	LC	circumpolar	subAntarctic
Great Shearwater	*Puffinus gravis*		summer	pelagic	disp-aggreg	surface	fish, inverts	.	BCC	LC	N & S Atlantic	subAntarctic
Sooty Shearwater	*Puffinus griseus*	*	summer	pelagic	disp-aggreg	surface	fish, inverts	.	.	NT	circumpolar	subAntarctic
Manx Shearwater	*Puffinus*	*	summer	pelagic	dispersed	surface	fish, inverts	.	.	LC	N & S Atlantic	temperate
Audubon's Shearwater	*Puffinus lherminier*		summer	pelagic	dispersed	surface	fish, inverts	.	BCC	LC	N America	temp-trop
Wilson's Storm-Petrel	*Oceanites oceanicus*	*	summer	pelagic	dispersed	surface	plankton	.	.	LC	circumpolar	subAntarctic
Leach's Storm-Petrel	*Oceanodroma leucorhoa*		summer	pelagic	dispersed	surface	plankton	E	.	VU	circumpolar	subArctic
Gannets & Cormorants												
Northern Gannet	*Morus bassanus*	*	winter	coast-pelagic	dispersed	mid-water	fish	.	.	LC	N Atlantic	subArctic
Double-crested Cormorant	*Phalacrocorax auritus*	*	year-round	coast-inland	dispersed	mid-water	fish	.	.	LC	N America	subArc-temp
Great Cormorant	*Phalacrocorax carbo*		year-round	coast-inland	dispersed	benthos	fish	.	BCC	LC	Eurasia, Africa	subArc-subAnt
Gulls & Jaegers												
Black-legged Kittiwake	*Rissa tridactyla*	*	winter	pelagic	dispersed	surface	fish, inverts	.	.	LC	circumpolar	Arctic
Bonaparte's Gull	*Larus philadelphia*	*	winter	pelagic	dispersed	surface	fish, inverts	.	.	LC	N America	subArctic
Black-headed Gull	*Chroicocephalus ridibundus*		rare	coastal	dispersed	surface	fish, inverts	.	.	LC	W Europe	temperate
Little Gull	*Hydrocoloeus minutus*		rare	coastal	dispersed	surface	fish, inverts	.	.	LC	circumpolar	subArctic
Laughing Gull	*Larus atricilla*	*	summer	coastal	dispersed	surface	fish, inverts	.	.	LC	Americas	temp-trop
Ring-billed Gull	*Larus delawarensis*		year-round	coastal	dispersed	surface	fish, inverts	.	.	LC	N America	temperate
Herring Gull	*Larus argentatus*	*	year-round	coastal	dispersed	opportunistic		.	.	LC	circumpolar	temperate
Icelandic Gull	*Larus glaucoides*	*	winter	coastal	dispersed	opportunistic		.	.	LC	circumpolar	Arctic
Lesser Black-backed Gull	*Larus fuscus*		rare	coastal	dispersed	opportunistic		.	.	LC	W Europe	temperate
Glaucous Gull	*Larus hyperboreaus*		winter	coastal	dispersed	opportunistic		.	.	LC	circumpolar	Arctic
Great Black-backed Gull	*Larus marinus*		year-round	coastal	dispersed	opportunistic		.	.	LC	circumpolar	temperate
Pomarine Jaeger	*Stercorarius pomarinus*	*	passage	pelagic	dispersed	surface	fish, inverts	.	.	LC	circumpolar	Arctic
Parasitic Jaeger	*Stercorarius parasiticus*		passage	pelagic	dispersed	surface	fish, inverts	.	.	LC	circumpolar	Arctic
Long-tailed Jaeger	*Stercorarius longicaudus*		passage	pelagic	dispersed	surface	fish, inverts	.	.	LC	circumpolar	Arctic

Table 6.2-6 Basic Ecological Traits of Marine Birds in the Region and Their Conservation Status at State, Federal, and Global Scales[1] (Continued)

Species	Scientific Name	Map	Regional Presence	Distribution		Diet		Conservation Status[2]			Global Distribution	Breeding Region
Terns												
Least Tern	*Sternula antillarum*		summer	coastal	dispersed	surface	fish, inverts	SC	SC	LC	N. America	temp-trop
Caspian Tern	*Sterna caspia*		summer	coastal	dispersed	surface	fish, inverts	.	.	LC	N Am, Eura, Afr	temp-trop
Black Tern	*Chlidonias niger*		passage	coastal	dispersed	surface	inverts, fish	.	.	LC	N/S Am, Euro, Afr	inland temp
Roseate Tern	*Sterna dougalli*	*	summer	coastal	dispersed	surface	fish, inverts	E	E	LC	N/S Am, Asia, Afr	temp-trop
Common Tern	*Sterna hirundo*	*	summer	coastal	dispersed	surface	fish, inverts	SC	.	LC	circumpolar	subArc-trop
Arctic Tern	*Sterna paradisae*		passage	coastal	dispersed	surface	fish, inverts	SC	BCC	LC	circumpolar	Arctic
Forster's Tern	*Sterna forsteri*		summer	coastal	dispersed	surface	fish, inverts	.	.	LC	N America	inland temp
Royal Tern	*Sterna maxima*		summer	coastal	dispersed	surface	fish, inverts	.	.	LC	N/S Am, Africa	temp-trop
Auks												
Dovekie	*Alle alle*	*	winter	pelagic	dispersed	mid-water	plankton	.	.	LC	circumpolar	Arctic
Common Murre	*Uria aalge*	*	winter	pelagic	dispersed	mid-water	fish, inverts	.	.	LC	circumpolar	Arc-subArc
Thick-billed Murre	*Uria lomvia*		winter	pelagic	dispersed	mid-water	fish, inverts	.	.	LC	circumpolar	Arctic
Razorbill	*Alca torda*	*	winter	pelagic	dispersed	mid-water	fish, inverts	.	.	NT	N Atlantic	sub-Arctic
Black Guillemot	*Cepphus grylle*		year-round	coastal	dispersed	benth-mid	fish, inverts	.	.	LC	circumpolar	Arc-temp
Atlantic Puffin	*Fratercula artica*		winter	pelagic	dispersed	mid-water	fish	.	.	VU	N Atlantic	subArc-temp
Shorebirds												
Red-necked Phalarope	*Phalaropus lobatus*		passage	pelagic	dispersed	surface	plankton	.	.	LC	circumpolar	Arctic
Red Phalarope	*Phalaropus fulicarius*	*	passage	pelagic	dispersed	surface	plankton	.	.	LC	circumpolar	Arctic

[1] Adapted from eBird data (from BOEM, 2014) and cross-referenced with the US Fish and Wildlife Service (“USFWS”) IPaC database (https://ecos.fws.gov/ipac/)

[2] Conservation Status: E = Endangered, T = Threatened, SC = Special Concern, BCC = Bird of Conservation Concern, VU = Vulnerable, NT = Near Threatened, LC = Least Concern.

the coast of Massachusetts has been linked to long-term variations in oceanic climate (Veit & Manne, 2015). In winters with prolonged harsh weather, which may prevent foraging for extended periods, these generally pelagic species often move inshore, or are driven considerably further south than usual. As a group, auks are commonly impacted in this way during severe storms, although die-off events also regularly impact the petrels and shearwaters, and occasionally Northern Gannets (Fraser, 2017). The regional MDAT abundance models show that auks are concentrated offshore and south of Nova Scotia.

The annual exposure score for the auk group (three species) ranged from insignificant to unlikely. Overall, Common Murre (*Uria aalge*) is expected to have insignificant exposure with unlikely exposure limited to the winter; Dovekie (*Alle alle*) is expected to have insignificant exposure with potential exposure in the winter; and Razorbill (*Alca torda*) is expected to have unlikely exposure that ranges from unlikely in the fall and winter, and potential in the spring.

6.2.1.5 Federally-Listed Species

6.2.1.5.1 Roseate Tern

Species General Description: Roseate Terns are a small tern species that breed colonially on islands. The northwest Atlantic Ocean population of Roseate Terns breeds in the northeastern US and Atlantic Canada, and winters in South America, primarily eastern Brazil (Nisbet et al., 2014; USFWS, US 2010). Roseate Terns generally arrive at their northwest Atlantic breeding colonies in late April to late May, with nesting occurring between roughly mid-May and late July. They commonly forage during the breeding season in shallow water areas (i.e., <5 m [16.4 feet ("ft")] water depth), such as sand bars (Nisbet et al., 2014; USFWS, 2010). Roseate Terns forage by plunge-diving or surface-dipping to catch small fish, such as sand lance (*Ammodytes* spp) (Goyert et al., 2014; Nisbet et al., 2014).

Over 90% of Roseate Terns in this population breed at three colony locations in Massachusetts (Bird Island, Ram Island, and Penikese Island in Buzzards Bay) and one colony location in New York (Great Gull Island, near the entrance to Long Island Sound) (Loring et al., 2017; Nisbet et al., 2014). Breeding Roseate Terns generally stay within about 10 km (6.2 mi) of the colony to forage for food, though they may travel 30-50 km (18.6 – 31.0 mi) from the colony while provisioning chicks (Burger et al., 2011; Loring et al., 2017; Nisbet et al., 2014; USFWS, 2010). The closest Roseate Tern nesting colony to the WDA is located at Norton Point/Katama Beach in Edgartown, about 23.5 km (14.6 mi) from the northernmost edge of the WDA, and had 35 breeding pairs as of 2015 (Mostello & Longsdorf, 2017).

Following the breeding season, adult and hatch year Roseate Terns move to post-breeding coastal staging areas from approximately late July to mid-September (USFWS, 2010). There are roughly 20 staging areas in southeastern Cape Cod and nearby islands, which represent the majority of the breeding population for the northwest Atlantic (USFWS, 2010). Foraging activity during the staging period is known to occur up to 16 km (10 mi) from the coast, though most foraging activity occurs much closer to shore (Burger et al., 2011). Monomoy Island and surrounding areas, known as one of the primary pre-migratory staging areas for the species, are about 55-60 km (34.2-37.3 mi) from the WDA. The nearest pre-migratory staging area to the WDA is located at Katama Beach on the south side of Martha's Vineyard (23.5 km [14.6 mi] from the WDA).

Roseate Tern migration routes are poorly understood, but they appear to migrate primarily pelagically (Burger et al., 2011; Mostello et al., 2014; Nisbet, 1984; Nisbet et al., 2014; USFWS, 2010,). Six Roseate Terns tracked with data loggers in the 2000's flew directly between Massachusetts and eastern Caribbean islands during spring and fall migration, crossing the ocean near the edge of the continental shelf, and in some cases spending several days at sea (Mostello et al.; 2014, Nisbet et al., 2014; USFWS, 2010). The trip from Cape Cod to Puerto Rico in the fall took 1.5-2.5 days on average (900-1,500 km/day [559-932 mi/day]), with birds flying all night and stopping to feed at times during the day (Mostello et al., 2014; Nisbet et al., 2014). Spring migration from South America to breeding locations occurred more quickly overall, but migration between the northeastern Caribbean and Massachusetts was less direct, tended farther west than in fall (though still well offshore), and included nocturnal as well as diurnal stopover periods (Mostello et al., 2014; Nisbet et al., 2014). Spring pre-breeding staging locations appear to be similar to post-breeding staging areas (Mostello et al., 2014).

Listing and Population Status: The northwest Atlantic Ocean population of Roseate Terns has been federally-listed as endangered under the Endangered Species Act ("ESA"), 16 U.S.C. ch. 35 § 1531 et seq., since 1987. Other breeding populations of Roseate Terns, such as the Caribbean breeding population, are unlikely to occur in the WDA (BOEM, 2014). Declines in the northwest Atlantic population have been largely attributed to low reproductive productivity, partially related to predator impacts on breeding colonies and habitat loss and degradation, though adult Roseate Tern survival is also unusually low for a tern/small gull species (USFWS, 2010). As of 2015, 50% of the population's approximately 3,900 pairs nested in Massachusetts (Mostello & Longsdorf, 2017).

Regional Information: Areas around Cape Cod that have been identified as important for Roseate Tern foraging activity in past years have largely been concentrated in Buzzard's Bay, Vineyard Sound, and along the southern coast of the Cape in Nantucket Sound (Minerals Management Service ["MMS"], 2008), though foraging locations can be highly dynamic. Non-breeding individuals, including juveniles and non-reproductive adult birds, are thought to move between foraging and staging areas more frequently and to move over longer distances than breeding individuals (USFWS, 2017a).

Recent data suggest that Nantucket Shoals may also be an important area for Common Terns and Roseate Terns in spring (during the month of May), prior to initiation of breeding (Veit et al., 2016). In recent aerial surveys of BOEM's MA WEA and vicinity, *Sterna* terns were observed offshore most commonly during the spring season, though median estimates of terns per square kilometer remained low in all seasons (Veit et al., 2016).

WDA Specific Information: Overall, the regional and site-specific information indicate low use of the WDA by Roseate Tern during spring, summer, and fall (terns are not present in the winter). The MDAT abundance models suggest that Roseate Tern occupancy and abundance in the WDA is likely to be much lower than in Nantucket Sound in all seasons examined- spring, summer, and fall (Kinlan et al., 2016)- though it should be noted that model performance was quite poor, particularly in spring, likely due, in part, to the relatively few Roseate Tern observations in the dataset (n = 328). The Veit survey data only has three records of terns (not identified to species) in the WDA for all seasons and years combined (Veit et al., 2016). Additional surveys were then conducted to gather supplementary information during the spring in which no Roseate Terns were observed in the WDA during boat surveys conducted in April and May of 2018 (see Appendix III-O).

During the breeding and post-breeding periods, very few, if any, Roseate Terns are predicted to occur within the WDA (BOEM, 2014; Kinlan et al., 2016). Survey data from the region suggest that Roseate Terns and other terns are most commonly observed around the Muskeget Channel, between Martha's Vineyard and Nantucket (BOEM, 2014; Veit et al., 2016).

Roseate Terns may occur at the WDA ephemerally during spring and fall migration, as well as during post-breeding movements towards staging areas (BOEM, 2014; Burger et al., 2011). Recent tracking data shows that in July/August, individuals move between staging locations on islands in Nantucket Sound, Block Island, and Montauk, including potential movements through the BOEM MA WEA, BOEM Rhode Island WEA, and Block Island Wind Farm (Loring et al., 2017). Though these data are still being analyzed, there is no evidence of post-breeding movements through the WDA (Loring et al., 2017), likely due to its location to the south of known breeding and staging locations.

In sum, Roseate Terns are expected to have low use of the WDA during all seasons, and any exposure will probably occur only during migration. The Veit survey data recorded only three unidentified terns in the WDA and the annual exposure analysis for Roseate Tern was insignificant. The MDAT abundance models predict low use of the WDA, with birds concentrated generally closer to shore than the WDA. Since Roseate Terns generally forage in shallow water they would not be expected to use the WDA for feeding habitat. Given that terns are rarely observed in the WDA and exposure is likely limited to migration, the expected exposure of Roseate Terns is insignificant.

6.2.1.5.2 Piping Plover

Species General Description: Piping Plovers are a small shorebird that nest on beaches, sand flats, and alkali wetlands along the Atlantic coast of North America, the Great Lakes, and in the Midwestern plains (Elliott-Smith & Haig, 2004). Piping Plovers feed on terrestrial and aquatic invertebrates, particularly in the intertidal zone and along wrack lines, and spend most of their time on the ground rather than aloft (Elliott-Smith & Haig, 2004). The Atlantic coast-breeding subspecies of Piping Plovers, which is the only population likely to occur in the vicinity of the WDA, breeds as individual pairs on sandy beaches from Newfoundland to North Carolina (BOEM, 2014; Elliott-Smith & Haig, 2004). Breeding generally occurs in May through early August, with variation in onset of breeding related to local pair densities as well as seasonal weather conditions (Elliott-Smith & Haig, 2004). Non-migratory movements in May-August appear to be exclusively coastal (Burger et al., 2011). Nocturnal activities during the breeding period are less well known, but appear to be similar to daytime activities in many respects, including foraging, incubating nests, and short local flights when birds are disturbed (Staine & Burger, 1994). Band recovery data suggests that there may be several distinct breeding populations within the Atlantic coast subspecies, with individuals largely returning to the areas where they were hatched or bred in previous years (Amirault-Langlais et al., 2014; USFWS, 2009).

Migration periods are primarily April-May and August-September (BOEM, 2014), though breeding plovers arrive in Massachusetts beginning around mid-March. Post-breeding movements of fledged chicks (≤50 km [31.1 mi]) and adults can occur prior to initiation of migration (Elliott-Smith & Haig, 2004), and post-breeding migratory movements can begin as early as June, with adult birds departing Massachusetts by late August (Elliott-Smith & Haig, 2004; Loring et al., 2017). There is some suggestion that hatch year birds may be delayed on their first fall migration, arriving at wintering grounds several months after adults, but little data are available (Elliott-Smith & Haig, 2004). Migration occurs primarily during nocturnal periods, with the average takeoff time in Massachusetts and Rhode Island appearing to be around 5:00-6:00 PM (Loring et al., 2017). Both breeding and wintering habitats include islands >5 km [3.1 mi] from the coast, including the Bahamas, which is >160 km (99.4 mi) from the US Atlantic coastline (Normandeau Associates Inc., 2011). This, along with the infrequency of observations of migratory flocks along the Atlantic coast, has been suggested to indicate that many Atlantic plovers, like the inland-breeding subspecies, may make nonstop long-distance migratory flights (Normandeau Associates Inc., 2011).

The species winters in the coastal southeastern United States and Caribbean (BOEM, 2014; Elliott-Smith & Haig, 2004; USFWS, 2009). The winter range of the species is imperfectly understood, particularly for US Atlantic breeders and for wintering locations outside the US, but includes the southeastern coast of the US from North Carolina to Texas, as well as Mexico, and several Caribbean islands (USFWS, 2009). Within the US wintering range, the

Atlantic subpopulation appears to primarily winter along the southern Atlantic coast and the Gulf coast of Florida, though Massachusetts-breeding birds are known to winter in Texas as well (Elliott-Smith & Haig, 2004; USFWS, 2009).

Listing and Population Status: The Atlantic population is listed as threatened under the ESA, with approximately 1,765 US nesting pairs as of 2016 (USFWS, 2017b), and is heavily managed on the breeding grounds to promote population recovery (Elliott-Smith & Haig, 2004). Coastal habitat loss and degradation, as well as human-related disturbance, represent some of the biggest threats to the population; predation is also an issue on the breeding grounds, and in Massachusetts this issue is exacerbated in association with human-related disturbance (BOEM, 2014; Elliott-Smith & Haig 2004; USFWS, 2009). The viability of the species is heavily dependent upon adult and juvenile survival rates (USFWS, 2009). However, the New England recovery unit of the population has exceeded or nearly met the USFWS-defined minimum abundance goal for recovery (625 pairs) every year since 1998 (USFWS, 2009). The Massachusetts population, by far the largest of the New England states, was estimated to be 649 pairs in 2016 (USFWS, 2017b).

Regional Information: Piping Plovers are present in Massachusetts during spring and fall migratory periods and during the breeding season (mid-March to late August or early September) (BOEM, 2014; Elliott-Smith & Haig, 2004). Large numbers of Piping Plovers have been observed in pre-migratory staging in southeastern Cape Cod in late summer (BOEM, 2014).

Only recently have data started to become available on the potential for macro-scale exposure of migrating Piping Plovers to offshore WEAs along the Atlantic coast. The species was historically thought to migrate along the coast (e.g., within ~5 km [3.1 mi] of the coast), because of an observed strong association with beaches and mudflats, although there was little actual evidence regarding migration routes or stopover sites (Burger et al., 2011; Elliott-Smith & Haig, 2004; USFWS, 2009).

However, Piping Plovers that bred in Rhode Island and Monomoy National Wildlife Refuge were recently tracked with nanotags (a type of VHF transmitter; n = 50) and monitored using automated telemetry stations in terrestrial areas. The telemetry stations standard detection range did not extend into the WDA. Migration trajectories in areas well offshore are interpolated from observed flight trajectories in coastal areas, as well as subsequent detections of individuals at other telemetry stations. The tracked individuals primarily chose offshore migration routes from their nesting locations (Loring et al., 2017); approximately 70% of Piping Plovers from Monomoy flew on a southward trajectory over Nantucket Island and eastern Nantucket Sound, apparently east of the WDA. Over half of Rhode Island birds also chose an offshore migration route, flying through Block Island Sound (between Block Island and Montauk), to the west of the WDA (Loring et al., 2017). Most of the remaining birds took more coastal routes west through the Sounds of Nantucket, Rhode Island, Block Island, and Long Island (Loring et al., 2017).

These recent data present evidence for offshore migratory "hops" between coastal areas such as Cape Cod, Long Island, coastal New Jersey/Delaware, and the Outer Banks of North Carolina. Large flocks of Piping Plovers have been observed during migratory stopover in Virginia, Cape May, New Jersey, and Cape Lookout, North Carolina (Elliott-Smith & Haig, 2004), providing additional evidence in support of this hypothesis. BOEM recently suggested that "[d]uring their migratory periods, primarily April and May in springtime and August and September in fall, at least some individuals of this species likely traverse the [BOEM MA] WEA, as migration does not appear to be concentrated along the coast" (BOEM, 2014).

WDA Specific Information: Nanotag telemetry stations did not have coverage of the WDA due to its distance from shore, but migratory flight trajectories generally suggest that migration routes may be located to the east and west of the WDA. There are no records of Piping Plovers in the WDA during diurnal periods, and there is no data available for nocturnal periods. In sum, since Piping Plover exposure to the WDA would hypothetically be only during migration, there are little to no records of the birds offshore, and there is no breeding or foraging habitat for the species in the WDA. Thus, the expected exposure is insignificant.

6.2.1.5.3 Red Knot

Species General Description: Red Knots are medium-sized shorebirds with some of the longest migrations in the world, undertaking nonstop flights of up to 8,000 km (4,970 mi) on their circumpolar travels between breeding and wintering locations (Baker et al., 2013). When not actively migrating, Red Knots feed exclusively in terrestrial locations, primarily in the intertidal zone, on mussels, clams, and other invertebrates, and spend most of their time on the ground rather than aloft.

Red Knots tend to embark on migratory flights a few hours before sunset, on sunny days and days with tailwinds, and to migrate in flocks numbering in the dozens to hundreds of individuals (Baker et al., 2013). Migration routes appear to be highly diverse. Some individuals fly over the open ocean from the northeastern US directly to stopover/wintering sites in the Caribbean and South America, while others make the ocean "jump" from farther south, or follow the US Atlantic coast for the duration (Baker et al., 2013; BOEM, 2014). Some of this variation may be due to birds avoiding large storms in the Atlantic (Baker et al., 2013).

Listing and Population Status: The *rufa* subspecies of the Red Knot is listed as threatened under the ESA, primarily because the Atlantic flyway population decreased by approximately 70% from 1981 to 2012, to <30,000 individuals (USFWS, 2015; Baker et al., 2013; Burger et al., 2011). This subspecies appears to include three distinct populations in the western Hemisphere, with individuals wintering in the southeastern US and Caribbean, northern Brazil, and Tierra del Fuego (Baker et al., 2013). All three populations breed in the high Arctic, and share several key migration stopover areas along the US. east coast, particularly in Delaware Bay and coastal islands of Virginia (Burger et al., 2011). Increasingly limited food resources in these staging areas, as well as breeding conditions in the Arctic and habitat degradation on the wintering grounds, are thought to be contributing to the population's decline (Baker et al., 2013). Impacts of climate change on habitats, food availability, and migration are also expected to negatively influence Red Knot populations. Population status is thought to be strongly influenced by adult survival and recruitment rates, conditions in the breeding grounds, and food availability on stopover sites (97-98% of individuals are estimated to use the same small number of stopover locations in some areas) (Baker et al., 2013).

Regional Information: The Red Knot is present in Massachusetts only during migratory periods (BOEM, 2014). All three populations of *rufa* are known to stop over on Monomoy Island during southward migration in the fall (Baker et al., 2013). The fall migration period is July-October, and is characterized by a concentration of migrant activity and departures in Massachusetts, particularly Cape Cod in August (Baker et al., 2013; Burger et al., 2011). As well as arriving and departing at slightly different times, adults and juveniles appear to use different stopover locations in Cape Cod and mainland Massachusetts (Baker et al., 2013).

During northward migration in spring, all three wintering populations of *rufa* use Delaware Bay as a key stopover location in late April to June, before undertaking long flights to locations in Canada (Baker et al., 2013). Birds in the southeastern US wintering population may also make multiple stops along the eastern seaboard, including in Massachusetts; spring migration through Massachusetts may thus include both offshore migratory activity and more coastal activity after birds make landfall farther south (BOEM, 2014). Reports from the 1800's suggest many thousands of Red Knots stopping over in Massachusetts in late May and early June, but relatively few birds are observed in Massachusetts Bay today (Baker et al., 2013). While at stopover locations, Red Knots make local movements (e.g., commuting flights between foraging locations related to tidal changes), but are thought to remain within 5 km (3.1 mi) of shore (Burger et al., 2011).

WDA Specific Information: There are no records of Red Knot in the WDA. Most adult *rufa* fly offshore over the Atlantic from Canadian or US staging areas to South America (Baker et al., 2013); this is the period in which Red Knots could potentially move through the WDA (BOEM, 2014). However, since Red Knot exposure to the WDA is limited to migration and there is no habitat for the species in the WDA, the expected exposure is insignificant.

6.2.1.5.4 Bald and Golden Eagle

Species General Description: Bald Eagles are broadly distributed across North America. The species generally nests and perches in association with water (lakes, rivers, bays) in both freshwater- and marine-based habitats, often remaining within roughly 500 m (1,640 ft) of the shoreline (Buehler, 2000). Foraging habits are seasonally opportunistic, but individuals generally prefer fish when available. In some regions, the diets of Bald Eagles nesting in offshore coastal settings are dominated by birds (i.e., waterfowl, cormorants, and gulls), whereas inland nesters in New England largely focus on fish (Murie, 1940; Todd et al., 1982). Bald Eagles commonly scavenge dead birds, fish, and mammals, particularly during the winter when live fish prey are more scarce.

Golden Eagle (*Aquila chrysaetos*) diets are generally comprised of small mammals such as rabbits, mice and prairie dogs, but numerous other prey items have also been reported (Kochert et al., 2002). Golden Eagles are generally associated with open habitats, particularly in the western US, but satellite-tracked individuals wintering in the eastern US have also been documented to heavily utilize forested regions (Katzner et al., 2012). In addition to breeding populations in Europe and Asia, Golden Eagles are broadly distributed across western North America, but are comparatively rare in the eastern US (Kochert et al., 2002). Golden Eagles commonly winter in the southern Appalachians and are regularly observed in the mid-Atlantic US, spanning coastal plain habitat in Virginia, Delaware, North Carolina, South Carolina, and other southeastern US states. Individuals migrating between Appalachian states and easternmost breeding populations in Canada generally use inland migration routes following the Appalachian Mountains, rather than coastal migration flyways (Katzner et al., 2012).

Unlike many groups of birds, such as falcons, gulls, and shorebirds, eagles have a high weight to wing area ratio (Mendelsohn et al., 1989). This wing-loading characteristic causes eagles to rely heavily upon thermals during long-distance movements and to generally avoid large water crossings (Kerlinger, 1985). Bald Eagles will, however, travel to islands to nest, forage (i.e., seabird colonies) (Todd et al., 1982), and presumably to stopover during long-distance movements (Mojica et al., 2008).

Listing and Population Status: Bald Eagles were removed from the federal list of threatened and endangered species in 2007; but are currently listed as threatened in Massachusetts. Breeding populations of Golden Eagles are extirpated in the eastern US, (Katzner et al., 2012), and the nearest known breeding populations are in Canada, where they are common in several eastern Canadian Provinces (i.e., Québec, Newfoundland, and Labrador) (Katzner et al., 2012). Both Bald Eagles and Golden Eagles remain federally protected under the BGEPA.

Regional Information: Bald Eagles are present year-round in Massachusetts, and are on Martha's Vineyard, Nantucket, and other nearby islands (eBird 2017). In a study evaluating the space use of Bald Eagles captured in Chesapeake Bay, the Cape Cod region was associated with very low levels of use (Mojica et al., 2016). In 2012-2013, a large offshore area in the mid-Atlantic US surveyed using both boat-based and aerial surveys detected only four Bald Eagles, all <6 km (3.7 mi) from shore (Williams et al., 2015). Given the fact that the study area in that study was near one of the largest Bald Eagle population centers in North America (Chesapeake Bay), this finding supports the hypothesis that Bald Eagles rarely venture large distances offshore.

WDA Specific Information: The general morphology of both Bald Eagles and Golden Eagles dissuades regular use of offshore habitats. These two species generally rely upon thermals, which are poorly developed over the ocean, during migration movements. Golden Eagle exposure in the WDA is expected to be insignificant due to their dietary habits, limited distribution in the eastern US, and reliance on terrestrial habitats (BOEM, 2014). Bald Eagle exposure in the WDA is also expected to be insignificant because the WDA is not located along any likely or known Bald Eagle migration route, Bald Eagles tend not to fly over large waterbodies, and features that might potentially attract them offshore (i.e., islands) are absent in the vicinity. Since exposure is expected to be insignificant for both eagle species and there is no evidence that they will be exposed to the WDA, eagles will not be addressed further.

6.2.2 Potential Impacts of the Project

Potential direct and indirect impacts were evaluated by considering how vulnerable species will be exposed (see Section 6.2.1) to impact-producing factors ("IPFs"). Vulnerability was defined as behavioral factors (e.g., flight, height, and avoidance) that increase the likelihood that a bird will either collide with a turbine or be displaced from the WDA (Goodale & Stenhouse, 2016). For each species group, vulnerability was evaluated based upon existing assessments (e.g., Furness et al., 2013) and documented behavioral response to offshore wind farms in the literature. Levels of behavioral vulnerability are defined in Table 6.2-7.

Table 6.2-7 Definitions Behavioral Vulnerability

Behavioral Vulnerability Level	Definition
Insignificant	Low ranking for collision and displacement risk in Furness et al., 2013 AND/OR No evidence of collisions or displacement in the literature
Unlikely	Low ranking for collision and displacement risk in Furness et al., 2013 AND/OR Little evidence of collisions or displacement in the literature
Potential	Moderate ranking for collision and displacement risk in Furness et al., 2013 AND/OR Evidence of collisions or displacement in the literature
Likely	High ranking for collision and displacement risk in Furness et al., 2013 AND/OR Significant evidence of collisions or displacement in the literature

IPFs are defined as the changes to the environment caused by project activities during each offshore wind farm development phase (i.e., hazards) (BOEM, 2012; Goodale & Milman 2016). IPFs for marine birds are summarized in Table 6.2-8.

Table 6.2-8 Impact- Producing Factors for Birds

Impact-producing Factors	Wind Development Area	Offshore Export Cable Corridor	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Pile driving for WTG and ESP Foundations	X		X		
Increased vessel traffic	X	X	X	X	X
Wind Turbine Generators	X		X	X	X

Vessels installing the offshore export cable are not expected to be an IPF because exposure will be transitory and ephemeral. Coastal and marine birds may encounter a cable installation vessel, but the exposure to the vessel, in any given location, will be limited to a finite temporal period. Therefore, the impact assessment below is focused on activities occurring in the WDA. To be at risk of a direct or an indirect impact, a species must be both exposed to a wind farm and be vulnerable to either displacement or collision (Goodale & Stenhouse, 2016).

The impacts of operating offshore wind farms on birds are generally characterized as direct effects (collision) that cause injury or death, and the indirect effects (displacement) that may cause habitat loss (Drewitt & Langston, 2006; Fox et al., 2006; Goodale & Milman, 2016). While rare for projects built offshore, collisions have been recorded at wind farms built directly adjacent to seabird colonies (Everaert & Stienen, 2007) and generally occur in two ways: birds collide with the superstructure or rotors during operation, or birds are forced to the ground due to the vortex created by the moving rotors (Drewitt & Langston, 2006; Fox et al., 2006). Certain groups of birds are displaced by offshore wind developments through avoidance behavioral responses (Fox et al., 2006; Krijgsveld et al., 2011; Lindeboom et al., 2011), which has been documented for seaducks, gannets, auks, geese, and loons (Desholm & Kahlert, 2005; Garthe et al., 2017; Langston, 2013; Larsen & Guillemette, 2007; Lindeboom et al., 2011; Percival, 2010; Plonczkier & Simms, 2012). Birds that avoid the wind farm area completely experience effective habitat loss (Drewitt & Langston, 2006; Langston, 2013; Masden et al., 2009; Petersen et al., 2011). This avoidance, however, only results in a small increase in energy expenditure (Masden et al., 2009) and there is little evidence to suggest that avoidance and potential displacement from wind developments is reducing fitness, leading to critical habitat loss, or adversely affecting populations.

The risk of impacts caused by collision and displacement occurs when vulnerable species are exposed to the hazard of the wind farms. The offshore wind farm hazards most likely to cause adverse effects for birds are the rotors (collision) and the project's footprint (displacement) (Goodale & Milman, 2016). Individual species vulnerability is based on intrinsic or innate behaviors that will increase exposure rates, such as basic feeding, breeding, migrating, or sheltering behaviors. Behaviors contributing to collision vulnerability are primarily flight behaviors that increase the likelihood that a bird will be struck by a turbine blade. Species vulnerability can also be caused by a species' response to the presence of an offshore wind farm. For some species, this may be avoidance that can lead to partial or complete displacement from a WDA, whereas for others, it may involve an attraction to wind farm structures (Furness et al., 2013).

6.2.2.1 Construction and Installation

During construction, temporary IPFs can range from jack-up barges to the turbines, summarized in Table 6.2-8. For the analysis below, the full range of turbines that may be used by the Project are considered (eight megawatt ["MW"] and ~14 MW). Since there is little information on how birds respond to cable construction activities, the IPFs of Offshore Export Cable Corridor and the WDA construction activities are considered together. It is also assumed that foundation type will not significantly change the IPFs during construction. If the larger turbines are used, the overall disturbed area and duration of construction may be less. During construction and installation, the primary hazards to birds that may lead to mortality or displacement are:

Temporary hazards potentially causing mortality or injury:

- Vertical structures of construction equipment and turbines that could be a collision hazard
- Lighting of construction vessels that may attract birds

Temporary hazards potentially causing displacement and habitat modification/loss:

- Noise generated by pile-driving that could lead to avoidance
- Boat traffic that could lead to attraction and/or avoidance

(adapted from MMS, 2007).

6.2.2.1.1 Potential Direct and Indirect Impacts of Construction

The potential direct impacts are mortality or injury due to collision with construction equipment. For most bird species, the primary impact of concern is collisions during operations rather than during construction, because the construction period is temporary and of relatively short duration. There is a small possibility of collision with lighted structures (vessels, construction equipment, and turbines) during construction in low light conditions and in severe/poor weather. Mitigation measures will reduce any impacts to insignificant levels because most birds, with exception of gulls, are less likely to be attracted to vessels during fair weather conditions. The potential indirect impact is displacement due to disturbance by construction vessels and/or pile driving noise and is discussed below. Higher levels of boat traffic and human activity, including operation of large machinery during construction, could cause temporary displacement/ avoidance in some species.

Coastal and Marine Birds

Coastal birds (shorebirds, waterfowl, waterbirds, wading birds, falcons, and songbirds) are expected to have insignificant to unlikely behavioral vulnerability to collision with construction equipment and an insignificant behavioral vulnerability to displacement. While birds may encounter the construction equipment during migration and may land on vessels, mortality from collision is unlikely. The potential for colliding with lit structures in the marine environment may increase if there is substantial lighting (e.g., Hüppop et al., 2006), but lighting can be minimized by using best management practices. Any avoidance behavior that coastal birds exhibit would reduce vulnerability to collision; furthermore, exposure of coastal birds will generally be limited to migration (see Section 6.2.1).

In summary, coastal birds are expected to have insignificant to unlikely exposure, primarily during migration, to construction activities in the Offshore Project Area. In the unlikely event that they would be exposed to construction IPFs, they are expected to have insignificant to unlikely behavioral vulnerability. Because of the limited exposure, short-term duration of the IPFs, and lack of behavioral vulnerability, population level impacts are expected to be unlikely. Risks will be further minimized through mitigation measures, as discussed in Section 6.2.2.1.2 below.

Marine birds (loons and grebes, seaducks, gannets, cormorants, jaegers and gulls, terns, shearwaters and petrels, and auks) as a group have unlikely behavioral vulnerability to collision with construction equipment or displacement by construction activities. Marine birds are known to be attracted to offshore vessels and structures, especially when lighted (Montevecchi, 2006; Wiese et al., 2001). Shearwaters and petrels forage on vertically migrating bioluminescent prey and are instinctively attracted to light sources of any kind (Imber, 1975). This may be particularly true during periods of poor visibility, when collision risk is likely to be highest. However, there is little data on avian behavior in the marine environment during such periods, as surveys are limited to periods of good weather during daylight hours. Gulls may be attracted to and perch on construction equipment.

In contrast, some marine birds (e.g., seaducks and loons) may be disturbed by wind farm vessels, equipment, and activities, which may lead to temporary displacement from cable installation and wind farm construction areas (MMS, 2007). Noise from pile driving may cause birds to avoid the construction area and can disturb the local prey base. When pile driving occurs close to tern colonies (within 2 km [1.24 mi]), pile driving noise may disperse the local abundance of prey fish (e.g., herring). The decreased abundance of prey can reduce seabird foraging success and may cause reduced reproductive success for multiple years (Perrow et al., 2011). However, the WDA does not appear to be located in a regionally important seabird foraging area (see Section 6.2.1) and is far from the nearest tern colony. Any short-term reduction in the prey base would be expected to recover completely once construction was completed. In addition, birds may be displaced by boat and helicopter traffic (Fox et al., 2006; Petersen et al., 2006). While there may be short-term disturbance of resident birds during offshore wind farm construction, most birds that are initially disturbed return to the area after construction activities are completed (Adams et al., 2016). Overall, bird exposure to construction IPFs will be ephemeral and limited because the Project is located far offshore.

In summary, marine birds are expected to have insignificant to potential exposure to construction activities in the Offshore Project Area. In the low likelihood that they would be exposed to construction IPFs, they are not expected to have behavioral vulnerability. Because of the limited exposure, short-term duration of the IPFs, and low behavioral vulnerability, population level impacts are expected to be unlikely. Risks will be further minimized through mitigation measures.

Federally-listed species

Because the construction phase of the project is temporary, federally-listed birds are unlikely to collide with construction equipment and will not be permanently displaced.

Roseate Tern: Roseate Terns have insignificant to unlikely behavioral vulnerability to collision with construction equipment and an insignificant behavioral vulnerability to displacement. As described in the above section, marine birds can be attracted to offshore structures that are illuminated, especially during periods of poor visibility. However, there are limited data on Roseate Tern behavior during periods of poor visibility, including inclement weather and nocturnal time periods (MMS, 2008; USFWS, 2008). Data on Roseate Tern flight height indicates that non-migrating birds are generally flying below the WTGs lowest blade position (27 m [89 ft]) (MMS, 2008; Nisbet et al., 2014); the altitude at which Roseate Terns migrate offshore is unknown, but is thought to be higher than foraging and nearshore flight altitudes, perhaps in the hundreds to thousands of meters. (MMS, 2008; Perkins et al., 2004).

Evidence suggests that tern colonies located in areas with high boat traffic are not impacted (Burger et al., 2011). As discussed above, pile-driving can reduce the prey base for terns if construction occurs close to colonies (Perrow et al., 2011). Roseate Terns have a more specialized diet than Common Terns, including a higher dependence on small schooling fishes, and, like many tern species, are highly dependent on food availability for successful reproduction (Nisbet et al., 2014). Construction-related disturbance to prey populations, particularly American Sand Lance (*Ammodytes americanus*), could have potential indirect effects on Roseate Tern populations if construction were to occur in key foraging areas or close to a breeding colony. Sand lance are capable of hearing low-frequency sounds (Strobel & Mooney, 2012), including sounds in the range produced by pile driving. However, since the Project is located far from the nearest Roseate Tern colony and the WDA is not identified as an important foraging area for Roseate Terns, construction activities are expected to have little effect to the prey base.

In summary, Roseate Terns are expected to have insignificant exposure to construction activities occurring in the Offshore Project Area. In the unlikely event that they would be exposed to construction IPFs, they are expected to have insignificant to unlikely behavioral vulnerability to collision with, or displacement from, construction activities. Because of the limited exposure, short-term duration of the IPFs, and the lack of behavioral vulnerability, the loss or disturbance of Roseate Tern individuals is unlikely. Risks will be further minimized through mitigation measures.

Piping Plover and Red Knot: Piping Plover and Red Knot have insignificant to unlikely behavioral vulnerability to collision with construction equipment and insignificant behavioral vulnerability to displacement. Based on Burger et al. (2011), Red Knots are thought to migrate at flight heights well above the rotor swept zone ("RSZ") under most circumstances, thus greatly reducing exposure to collisions with turbines, construction equipment, or other structures. Piping Plovers are also likely to fly above the RSZ during long-distance migration flights. Both species also have good visual acuity and maneuverability in the air (Burger et al., 2011), and there is no evidence to suggest that they are particularly vulnerable to collisions or displacement.

In summary, Piping Plovers and Red Knots are expected to have insignificant exposure to construction activities occurring in the Offshore Project Area. In the unlikely event that they would be exposed to construction IPFs, they are expected to have insignificant to unlikely behavioral vulnerability to collision with, or displacement from, construction activities Because of the limited exposure, short-term duration of the IPFs, and the lack of behavioral vulnerability based on flight height during migration, anticipated loss of, or disturbance to, Piping Plover and Red Knot individuals in unlikely. Risks will be further minimized through mitigation measures.

6.2.2.1.2 Avoidance, Minimization, and Mitigation Measures

The Project has taken steps to avoid exposure of birds by locating the WTGs offshore. To further minimize potential bird mortality from collision, the Project will reduce lighting as much as is practicable during construction. The Project will follow Federal Aviation Administration ("FAA") recommendations to use red-flashing lights (Orr et al., 2013). In addition, when practicable, the Project will down-shield lighting and/or use down-lighting to limit bird attraction and disorientation (Poot et al., 2008). Anti-perching is incorporated in

Table 6.2-9 Summary of Potential Impacts to Birds During Construction in the Offshore Project Area and Mitigation Actions

Species Group	Subgroup	Primary Impact Type	Hazard[1]	Hazard Intensifier	Annual Exposure[2]	Behavioral Vulnerability	Mitigation Options
Coastal Birds	Shorebirds	Collision	V & C	Lighting	Insignificant	Insignificant	Reduce lighting
	Waterfowl & waterbirds	Displacement	V & C	# Vessels	Insignificant	Insignificant	None needed
	Wading birds	Collision	V & C	Lighting	Insignificant	Insignificant	Reduce lighting
	Raptors	Collision	V & C	Perching sites	Insignificant-Unlikely	Insignificant	Reduce lighting
	Songbirds	Collision	V & C	Lighting	Insignificant-Unlikely	Unlikely	Reduce lighting
Marine Birds	Loons and grebes	Displacement	V & C	# Vessels	Insignificant (s,w)	Unlikely	None needed
	Seaducks	Displacement	V & C	# Vessels	Insignificant (s,f,w)	Unlikely	None needed
	Gannets	Collision and displacement	V & C	Lighting and perching sites	Unlikely (s,f,w)	Unlikely	Reduce lighting
	Cormorants	Collision	V & C	Perching sites	Insignificant (s,su,f,w)	Unlikely	None needed
	Jaegers and Gulls	Collision	V & C	Lighting and perching sites	Insignificant-Potential (s,su,f)	Unlikely	Reduce lighting
	Terns	Collision and change in prey	V & C	Lighting and perching sites	Insignificant (s,f)	Unlikely	Reduce lighting
	Shearwaters and petrels	None	V & C	None	Insignificant - Unlikely (s,su,f)	Unlikely	None needed
	Auks	Displacement	V & C	# Vessels	Insignificant-Unlikely (s,f,w)	Unlikely	None needed

Table 6.2-9 Summary of Potential Impacts to Birds During Construction in the Offshore Project Area and Mitigation Actions (Continued)

Species Group	Subgroup	Primary Impact Type	Hazard[1]	Hazard Intensifier	Annual Exposure[2]	Behavioral Vulnerability	Mitigation Options
Federally-Listed	Roseate Tern	Collision and change in prey	V & C	Lighting and perching sites	Insignificant (s,f)	Insignificant-Unlikely	Reduce lighting
	Piping Plover	Collision	V & C	Lighting	Insignificant (s,f)	Insignificant-Unlikely	Reduce lighting
	Red Knot	Collision	V & C	Lighting	Insignificant (s,f)	Insignificant-Unlikely	Reduce lighting
	Eagles	Collision	V & C	Perching sites	Insignificant	-	None needed

[1] V & C = Vessel and Construction Equipment

[2] Exposure categories: s = spring (March-May); su = summer (June-August); f = fall (September – November); w = winter (December – February); r = resident (year-round)

the design of the turbines through the use of tubular WTG support towers (see Section 3.1.1 of Volume I). In accordance with safety and engineering requirements, the Project will consider anti-perching devices, where and if appropriate, to reduce potential bird perching locations. Using a standardized protocol, the Project will document any dead or injured birds found on vessels and structures during construction.

6.2.2.2 Operations and Maintenance

During operation, IPFs can range from WTGs to maintenance activities. In this section, only the IPFs associated with the WDA will be discussed because the offshore cable system is not considered to have IPFs that will impact birds.

Potential impacts from collisions and displacement are not likely to be significantly different between turbine scenarios (eight to ~14 MW) because, regardless of turbine type, the total wind farm rotor swept area would change only by 4%[13]. The top most position of the blade for the ~14 MW turbine is 64 m (210 ft) higher than the eight MW turbine; the hub height is 35 m (115 ft) higher; and the distance between the mean sea level and lowest position of the blade is nearly identical with only 5 m [16 ft] difference between the two turbine types.

Additionally, there are conflicting results in the few modeling studies that have attempted to quantify how change in turbine size will affect collision risk. One effort estimated that a 10% increase in rotor diameter will lead to a 3.55% increase in mortality estimates (Chamberlain et al., 2006) while another predicted that an increase in turbines would lead to a decline in mortality: increasing turbines from two to three MW decreases risk by 29%, and reduces it by an additional 29% when the turbine size is increased to five MW (Johnston et al., 2014). Given the lack of clear evidence in the literature on the effects of turbine size on mortality, and the small difference between the total wind farm rotor swept area, the different turbine scenarios are not considered to substantially change the assessment of potential direct impacts.

The foundations for the Project may be all monopiles or a mix of monopile and jacket foundations (up to ten jackets for WTG foundations and up to two jackets for ESP foundations). With the exception of species known to use offshore wind turbines for perching (e.g., gulls and cormorants), the hazard of the different foundation type is not likely to be different for most species of birds. Unless otherwise noted, the hazard associated with the two possible foundation types are considered the same in the impact assessment below. During operation, the primary hazards to birds that may lead to mortality or displacement are:

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[13] This calculation is based on an 800 MW project requiring 57 ~14 MW WTGs with a maximum rotor diameter of 222 m (729) compared to 100 eight MW WTGs with a minimum rotor diameter of 164 m (538 ft).

Hazards potentially causing mortality or injury (direct impacts)

- Wind turbines (eight - ~14 MW)
- Electrical service platforms
- FAA and US Coast Guard required lighting (see Section 3.1.1 of Volume I)

Hazards potentially causing displacement and habitat modification/loss (indirect impacts)

- Total Wind Development Area
- Maintenance vessels and helicopters

6.2.2.2.1 Potential Direct Impacts of Operations and Maintenance

The primary potential direct impact of the Project to birds is mortality or injury due to collision with offshore WTGs. The mortality from collisions is dependent on many different factors, including site, species, season, weather, and lighting. Collision risk with offshore WTGs for a particular bird species can vary depending on age, behavior, and timing within a breeding cycle (e.g., while feeding chicks) (Drewitt & Langston, 2006). Birds can collide with the superstructure (nacelle and tower) or the rotating turbine blades, and can be forced to the ground by the vortex created by the moving rotors (American Wind Wildlife Institute ["AWWI"], 2016; Drewitt & Langston, 2006; Fox et al., 2006). With the exception of a wind development built on a breakwater located close to a tern colony in Zeebrugge, Belgium (Everaert & Stienen, 2007), few direct mortalities have been observed at operating offshore wind farms (Petersen et al., 2006; Pettersson, 2005).

Coastal and Marine Birds

Coastal birds: The primary groups of coastal birds that will be exposed to the Project are shorebirds, waterfowl, wading birds, falcons, and songbirds. Since the Project is located 23 km (14.3 mi) from shore, exposure of coastal birds is limited and will be most likely during spring and fall migration (see Section 6.2.1).

Shorebirds, coastal waterfowl, waterbirds, and wading birds: Shorebirds, coastal waterfowl, and wading birds are expected to have unlikely behavioral vulnerability to collision. There is little empirical evidence that shorebirds, coastal waterfowl (i.e., ducks, geese, and swans; excluding seaducks), or wading birds are vulnerable to collision with offshore wind turbines. During migration, shorebirds will likely fly significantly above the RSZ (i.e., >255 m [837 ft]). They are considered to fly high during migration off Cape Cod (Nisbet, 1963) and have been documented to fly at a mean altitude of 2,000 m (6,562 ft) (5% of birds flew above 4,400 m [14,436 feet] and a maximum height recorded was 6,650 m [21,818 feet]) in a radar study conducted over New Brunswick and Nova Scotia [Richardson, 1979]).

No shorebirds are described as being observed with Visual Automatic Recording System ("VARS") at the *alpha ventus* offshore wind farm in Germany (Hill et al., 2014). Studies indicate that waterfowl avoid offshore wind farms and therefore have unlikely vulnerability to collision. Radar studies indicate that geese avoid offshore wind farms both in the vertical and horizontal planes (Plonczkier & Simms, 2012) and Global Positioning System ("GPS") tracking of swans suggest the birds gain altitude to avoid wind farms (Griffin et al., 2011).

Avoidance behavior has also been documented for Tufted Duck (*Aythya fuligula*), Common Pochard (*Aythya ferina*, a species similar to Redhead or Canvasback), and Greater Scaup (*Aythya marila*) (Dirksen & van der Winden, 1998 *in* Langston, 2013). There is little information on wading bird interactions with terrestrial and offshore wind turbines, but some studies suggest wading birds have lower densities around terrestrial turbines (Leddy et al., 1999) and thus would have lower vulnerability to collision. No wading birds are described as being observed with VARS at the *alpha ventus* offshore wind farm in Germany (Hill et al., 2014).

In summary, shorebirds, waterfowl, waterbirds, and wading birds are expected to have insignificant exposure, primarily during migration, to operational activities in the Offshore Project Area. If this low likelihood event occurred, where they would be exposed to operational IPFs, they are not expected to have likely behavioral vulnerability to collision. Because of the limited exposure and lack of vulnerability, population level impacts to this species group are expected to be unlikely. Risks will be further minimized through mitigation measures.

Raptors: The raptors exposed to the Project are probably limited to fall migrating Peregrine Falcons, Merlins, and Ospreys (see Section 6.2.1) that are expected to have unlikely to potential behavioral vulnerability to collisions. Falcons may be attracted to turbines as perching sites and Peregrine Falcons and Kestrels have been observed landing on the platform deck of offshore wind turbines (Hill et al., 2014). Satellite-tagged Ospreys and Peregrine Falcons have been confirmed to perch on offshore barges and structures. Little information exists documenting Peregrine Falcon mortalities, especially in offshore settings. However, Peregrine Falcon moralities have not been documented at European offshore wind developments. In addition, Desorbo et al. (2015) and Jensen et al. (2014) considered Peregrine Falcons to have a low collision risk vulnerability at the Horns Rev 3 wind development.

While Peregrine Falcon collisions with transmission lines have been documented (Olsen & Olsen, 1980; White et al., 2002), only a few accounts of mortalities are associated with terrestrial-based wind turbines in Europe (Dürr, 2011; Hötker et al., 2006; Meek et al., 1993) and one in New Jersey (Mizrahi et al., 2009). At some projects, with known falcon activity, no carcasses were found in post-construction mortality studies (Bull et al., 2013; DiGaudio & Geupel, 2014; Hein et al., 2013). American Kestrel carcasses have been found in post-construction monitoring with smaller terrestrial turbines (1.8 MW) in Washington

State (Erickson et al., 2008), but American Kestrel mortality has been demonstrated to decrease as turbine size increases (Smallwood, 2013). Limited tracking studies of Peregrine Falcons and Merlins indicate that falcons generally use overland routes during spring migration, but that during the fall they routinely fly over the ocean (Desorbo et al., 2015; Desorbo et al., 2017; Cochran, 1985). Two fall migrating peregrines tracked from Maine, bypassed Cape Cod and flew through central Massachusetts to the Block Island area in Rhode Island (Desorbo et al., 2012). It remains unclear if the routes of these birds are reflective of broader migrations patterns in the population.

In summary, falcons and Osprey are expected to have insignificant to unlikely exposure, primarily during migration, to operational activities in the Offshore Project Area. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have unlikely to potential behavioral vulnerability to collision. Because exposure is probably limited to individual migrants, population level impacts to falcons and Osprey are expected to be unlikely. Risks will be further minimized through mitigation measures.

<u>Songbirds:</u> Songbirds are expected to have unlikely to potential behavioral vulnerability to collision. Mortalities of songbirds are documented at terrestrial wind turbines (Erickson et al., 2014). In some instances, songbirds may be able to avoid colliding with offshore wind turbines (Petersen et al., 2006), but are known to collide with illuminated terrestrial and marine structures (Fox et al., 2006). Movement during low visibility periods creates the highest collision risk conditions: at an offshore research station with substantial lighting, songbird mortalities have been documented during poor weather conditions (Hüppop et al., 2006). While terrestrial avian fatality ranges from three to five birds per MW per year (AWWI, 2016), direct comparisons between morality rates recorded at terrestrial and offshore wind developments should be made with caution because collisions with offshore wind turbines could be lower either due to differing behaviors or lower exposure (NYSERDA, 2015). At Nysted, Denmark, in 2,400 hours of monitoring with an infrared video camera, only one collision of an unidentified small bird was detected (Petersen et al., 2006). Migrating songbirds have been detected at or in the vicinity of offshore wind developments (Kahlert et al., 2004; Krijgsveld et al., 2011; Pettersson & Fågelvind, 2011) and may have greater passage rates during the middle of the night (Huppop & Hilgerloh, 2012).

Passerines (songbirds) typically migrate at between 90-600 m (NYSERDA, 2010), but can fly lower during inclement weather or with headwinds. In a study in Sweden, nocturnal migrating songbirds flew on average at 330 m above the ocean during the fall and 529 m during the spring (Pettersson, 2005). Given the limited understanding of songbird migration, exposure of migratory songbirds to the WDA is uncertain, but some birds will likely cross the WDA during fall migration. Under poor weather conditions, individual vulnerability to collision may increase as birds fly at lower altitudes and may be more likely to fly through the RSZ. Mortality is likely to be highly stochastic and infrequent. However, the mortality from all terrestrial wind turbines in the US and Canada combined is predicted to have a small effect on passerine populations (Erickson et al., 2014).

In summary, songbirds are expected to have insignificant to unlikely exposure, primarily during migration, to operational activities in the Offshore Project Area. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have unlikely to potential behavioral vulnerability to collision during migration. Because exposure is probably limited to individual migrants, and terrestrial wind farms are considered to have a small effect on most songbird populations, population level impacts to songbirds are expected to be unlikely. Risks will be further minimized through mitigation measures.

Marine birds: The primary groups of marine birds that will be exposed to the project are loons, grebes, and seaducks; gannets; cormorants; jaegers and gulls; terns; shearwaters, petrels, and auks.

Loons, grebes, and seaducks: Loons, grebes, and seaducks are expected to have insignificant to unlikely behavioral vulnerability to collision because these birds have consistently been documented to strongly avoid offshore wind projects and are widely considered to have low vulnerability to collision (Furness et al., 2013). Pre- and post-construction monitoring at offshore developments demonstrates that Red-throated Loons consistently avoid wind farms and do not habituate to the development (Lindeboom et al., 2011; Percival, 2010). Consequently, due to consistent avoidance behavior, Red-throated Loons are identified as vulnerable to displacement from offshore developments, but are not likely to collide with offshore wind turbines.

There is little empirical evidence on how Common Loons will respond to offshore wind developments, but they will likely respond similarly to Red-throated Loons and are not considered vulnerable to collision. Grebes rank low for collision risk because they tend to fly close to the sea surface and rarely fly between 20-150 m (65.6-492.1 ft) above sea level (Furness et al., 2013). Seaducks avoid offshore wind developments and avoidance behavior has been clearly documented for Black Scoters (Lindeboom et al., 2011) and Common Eider (Desholm & Kahlert, 2005; Larsen & Guillemette, 2007).

In summary, the loons, grebes, and seaducks group are expected to have insignificant exposure to operational activities in the Offshore Project Area. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have insignificant to unlikely behavioral vulnerability to collision. Because of limited exposure and because this species group has been documented to avoid offshore wind farms, population level impacts to this species group are expected to be unlikely. Risks will be further minimized through mitigation measures.

Northern Gannet: Northern Gannets are expected to have unlikely behavioral vulnerability to collision. While Northern Gannets are considered by some to be vulnerable to collision risk (Cleasby et al., 2015; Furness et al., 2013; Garthe et al., 2014), many studies indicate they avoid wind developments (Garthe et al., 2017; Hartman et al., 2012; Vanermen et al., 2015). Satellite tracking studies indicate near complete avoidance of active wind developments by Northern Gannets (Garthe et al., 2017); for example, avoidance rates have been estimated to be 64-84% (macro) and a 99.1% (total) (Cook et al., 2012; Krijgsveld et al., 2011; Vanermen et al., 2015). When Northern Gannets enter a wind development they infrequently fly between 20-150 m (65.6-492.1 ft) above sea level (Cook et al., 2012), and models indicate a low proportion of birds fly at risk height (Johnston et al., 2014). Combined, these studies from Europe suggest that Northern Gannets exhibit unlikely vulnerability to collision. In North America, Northern Gannet populations have been increasing in recent decades (Chardine et al., 2013).

In summary, Northern Gannets are expected to have unlikely exposure to operational activities in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have unlikely behavioral vulnerability to collision. Because Northern Gannets have been documented to avoid offshore wind farms and the populations of Northern Gannets have been generally increasing, population level impacts to this species group are expected to be unlikely. Risks will be further minimized through mitigation measures.

Double-crested Cormorant: Double-crested Cormorants are expected to have unlikely behavioral vulnerability to collision. Cormorants have been documented to be attracted to wind turbines because of an increase in food resources, due to reduced fishing effort and newly available loafing habitat (Krijgsveld et al., 2011; Lindeboom et al., 2011), but are not considered to have high vulnerability to collisions because they infrequently fly between 20-150 m (65.6 – 492.1 ft) above sea level (Furness et al., 2013). Turbines with jacket foundations may provide additional perching sites for cormorants, which have the potential to increase attraction and possibly intensify vulnerability to collision.

In summary, Double-crested Cormorants are expected to have insignificant exposure to the operational activities in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have unlikely behavioral vulnerability to collision. Because Double-crested Cormorants will have insignificant exposure to the WDA and unlikely behavioral vulnerability, population level impacts to this species group are expected to be unlikely. Risks will be further minimized through mitigation measures.

Jaegers and gulls: Jaegers and gulls are expected to have potential to likely behavioral vulnerability to collisions. Little is known about how jaegers will respond to offshore wind turbines, but the birds generally fly below the RSZ (0-10 m [0-32.8 ft] above the sea surface), although they could fly higher during kleptoparasitic chases (Wiley & Lee, 1999). Jaegers (called skuas in Europe) rank close to the top of collision vulnerability assessments preceded only by gulls, Northern Gannets, and Black-legged Kittiwakes (Furness et al., 2013). Gulls consistently rank at the top of collision vulnerability assessments (Furness et al., 2013) because they can fly within the RSZ (Johnston et al., 2014) and have been documented to be attracted to turbines (Vanermen et al., 2015). Herring Gulls and Great Black-backed Gulls frequently fly between 20-150 m (65.6-492.1 ft) above sea level (Cook et al., 2012).

While the collision risk is thought to be greater for gulls, total avoidance rates are estimated to be 98% (Cook et al., 2012). At Horns Rev, Denmark, gull numbers increased at the wind development, possibly due to their attraction to boat traffic, new food resources, or new loafing habitat (i.e., perching areas) (Fox et al., 2006). In Belgium, numbers of Lesser Black-backed Gulls increased by a factor of 5.3 and Herring Gulls by 9.5 turbines (Vanermen et al., 2015).

However, there can be inter- and intra-annual variation in the degree that birds interact with offshore wind developments. Lesser Black-backed Gulls are found to be present at differing levels per year, and the birds' use of the offshore environment was highest during chick-rearing and lowest before breeding and during incubation. In addition, males and females use the area differently, with males present more in the late breeding season (Thaxter et al., 2015). Turbines with jacket foundations may provide additional perching sites for gulls, which have the potential to increase attraction and possibly intensify vulnerability to collision. Based upon jaegers and gulls consistently ranking high in collision vulnerability assessments, gulls attraction to turbines, and the amount of time they fly within the RSZ, individual vulnerability to collision is expected to be potential to likely. Jaegers are not identified as species of conservation concern (Audubon, 2017) and resident gull populations in the region are not considered of conservation concern (Burger, 2015; Good, 1998; Nisbet et al., 2017; Pollet et al., 2012).

In summary, the jaegers are expected to have insignificant exposure to the operational activities in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have potential behavioral vulnerability to collision. Because jaegers have stable populations, population level impacts to this species are expected to be unlikely. Gulls are expected to have insignificant to potential exposure to operational activities in the WDA and likely behavioral vulnerability to collision. Because gull populations are stable, population level impacts to this species group are expected to be unlikely. Risks will be further minimized through mitigation measures.

<u>Terns:</u> Terns are expected to have unlikely behavioral vulnerability to collisions. Terns rank in the middle of collision vulnerability assessments (Furness et al., 2013; Garthe & Hüppop, 2004) because they rarely to infrequently fly between 20-150 m (65.6-492.1 ft) above sea level, have a 30-69.5% macro avoidance rate (Cook et al., 2012), and have been demonstrated to avoid rotating turbines (Vlietstra, 2007). For Common Terns and Arctic Terns, the probability of mortality is predicted to decline as the distance from the colony increases. Based upon one year of nanotag data collected at Petit Manan Island, Maine, tests of a decision support model suggests that the probability of occupancy and mortality

rates at a turbine project drops to near zero beyond 15 km (9.3 mi) from a tern colony (Cranmer et al., 2017). Common Terns and Roseate Terns tended to avoid the airspace around a 660 kilowatt ("kW") turbine at the Massachusetts Maritime Academy in the US when the turbine was rotating and usually avoided the RSZ (Vlietstra, 2007). This finding is corroborated by mortality monitoring of small to medium turbines (200 and 600 kW) in Europe, where mortality rates rapidly declined with distance from the colony (Everaert & Stienen, 2007). Most observed tern mortalities in Europe have occurred at turbines < 30 m from nests (Burger et al., 2011), although turbines located directly between foraging and nesting grounds have also been implicated (MMS, 2008).

In summary, terns are expected to have insignificant exposure to the operational activities in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have unlikely behavioral vulnerability to collision. Because exposure will be limited and the birds generally do not fly through the RSZ, population level impacts to terns are expected to be unlikely. Risks will be further minimized through mitigation measures.

Shearwaters, storm-petrels, and auks: Shearwaters, storm-petrels, and auks are expected to have insignificant behavioral vulnerability to collision. Shearwaters, storm-petrels, and auks all rank extremely low for collision risk (Furness et al., 2013). Auks have a 45-68% macro-avoidance rate and a 99.2% total avoidance rate. Atlantic Puffins, Razorbills, Common Murres, and storm-petrels all tend to fly close to the sea surface and rarely fly within the RSZ (Cook et al., 2012).

In summary, shearwaters, storm-petrels, and auks are expected to have insignificant to unlikely exposure to the operational activities in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to collision. Because these species have insignificant to unlikely exposure and insignificant behavioral vulnerability population level impacts to these species are expected to be unlikely. Risks will be further minimized through mitigation measures.

Federally-Listed Species

During operation and maintenance, federally-listed birds are unlikely to collide with turbines or electrical service platforms. Roseate Terns, Piping Plovers, and Red Knots may have a low potential to fly over the WDA during migration, but are unlikely to fly within the RSZ under most circumstances. None of these species are expected to occur in the WDA during breeding or wintering seasons.

Roseate Tern: As discussed in the Description of the Affected Environment (Section 6.2.1) Roseate Terns are unlikely to occur in the WDA except possibly during migration and post-breeding dispersal to staging sites. Aerial surveys conducted in the WDA only detected three unidentified terns in three years of surveys, and the majority of the WDA is outside tern high use areas (see Section 6.2.1.4.6; Veit et al., 2016). Roseate Terns may fly over the WDA during migration, but are unlikely to fly within the RSZ; moreover, terns have been observed to regularly exhibit micro-avoidance behaviors to avoid actively spinning turbine blades. If Roseate Terns are exposed to the Project, they are expected to have unlikely behavioral vulnerability to collisions because terns do not rank high in collision vulnerability assessments (Furness et al., 2013), infrequently fly between 20-150 m (65.6-492.1 ft) above sea level (Cook et al., 2012), and avoid rotating turbines (Vlietstra, 2007).

Data on Roseate Tern flight height indicates that non-migrating birds are generally flying below the WTGs lowest blade position (27 m [89 ft]). Flight height during foraging typically varies from one to 12 m (39.4 ft) above the water's surface, and is most commonly <6 m (19.7 ft) (Nisbet et al., 2014). Roseate Terns do conduct courtship flights ("High Flights") that can range from 30-300 m (98.4-984.3 ft) in altitude and may continue throughout much of the breeding season (Nisbet et al., 2014); such displays are most common near the breeding grounds, they have also been observed at foraging locations (MMS, 2008). European studies of related tern species have suggested that they rarely fly between 20-150 m (65.6-492.1 ft) above sea level during local flights (Jongbloed, 2016). In the US, data on Roseate Terns from a single 660 kW terrestrial wind turbine in Buzzard's Bay, Massachusetts suggested that most Roseate Terns flew below the rotor swept zone of the small turbine when flying over land (9-21 m [29.5-68.9 ft]) (Burger et al., 2011). Estimates of tern flight height from surveys in the Nantucket Sound area suggested that 95% of Common/Roseate Terns flew below Cape Wind's proposed RSZ of 23-134 m (75.5-439.6 ft) (MMS, 2008).

The altitude at which Roseate Terns migrate offshore is unknown, but is thought to be higher than foraging altitudes or nearshore flight altitudes (perhaps in the hundreds to thousands of meters) (MMS, 2008; Perkins et al., 2004). However, Roseate Terns tracked with immersion sensors frequently rested on the water's surface during migration and wintering periods (two to three hours/day on average, including at night) (Nisbet et al., 2014), so they do occasionally drop down to lower altitudes. Boat survey data for the Cape Wind project during the post-breeding period suggested that terns flying into headwinds may also maintain lower altitudes, potentially due to weaker headwinds close to the water's surface, while birds are more likely to climb to higher altitudes when taking advantage of tailwinds (MMS, 2008).

A similar pattern has been seen in overland migration in Common Terns and Arctic Terns, with birds migrating at 1,000-3,000 m (3,281-9,843 ft) above sea level except in strong headwinds (Alerstam, 1985). As with Common/Roseate Terns observed during boat surveys in the post-breeding period, data from other tern species suggest that flight height during migration varies with weather; headwinds may constitute optimal weather conditions for combining foraging with low-altitude migration (Jongbloed, 2016), while terns choose to fly at higher altitudes in tailwinds.

There is limited nocturnal and crepuscular data available, but it appears that nocturnal flights during breeding and post-breeding periods are limited to travel to/from foraging areas, and occur only at time periods near dusk and dawn (MMS, 2008). Terns in nocturnal transit between roosting and daytime use areas (e.g., shoals and other foraging locations, coastal loafing locations) may fly at higher altitudes (e.g., 37-60 m [121.4-196.9 ft)] (MMS, 2008).

Studies at operating turbines indicate that terns exhibit avoidance behavior. In Europe, terns have been documented to lower their flight altitude when approaching wind developments to avoid their RSZs (Krijgsveld et al., 2011). At the 660 kW terrestrial wind turbine in Buzzard's Bay, Massachusetts, no tern mortalities were found during a multi-year study, though Common Terns regularly flew within 50 m (164 ft) of the turbine (Burger et al., 2011). There was little evidence of terns reducing avoidance of this turbine in fog, but micro-avoidance of actual RSZs occurred when turbines were spinning. Terns may detect turbine blades during operation, both visually and acoustically, and avoid flying between turbine rotors while they are in motion (MMS, 2008; Vlietstra 2007).

In summary, Roseate Terns are expected to have insignificant exposure to the operational activities occurring in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have unlikely behavioral vulnerability to collision. Because the exposure will be limited, and the birds generally avoid, or do not fly through the RSZ, the anticipated loss of Roseate Tern individuals is unlikely. Risks will be further minimized through mitigation measures.

Piping Plover and Red Knot: Piping Plover and Red Knot will have insignificant exposure to the WDA (see Section 6.2.1.5). If Piping Plover and Red Knot are exposed to the WDA they are expected to have insignificant to unlikely behavioral vulnerability to collisions.

Piping Plovers are not present in the WDA during breeding and nonbreeding seasons. The average flight height for non-courtship flights among breeding Piping Plovers was estimated one study to be <3 m (9.8 ft) (Stantial, 2014). Males conduct high, fluttering courtship flights prior to and during breeding, but these are located over the land-based territories (Elliott-Smith & Haig, 2004). As such, flight height during non-migratory periods is thought to remain low and to occur in the immediate vicinity of the coastline.

There is a small possibility of ephemeral presence in the WDA during migration. Migratory flight height is unknown (Burger et al., 2011), but evidence from a recent tracking study suggests the potential for high altitude migratory flights in at least some individuals (Paton, 2016). European studies indicate generally low mortality rates for shorebirds at coastal wind facilities, even facilities located in proximity to stopover and wintering habitats (Burger et al., 2011). There are no known interactions of Piping Plovers with wind turbines, including the limited number of turbines built near nesting locations, and no mortalities observed to date (Burger et al., 2011; USFWS, 2009). Piping Plovers may be able to avoid collisions, though vulnerability to collision may increase in periods of poor visibility (Burger et al., 2011).

Red Knots are not present in the WDA during the breeding season and may only have ephemeral presence during migration. Red Knot flight heights during migration are thought to normally be 1,000-3,000 m (3,281-9,843 ft), except during takeoff and landing at terrestrial locations (Burger et al., 2011), but Red Knots likely adjust their altitude to take advantage of local weather conditions, including flying at lower altitudes in headwinds (Baker et al., 2013). Individuals could fly at lower altitudes during periods of poor weather and high winds, or during shorter coastal migration flights (Burger et al., 2011). Data on Red Knot interactions with wind turbines are not available, but these birds are generally expected to be able to avoid collisions, though vulnerability to collision may increase in periods of poor visibility, high winds, and poor weather (Burger et al., 2011). Exposure to WTGs will depend in part on the degree of migratory movement through the WDA, which is unknown, but thought to be relatively low due to its distance from key stopover habitats (Burger et al., 2011).

In summary, Piping Plover and Red Knot are expected to have insignificant exposure to the operational activities occurring in the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have insignificant to unlikely behavioral vulnerability to collision. Because the birds have insignificant exposure risk, generally are not expected to fly through the RSZ during migration, and have not been found as fatalities at wind facilities, anticipated loss of Piping Plover and Red Knot individuals is unlikely. Risks will be further minimized through mitigation measures.

6.2.2.2.2 Potential Indirect Impacts of Operations and Maintenance

While direct collision mortality is the primary concern for terrestrial wind, behavioral avoidance responses to offshore wind farms, which can lead to displacement from habitat use areas, may have greater effects on birds in the offshore environment. Birds are displaced by wind developments through behavioral avoidance responses (Fox et al., 2006; Krijgsveld et al., 2011; Lindeboom et al., 2011), which has been documented for seaducks, gannets, auks, geese, and loons (Desholm & Kahlert, 2005; Garthe et al., 2017; Langston, 2013; Larsen & Guillemette 2007; Lindeboom et al., 2011; Percival, 2010; Plonczkier & Simms 2012). This avoidance may be a behavioral response to the visual stimulus (Fox et al., 2006). While macro-avoidance clearly reduces potential mortalities, birds that avoid the wind development area completely experience effective habitat loss (Drewitt & Langston, 2006; Langston, 2013; Masden et al., 2009; Petersen et al., 2011). This avoidance, however, only results in a small increase in energy expenditure (Masden et al., 2009) and there is little evidence to suggest that avoidance and potential displacement from wind developments is reducing fitness, leading to critical habitat loss, or adversely affecting populations.

Habitat change caused by the hard substrate of the offshore wind development can lead to indirect effects. The construction of wind turbines will have both a negative effect of direct loss of habitat (i.e., open ocean) and a positive effect with the gain of new habitat at turbine foundations and scour protection. However, these direct habitat changes represent less than 5% of an wind farm area and are not considered to be significant (Fox et al., 2006).

Coastal and Marine Birds

Coastal birds: Little is known about how most coastal birds may avoid offshore wind farms because they are generally not present in the offshore environment. Since geese, ducks, and swans have been documented to avoid wind farms (see Section 6.2.1.3.3), coastal waterfowl may exhibit avoidance behavior if they pass through the wind farm during migration. However, since most coastal birds are not using the WDA as critical breeding, foraging, staging, or wintering areas, any avoidance behavior would not cause displacement from important habitat. If the birds did exhibit avoidance behavior, they would be reducing potential collisions and reduce overall potential direct impacts.

Therefore, in summary, coastal birds are expected to have insignificant to unlikely exposure limited primarily to migration to the WDA. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to displacement. Because coastal birds are unlikely to be exposed to the WDA, there is little to no evidence that coastal birds will be displaced from offshore wind farms, and the WDA does not provide important habitat for this species group, population level impacts are expected to be unlikely.

Marine Birds

Loons and grebes: Loons and grebes are expected to have unlikely to likely behavioral vulnerability to displacement, respectively. Loons are identified as the birds most vulnerable to displacement (Furness et al., 2013; Garthe & Hüppop, 2004), and, as described in Section 6.2.1.4.1, Red-throated Loons consistently avoid offshore wind farms and are potentially permanently displaced. Common Loons may have similar avoidance responses. There is little data on how grebes respond to offshore wind farms, but some grebe species rank higher in displacement vulnerability assessments because they can be disturbed by ship and helicopter traffic (Furness et al., 2013).

In summary, loons are expected to have insignificant exposure to operational activities in the Offshore Project Area. If this low likelihood event occurred where they would be exposed to operational IPFs, they are expected to have potential to likely behavioral vulnerability to displacement. Because the WDA probably does not have important foraging habitat for loons, population level impacts to this species are expected to be unlikely. Grebes are expected to have insignificant exposure to the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have unlikely behavioral vulnerability to displacement. Because grebes have limited exposure to the WDA, population level impacts to this species are expected to be unlikely.

Seaducks: Seaducks are expected to have potential to likely behavioral vulnerability to displacement. After loons, seaducks are considered to have greater displacement vulnerability than all other seabirds (Furness et al., 2013). Avoidance behavior has been documented for Black Scoter, Common Eider (Desholm & Kahlert, 2005, Larsen & Guillemette, 2007), Tufted Duck, Common Pochard, and Greater Scaup (Dirksen & van der Winden, 1998 *in* Langston, 2013). Avoidance behavior of wind projects can lead to permanent or semi-permanent displacement, resulting in effective habitat loss (Langston, 2013; Percival, 2010; Petersen & Fox, 2007); however, for some species, this displacement may cease several years after construction as food resources, behavioral responses, or other factors change (Leonhard et al., 2013; Petersen & Fox, 2007). Avoidance occurs through macro-avoidance (Langston, 2013) and has been demonstrated by a 4.5-fold reduction in waterfowl flocks entering an offshore development post-construction (Desholm & Kahlert 2005). Birds entering the wind farms at night increased their altitude to avoid the turbines (Desholm, 2006).

In summary, seaducks are expected to have insignificant exposure to the operational activities in the WDA. They are expected to have potential to likely behavioral vulnerability to displacement. Because the WDA probably does not have important foraging habitat for seaducks and the birds concentrate closer to shore, and towards Nantucket Shoals (see Section 6.2.1), population level impacts to this species group are expected to be unlikely.

Northern Gannet: Northern Gannets are expected to have a potential behavioral vulnerability to displacement. While Northern Gannets rank low for displacement vulnerability (Furness et al., 2013), as discussed in Section 6.2.1.4.4, many studies indicate that they avoid wind developments (Garthe et al., 2017; Hartman et al., 2012; Vanermen et al., 2015). In Belgium, Northern Gannets have been shown to avoid wind development areas and have decreased in abundance by 85% after a project was constructed (Vanermen et al., 2015). However, there is little information on whether the avoidance behavior leads to permanent displacement. Since Northern Gannets feed on highly mobile surface-fish and follow their prey throughout the outer continental shelf (Mowbray, 2002), avoidance of the Project is unlikely to lead to habitat loss.

In summary, Northern Gannets are expected to have unlikely exposure to operational activities in the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have potential behavioral vulnerability to displacement. Because the species has unlikely exposure, due to a lack of important foraging habitat, population level impacts to this species are expected to be unlikely.

Double-crested Cormorants: Double-crested Cormorants are expected to have an insignificant behavior vulnerability to displacement because the birds have been documented to be attracted to wind developments (Krijgsveld et al., 2011; Lindeboom et al., 2011), are not a species known to exhibit avoidance behavior, and rank towards the middle of displacement vulnerability assessments (Furness et al., 2013).

In summary, Double-crested Cormorants are expected to have insignificant exposure to the operational activities in the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to displacement. Because vulnerability and exposure is insignificant, population level impacts to this species are expected to be unlikely.

Jaegers, gulls, and terns: Jaegers, gulls, and terns are expected to have insignificant behavioral vulnerability to displacement. There is little information available on how jaegers will respond to offshore wind farms, but jaegers rank low in vulnerability to displacement assessments (Furness et al., 2013) and there is no evidence in the literature that they are displaced from projects. Gulls and terns rank low in displacement vulnerability assessments (Furness et al., 2013), research suggests gulls and terns distribution and abundance is either not affected by the presence of wind farms or, in the case of gulls, that the birds may be attracted to them (Krijgsveld et al., 2011; Lindeboom et al., 2011).

In summary, the jaeger, gull, and tern groups are expected to have insignificant to potential exposure to the operational activities in the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to displacement. Because exposure is insignificant to potential and vulnerability to displacement is insignificant, population level impacts to this species are expected to be unlikely.

Shearwaters and storm-petrels: Shearwaters and storm-petrels are expected to have insignificant behavioral vulnerability to displacement. Both taxonomic groups rank at the bottom of displacement vulnerability assessments (Furness et al., 2013).

In summary, the shearwater and storm-petrel groups are expected to have insignificant to unlikely exposure to the operational activities in the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to displacement. Because exposure and vulnerability to displacement are insignificant, population level impacts to this species are expected to be unlikely.

Auks: Auks are expected to have potential behavioral vulnerability to displacement. Due to sensitivity to disturbance from boat traffic and a high habitat specialization, many auks rank high in displacement vulnerability assessments (Furness et al., 2013). Auks have a total avoidance rate of 99.2% (Cook et al., 2012); Common Murres decrease in abundance in the area of wind farms by 71%; and Razorbills by 64% (Vanermen et al., 2015). But auk populations are generally stable (Ainley et al., 2002, Lowther et al., 2002, Lavers et al., 2009).

In summary, the auk group is expected to have insignificant to unlikely exposure to the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have potential behavioral vulnerability to displacement. Because the WDA exposure is insignificant to unlikely, and it is not known to support important foraging habitat for auks, population level impacts to this species group are expected to be unlikely.

Federally-Listed Species

During operation and maintenance, the listed species are not expected to have vulnerability to displacement because the WDA does not appear to be a primary foraging location or travel corridor for breeding or staging Roseate Terns, Piping Plovers, or Red Knots.

Roseate Tern: Roseate Terns are expected to have insignificant behavioral vulnerability to displacement. Terns in general are not considered vulnerable to disturbance and do not rank high in displacement vulnerability assessments (Furness et al., 2013). Research also suggests that tern distribution and abundance is not affected by the presence of wind developments (Krijgsveld et al., 2011; Lindeboom et al., 2011). Even if terns avoid the WDA, there is no indication that Roseate Terns would lose important breeding season foraging habitat at the WDA because they prefer shallow waters such as shoals (Burger et al., 2011). If Roseate Terns forage during migration, they could avoid the WDA, but it is unclear if Roseate Terns migrate through the WDA or forage during migration (Burger et al., 2011).

In summary, Roseate Terns are expected to have insignificant behavioral vulnerability to avoidance of offshore wind farms and insignificant to unlikely exposure to the WDA. Because there is no evidence of behavioral vulnerability to displacement, and exposure will be limited, anticipated disturbance of Roseate Tern individuals is unlikely. Additionally, Roseate Terns are expected to have insignificant exposure to the operational activities occurring in the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to displacement. Therefore, anticipated disturbance of Roseate Tern individuals is unlikely.

Piping Plover and Red Knot: Piping Plovers and Red Knot are expected to have insignificant behavioral vulnerability to displacement. There is little evidence and research on shorebird avoidance at offshore wind developments. Piping Plovers and Red Knots would not be displaced during breeding or migratory staging because the WDA provides no habitat for the species during these life history stages. The birds could potentially be exposed to the Project ephemerally duing migration (see Section 6.2.1), but shorebirds generally fly at high altitudes well above the RSZ during migration (Nisbet, 1963; Richardson, 1979) and the WDA is not located near Red Knot (Burger et al., 2011) or Piping Plover stopover locations.

In summary, Piping Plover and Red Knot are expected to have insignificant exposure to the operational activities occurring in the WDA. In the unlikely event that they would be exposed to operational IPFs, they are expected to have insignificant behavioral vulnerability to disturbance. Because the birds have insignificant exposure and behavior risk, anticipated disturbance of Piping Plover and Red Knot individuals is unlikely.

6.2.2.2.3 Avoidance, Minimization, and Mitigation Measures

The Project has taken steps to avoid exposure of birds by locating the WTGs offshore. To further minimize potential bird mortality from collision, the Project will reduce lighting as much as is practicable during operations and maintenance. When practicable, the Project will (1) reduce the number of lights, (2) use low intensity lights, (3) avoid white lights, and (4) as appropriate, use flashing lights rather than steady burning lights (Orr et al., 2013). In addition, when practicable, the Project will use hooded lighting, colored lighting, or down-lighting to limit bird attraction and disorientation (Poot et al., 2008), limit outside light to necessary/required lighting, and close blinds on all windows in boat living quarters (Wiese et al., 2001). Lighting will also be only used when necessary for work crews. As described in Section 6.2.2.1.2, anti-perching is incorporated in the design of the turbines through the use of tubular WTG support towers (See Section 3.1.1 of Volume I). In accordance with safety and engineering requirements, the Project will consider anti-perching devices, where and if appropriate, to reduce potential bird perching locations. Vineyard Wind is developing a framework for a post-construction monitoring program for birds. Using a standardized protocol, the Project will document any dead or injured birds found on vessels and structures during the O&M phase.

Table 6.2-10 Summary of Potential Impacts to Birds in the WDA during Operation and Mitigation Actions

Species Group	Subgroup	Impact Type	Hazard	Hazard Intensifier	Annual Exposure*	Behavioral Vulnerability	Mitigation Options
Coastal Birds	Shorebirds	Collision	Turbines	Lighting	Insignificant	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Waterfowl & waterbirds	Collision	Turbines	Lighting	Insignificant	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Wading birds	Collision	Turbines	Lighting	Insignificant	Unlikely	None needed
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Raptors	Collision	Turbines	Perching sites	Insignificant-Unlikely	Unlikely-Potential	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Songbirds	Collision	Turbines	Lighting	Insignificant-Unlikely	Unlikely - Potential	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
Marine Birds	Loons and grebes	Collision	Turbine	Lighting	Insignificant (s,w)	Insignificant-Unlikely	None needed
		Displacement	Project footprint	Number of turbines		Unlikely – Likely	None needed
	Seaducks	Collision	Turbine	Lighting	Insignificant (s,f,w)	Insignificant-Unlikely	None needed
		Displacement	Project footprint	Number of turbines		Potential-Likely	None needed
	Gannets	Collision	Turbine	Lighting and perching sites	Unlikely (s,f,w)	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Potential	None needed
	Cormorants	Collision	Turbine	Lighting and perching sites	Insignificant (s,su,f, w)	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed

Table 6.2-10 Summary of Potential Impacts to Birds in the WDA during Operation and Mitigation Actions (Continued)

Species Group	Subgroup	Impact Type	Hazard	Hazard Intensifier	Annual Exposure*	Behavioral Vulnerability	Mitigation Options
	Cormorants	Collision	Turbine	Lighting and perching sites	Insignificant (s,su,f, w)	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Jaegers and gulls	Collision	Turbine	Lighting and perching sites	Insignificant-Potential (r & s,su,f)	Potential-Likely	None needed
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Terns	Collision	Turbine	Lighting	Insignificant (s,f)	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Shearwaters and petrels	Collision	Turbine	Lighting	Insignificant - Unlikely (s,su,f)	Insignificant	None needed
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Auks	Collision	Turbine	Lighting	Insignificant-Unlikely (s,f,w)	Insignificant	None needed
		Displacement	Project footprint	Number of turbines		Potential	Node needed
Federally-Listed	Roseate Tern	Collision	Turbine	Lighting and perching sites	Insignificant	Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Piping Plover	Collision	Turbine	Lighting	Insignificant	Insignificant-Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Red Knot	Collision	Turbine	Lighting	Insignificant	Insignificant-Unlikely	Reduce lighting
		Displacement	Project footprint	Number of turbines		Insignificant	None needed
	Eagles	Collision	Turbine	Perching sites	Insignificant	-	None needed
		Displacement	Project footprint	Number of turbines		-	None needed

* Exposure categories: s = spring (March-May); su = summer (June-August); f = fall (September – November); w = winter (December – February); r = resident (year-round)

6.2.2.3 Decommissioning

In general, potential impacts during decommissioning are expected to be similar to the construction period. However, there is no equivalent of pile driving during decommissioning, which reduces any noise-related impacts. Vineyard Wind is developing a framework for a post-construction monitoring program for birds. Using a standardized protocol, the Project will document any dead or injured birds found on vessels and structures during decommissioning. The Project will also consider best management practices available at the time of decommissioning to minimize any potential impacts to birds.

6.2.2.4 Summary of Findings

Overall, Project activities occurring in the Offshore Project Area are unlikely to cause population level impacts to any species or species group.

6.2.2.4.1 Coastal and Marine Birds

During construction, operation, and decommissioning, coastal birds are expected to be ephemerally exposed during migration and marine birds during all seasons. Overall, coastal birds are expected to have insignificant to unlikely behavioral vulnerability to construction activities and unlikely to potential vulnerability to WTGs. Of the coastal birds, Peregrine Falcons and songbirds are the only species groups that may have unlikely exposure to the WDA, and this will be limited to fall migration. Depending on the species, marine birds are expected to have range of behavioral vulnerability and range of exposure to the WDA. Of the marine birds, gulls are the species group with the potential exposure to the WDA. Impacts will be minimized though mitigation measures that include reducing lighting. During all phases of the Project, the Project will consider the best management practices available at the time to reduce any potential adverse effects to birds.

6.2.2.4.2 Federally-Listed Species

During construction, operations, and decommissioning, federally-listed species exposure is expected to be insignificant to unlikely and would largely be restricted to migration. Roseate Terns are expected to have insignificant exposure to the WDA and insignificant to unlikely vulnerability. Piping Plovers are expected to have insignificant exposure due to their proximity to shore during breeding, and insignificant to unlikely vulnerability. Like Roseate Terns, however, they may be exposed during migration periods, though flight heights during migration are thought to be generally well above the RSZ (i.e., >255 m [837 ft]). Red Knots are expected to have insignificant exposure and insignificant to unlikely behavioral vulnerability, due to their proximity to shore during stopovers and high flight heights during migrations. Impacts will be minimized though mitigation measures that include reducing lighting. During all phases, the Project will consider the best management practices available at the time to reduce any potential adverse effects to birds to the negligible level.

6.3 Bats

This section describes bat resources in the Project Area.

6.3.1 Description of the Affected Environment

Nine species of bats are present in Massachusetts. These species can be categorized into two major groups based on their wintering strategy: cave-hibernating bats and migratory tree bats. Both groups of bats are nocturnal insectivores that use a variety of forested and open habitats for foraging during the summer. Cave-hibernating bats are generally not observed offshore (> 5.6 km [3.5 miles]) and migrate in the winter from summer habitat to hibernacula in the New England regional area. The presence of the fungal disease white-nose syndrome ("WNS") in the hibernacula has caused high mortality of cave-hibernating bats and led to the Northern Long-Eared Bat (*Myotis septentrionalis*) being listed as threatened under the Endangered Species Act ("ESA"), 16 U.S.C. ch. 35 § 1531 et seq ,1973. Migratory tree bats, rather than hibernating in the winter months, fly to southern parts of the US and have been observed offshore (> 5.6 km [3.5 miles]) during migration.

Every bat species present in Massachusetts, except for Indiana Bat (*Myotis sodalist*), could be exposed to the Project (see Table 6.3-1). Exposure of cave-hibernating and migratory tree bats to the Onshore Project Area and the Offshore Project Area is assessed below. Then Northern Long-Eared Bat is discussed in separately in this section because it is a federally-listed species.

Table 6.3-1 Bat Species Present in Massachusetts and their Conservation Status

Common Name	Scientific Name	Type[1]	State Status	Federal Status
Eastern Small-Footed Bat	*Myotis leibii*	Cave-Hibernating Bat	E	-
Little Brown Bat	*Myotis lucifugus*	Cave-Hibernating Bat	E	-
Northern Long-Eared Bat	*Myotis septentrionalis*	Cave-Hibernating Bat	E	T
Indiana Bat[2]	*Myotis sodalis*	Cave-Hibernating Bat	E	E
Tri-Colored Bat	*Perimyotis subflavus*	Cave-Hibernating Bat	E	-
Big Brown Bat	*Eptesicus fuscus*	Cave-Hibernating Bat	-	-
Eastern Red Bat	*Lasiurus borealis*	Migratory Tree Bat	-	-
Hoary Bat	*Lasiurus cinereus*	Migratory Tree Bat	-	-
Silver-Haired bat	*Lasionycteris noctivagans*	Migratory Tree Bat	-	-

(E = endangered; T = threatened)

[1]* "Type" refers to two major life history strategies among bats in eastern North America; cave-hibernating bats roost in large numbers in caves during the winter, while migratory tree bats do not aggregate in caves and are known to migrate considerable distances.

[2] Not found in the eastern part of Massachusetts

6.3.1.1 Cave-hibernating and Migratory Tree Bats

6.3.1.1.1 Onshore Project Area

Disturbance of bat habitat by the construction of Onshore Facilities is limited to the Project's Onshore Substation. The Onshore Export Cable Route is not considered an Impact Producing Factor ("IPF") because it will primarily follow previously disturbed corridors. As such, it will not be discussed further in relation to bats.

The Project's Onshore Substation will be located on the eastern portion of a previously developed site within the Independence Park commercial/industrial area in the Town of Barnstable. Construction of the Onshore Substation will require the cutting of approximately 6.1 acres of mostly wooded land. Site vegetation is comprised primarily of Pitch Pine *(Pinus rigida)* and Scarlet Oak *(Quercus coccinea)* in the tree layer with Black Huckleberry *(Gaylussacia baccata)* and Lowbush Blueberry *(Vaccinium angustifolium)* dominant in the understory. Bracken Fern *(Pteridium aquilinum)* and Teaberry *(Gaultheria procumbens)* are present as ground covers. This type of Pitch Pine-Oak forest is very common on Cape Cod, often developing in sandy areas that have been subjected to repeated burnings (DeGraaf & Yamasaki, 2001). The Onshore Substation site lacks any available water source, but some small ponds are located within 427 meters (1,400 feet) of the site (see Section 3.2.5 of Volume I for further details). While bats may visit the Onshore Substation site at some point during their life cycle, this forested area is unlikely to provide important habitat due to its small size, proximity to a disturbed area, lack of a water source, and the absence of any caves or mines.

As a general matter, forested areas can serve as important foraging habitat for bats. Preferred foraging habitat, however, varies among species. The type of foraging habitat a bat species selects may be linked to the flight capabilities, preferred diet, and echolocation capabilities of each species (Norberg & Rayner, 1987). Small, maneuverable species like the Northern Long-Eared Bat and the Little Brown Bat (*Myotis lucifugus*) can forage in cluttered conditions, such as the forest understory or small forest gaps. Larger, faster-flying bats, such as the Hoary Bat (*Lasiurus cinereus*), often forage above the forest canopy or in forest gaps (Taylor, 2006). Some species, such as the Little Brown Bat and the Tri-Colored Bats (*Perimyotis subflavus)*, regularly forage over water sources. The Big Brown Bat, Eastern Red Bat (*Lasiurus borealis)*, and Hoary Bat are also known to use waterways as foraging areas, as well as travel corridors.

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

Caves and mines are a key habitat to for bats. These locations serve as winter hibernacula, fall swarm locations (i.e., areas where mating takes place in the fall months), and summer roosting locations for some individuals. Four main factors are understood to determine whether a cave or mine is suitable for use as a hibernaculum: low levels of disturbance; suitable temperature; suitable humidity; and suitable airflow (Tuttle & Taylor, 1998). The Onshore Substation site does not have caves and does not provided the required conditions for a hibernaculum.

As noted at the beginning of this section, the Onshore Substation site is mostly forested but not expected to serve as important habitat for bats. The small size of the area combined with the lack of water and proximity to a commercial/industrial zone provides limited foraging and roosting habitat. In addition, the Onshore Substation site does not provide cave habitat and does not possess the necessary features for a hibernaculum. This assessment is confirmed by the Natural Heritage Species Report (dated November 27, 2017) and online database (MassWildlife, 2017), which does not show any known roosting or hibernaculum sites in the Onshore Substation area or Town of Barnstable, as of November 29th, 2017. Thus, the Onshore Substation site will not be discussed further for non-listed species.

6.3.1.1.2 Offshore Project Area

This section assesses the potential exposure of cave-hibernating and migratory tree bats to the Offshore Project Area. During the Project's construction phase, the Offshore Project Area is inclusive of the Wind Development Area ("WDA") and Offshore Export Cable Corridor. During the operational phase, however, the assessment only includes the Wind Turbine Generators ("WTGs") within the WDA because the Offshore Export Cable Corridor does not have IPFs that affect bats. See Table 6.3-2 for definitions of exposure. See 6.2 of Volume III for further details.

Table 6.3-2 Definitions of Exposure Levels.

Exposure Level	Definition
Insignificant	Based upon the literature, little to no evidence of use of the offshore environment for breeding, wintering, or staging and low predicted use during migration
Unlikely	Based upon the literature, low evidence of use of the offshore environment during any season
Potential	Based upon the literature, moderate evidence of use of the offshore environment during any season
Likely	Based upon the literature, high evidence of use of the offshore environment and the offshore environment is primary habitat during any season

While there is uncertainty on the specific offshore movements of bats, the presence of bats in the marine environment has been documented in the US (Cryan & Brown, 2007; Dowling et al., 2017; Grady & Olson, 2006; Hatch et al., 2013; Johnson et al., 2011; Pelletier et al., 2013). For example, bats have been observed temporarily roosting on structures, such as lighthouses, on nearshore islands (Dowling et al., 2017) and there is historical evidence of bats, particularly the Eastern Red Bat, migrating offshore in the Atlantic Ocean (Hatch et al., 2013). In a mid-Atlantic bat acoustic study conducted during the spring and fall of 2009 and 2010 (86 nights), the maximum distance that bats were detected from shore was 21.9 kilometers ("km") (13.6 miles) and the mean distance was 8.4 km (Sjollema et al., 2014). In Maine, bats have been detected on islands up to 41.6 km (25.8 miles) from the mainland (Peterson et al., 2014). In the mid-Atlantic acoustic study, Eastern Red Bat comprised 78% (166 bat detections during 898 monitoring hours) of all bat detections offshore. In another study, Eastern Red Bats were detected in the mid-Atlantic up to 44 km (27.3 miles) offshore by high-definition video aerial surveys (Hatch et al., 2013).

Cave-hibernating bats generally exhibit lower activity in the offshore environment than migratory tree bats (Sjollema et al., 2014). These species hibernate regionally in caves, mines, and other structures, and feed primarily on insects in terrestrial and freshwater habitats. Their movements occur primarily during the fall. In the mid-Atlantic, the maximum distance *Myotis* bats have been detected offshore is 11.5 km (7.2 miles) (Sjollema et al., 2014). A recent nano-tracking study on Martha's Vineyard recorded Little Brown Bat (*n* = 3) movements off the island in late August and early September, with one individual flying from Martha's Vineyard to Cape Cod (Dowling et al., 2017). Big Brown Bats (*n* = 2) were also detected migrating from Martha's Vineyard later in the year, i.e., October-November(Dowling et al., 2017). These findings are supported by an acoustic study conducted on islands and buoys of the Gulf of Maine that indicate the greatest percentage of migration activity for cave-hibernating bats takes place between July and October (Peterson et al., 2014).

Migratory tree bats, on the other hand, leave New England in the winter months and journey to milder climates to overwinter. These bats have been documented in the offshore environment during migration (BOEM, 2014). Eastern Red Bats, for example, have been detected migrating from Martha's Vineyard in the late fall, (i.e., October-November), with one bat tracked as far south as Maryland before records ceased (Dowling et al., 2017). These results are supported by historical observations of Eastern Red Bats offshore as well as recent acoustic and survey results (Hatch et al., 2013; Peterson et al., 2014; Sjollema et al., 2014).

For both cave-hibernating and migrating tree bats, overall exposure to the Offshore Project Area is expected to be insignificant to unlikely. As detailed above, acoustic studies indicate low use of the offshore environment by cave-hibernating bats and such use is likely limited to the fall migration period. In addition, these species do not regularly feed on insects over the ocean. While migratory tree bats are detected more often in the offshore environment, exposure is likely to be limited to the migration period.

6.3.1.2 Federally-Listed Species

As shown in Table 6.3-2 above, two federally-listed bat species are present in Massachusetts: The Northern Long-Eared Bat and the Indiana Bat. The Northern Long-Eared Bat is found in eastern Massachusetts. The range of the Indiana bat, however, does include the eastern part of the state. Historical records only demonstrate its presence in western Massachusetts (Barbour & Davis, 1969). Thus, this assessment will focus solely on the potential exposure of Northern Long-Eared Bat to the Onshore and Offshore Project Areas.

The Northern Long-Eared Bat is an insectivorous bat that hibernates in caves, mines, and other locations (e.g., possibly talus slopes) in winter, and spends the remainder of the year in forested habitats. The bats prefer to roost in clustered stands of large trees with living or dead trees that have large cavities. The Northern Long-Eared Bat forages under the forest canopy, above fresh water, along forest edges, and along roads (MassWildlife 2012). The species' range includes most of the eastern and mid-western US and southern Canada. Due to impacts from WNS, the species has declined by 90-100% in most locations where the disease has occurred, and declines are expected to continue as the disease spreads throughout the remainder of the species' range (USFWS, 2016). WNS has been confirmed in Massachusetts (MassWildlife News, 2008). The devastating and on-going impact of WNS on the Northern Long-Eared Bat resulted in the species being listed as threatened under the ESA in 2015.

The Northern Long-Eared Bat is active from March to November (Brooks & Ford, 2005; Menzel et al., 2002). At summer roosting locations, it forms maternity colonies, which consist of aggregations of females and juveniles and is where females give birth to young in mid-June. Roosting tree-selection varies and the size of tree and canopy cover changes with reproductive stage (USFWS 2016). The bats are born flightless and remain so until mid-July (Carter & Feldhamer, 2005). Adult females and volant juveniles remain in maternity colonies until mid-August, at which time the colonies begin to break up and bats begin migrating to their hibernation sites (Menzel et al., 2002). Bats forage around the hibernation site and mating occurs prior to entering hibernation in a period known as fall swarm (Broders & Forbes, 2004; Brooks & Ford, 2005). Throughout the summer months, and during breeding, Northern Long-Eared Bats have small home ranges of less than 10 hectares (25 acres) (Silvis et al., 2016 *in* Dowling et al., 2017). Migratory movements, however, can be up to 275 km (170 miles) (Griffin, 1945 *in* Dowling et al., 2017).

Northern long-eared bats are present on Nantucket and Martha's Vineyard (Dowling et al., 2017) and are known to occur on Cape Cod in Massachusetts.

6.3.1.2.1 Onshore Project Area

As discussed above, the Onshore Project Area is limited to the Onshore Substation site for the purposes of this assessment. Due to its small size and proximity to a commercial/industrial zone, the location for the Onshore Substation is not expected to serve as valuable habitat for bats in general or Northern Long-Eared Bats, in particular. Furthermore, no known Northern Long-Eared Bat maternity roost trees or hibernaculum are located near the Onshore Substation site or the Town of Barnstable (MassWildlife, 2017). Given that the Onshore Substation site is unlikely to provide important habitat for Northern Long-Eared Bats and there are no known roost trees or hibernacula, it will not be discussed further.

6.3.1.2.2 Offshore Project Area

Northern Long-Eared Bats are not expected to be exposed to the WDA. While there is little information on the movements of Northern Long-Eared Bat with respect to ocean travel, a recent tracking study on Martha's Vineyard (n = 8; July-October 2016) "did not record any offshore movements by [N]orthern [L]ong-[E]ared [B]at" (Dowling et al., 2017, p. iv). If Northern Long-Eared Bats were to migrate over water, movements would likely be from Martha's Vineyard to the mainland. The related Little Brown Bat has been found to migrate from Martha's Vineyard to Cape Cod. As such, Northern Long-Eared Bats may likewise migrate to mainland hibernacula between August and September. Tracking data suggest that at least some Northern-Long Eared Bats overwinter on the island (Dowling et al., 2017). Nevertheless, given that the WDA is located far from shore, the exposure of Northern Long-Eared Bats is expected to be insignificant and will not be discussed further.

6.3.2 Potential Impacts of the Project

The potential direct impacts of the Project to bats were evaluated by considering the exposure of bats (see Affected Environment Section 6.3.1) to IPFs. IPFs are defined as the changes to the environment caused by project activities during each offshore wind development phase (BOEM, 2012; Goodale & Milman, 2016). Except for vessel activity during construction, the Offshore Export Cable Corridor is not considered an IPF for bats and no impact analysis is conducted. Bats may otherwise be exposed to the following IPFs: construction and maintenance vessels and the WTGs (Table 6.3-3). For the analysis below, the full range of turbines that may be used by the Project are considered (8 MW and ~14 MW).

Table 6.3-3 Impact- Producing Factors for Bats

Impact-producing Factors	Wind Development Area	Offshore Export Cable Corridor	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Increased vessel traffic	X	X	X	X	X
Wind Turbine Generators	X		X	X	X

The potential direct impact of the Project to bats is mortality or injury from collision with WTGs. Stationary objects are not generally considered a collision risk for bats (BOEM, 2014) because they are able to detect objects with echolocation (Horn, 2008; Johnson, 2004). Bat mortality has been documented at terrestrial wind farms in the US (Cryan & Barclay, 2009; Hayes, 2013; Martin et al., 2017; Pettit & O'Keefe, 2017; Smallwood, 2013). Although bat mortality has not been documented at offshore wind farms, the collision mortalities detected at terrestrial wind farms suggest that bats, if exposed, may be vulnerable to collisions with rotating offshore WTG.

6.3.2.1 Construction and Installation

6.3.2.1.1 Potential Attraction of Bats to Construction Activities in the Offshore Project Area

Bats may be attracted to construction vessels installing WTGs, Electrical Service Platforms ("ESP"), or offshore export cables. However, there is little to no evidence to suggest that these stationary objects pose any special risk to bats and behavioral vulnerability to collision is expected to be insignificant. As such, population level impacts are unlikely. Bats have the potential to be attracted to vessels to forage on insects, if insects are drawn to vessel lights. Where practicable, the Project will minimize lighting during construction activities in order to mitigate the risk of attracting bats.

6.3.2.1.2 Avoidance, Minimization, and Mitigation Measures

The Project has taken steps to avoid exposure of bats by locating the WTGs further offshore. During construction and installation lighting will be minimized to reduce potential attraction of bats to vessels and construction activities. In addition, the Project will not clear trees greater than 7.6 cm (3 inches) in diameter from June 1 to July 31 (unless a presence/probable absence surveys is conducted pursuant to current US Fish and Wildlife Service ("USFWS") protocols and no northern long-eared bats are documented).

6.3.2.2 Operations and Maintenance

6.3.2.2.1 Potential collision of bats with WTGs

As discussed in the Description of the Affected Environment (Section 6.3.1), the exposure of cave-hibernating bats to the WDA is expected to be insignificant to unlikely and would only occur rarely during migration when a small number of bats may occur in the MA Wind Energy Area given its distance from shore (BOEM, 2014). In contrast, migratory tree bats could pass through the WDA, but overall small numbers of migratory bats are expected in the MA Wind Energy Area given its distance from shore (BOEM, 2014).

There is evidence of bats visiting WTGs nearer to shore (4-7 km [2.5-4.3 miles]) in the Baltic Sea, a body of water surrounded by land (Ahlen et al., 2009; Rydell & Wickman, 2015). The WDA, however, is far offshore and there are no nearby landing areas, e.g. islands, which might otherwise increase the presence of bats in the WDA. The need for lighting during the operations and maintenance phase of the Project is expected to be minimal and best practices will be considered when it is necessary to mitigate any risks. In summary, bats have an insignificant to unlikely exposure to the WDA because WDA is located far offshore and bat exposure is likely limited to a few individuals of migrating tree bats in the fall. In the low likelihood event that bats would be exposed to operational IPFs, bats have unlikely to potential behavioral vulnerability to collision with WTG. Risks will be further minimized through mitigation measures. For these reasons, overall bat exposure to the WDA is likely to be limited to a few individuals and population level impacts are unlikely.

6.3.2.2.2 Avoidance, Minimization, and Mitigation Measures

The Project has taken steps to avoid exposure of bats by locating the WTGs further offshore. During operation, lighting will be minimized to reduce potential attraction of bats to WTGs and ESPs.

6.3.2.3 Decommissioning

The decommissioning phase IPFs, which bats will be exposed to (e.g., boat activity), are expected to be similar to the construction period (see Section 6.3.2.1). The Project will discuss best practices available at the time of decommissioning with BOEM and the USFWS to avoid and minimize potential impacts to bats.

6.4 Coastal Habitats

This section addresses impacts to coastal habitats that are located at the potential Landfall Sites in Yarmouth and Barnstable. It also includes a discussion of rare species potentially affected by construction, operation, and maintenance at the potential Landfall Sites, as well as mitigation measures to address potential impacts to coastal habitats.

6.4.1 Description of the Affected Environment

As described in Section 3.0 of Volume I and as shown on Figure 2.2-1 in Volume I, two Landfall Sites are currently being evaluated for the Project: Covell's Beach in Barnstable and at New Hampshire Avenue in Yarmouth. These sites, and any nearby coastal habitats, are described below.

Covell's Beach

The Covell's Beach Landfall Site is located on Craigville Beach Road near the paved parking lot entrance to a public beach owned and managed by the Town of Barnstable. This Landing Site is considered advantageous due to its relatively protected location within the Centerville Harbor bight, superior egress, and favorable onshore routing to the Barnstable Switching Station via public roads and electric transmission ROW.

Use of the Covell's Beach Landfall Site is not anticipated to require any disturbance to coastal habitats. A relatively small eelgrass bed has recently been identified offshore in the vicinity of Spindle Rock, and that area was surveyed to delineate the extent of the eelgrass (see Section 3.3 of the COP Addendum). Otherwise, the Covell's Beach Landfall Site is free of offshore eelgrass or other sensitive habitats in the nearshore area. Vessel anchors will be required to avoid known eelgrass beds (including those near Spindle Rock) and will avoid other sensitive seafloor habitats (hard/complex bottom) as long as it does not compromise the vessel's safety or the cable installation. Onshore construction impacts at this Landfall Site would be entirely limited to paved surfaces, including a public roadway and a parking lot.

New Hampshire Avenue

The New Hampshire Avenue Landfall Site is located just west of Englewood Beach, where a Town-owned road, New Hampshire Avenue, dead-ends. A paved Town-owned parking area is located approximately 91 meters ("m") (300 feet ["ft"]) north of the dead-end road and is a potential location for staging/laydown for horizontal directional drilling ("HDD") operations. Although workspace is limited at this location, the site is a good candidate due to its superior egress and favorable onshore routing to the Barnstable Switching Station via public roads and electric transmission ROW.

The precise Landfall Site is a small beach located at the southern end of New Hampshire Avenue where the road abruptly ends at a low concrete bulkhead. This small bulkhead connects, at either end, to two larger concrete bulkheads that guard the adjacent residential properties fronting on Lewis Bay. These larger bulkheads return toward New Hampshire Avenue along its two sidelines forming a small notch in the shoreline directly in line with the New Hampshire Avenue road layout.

Aside from potential impacts to this small beach area, use of the New Hampshire Avenue Landfall Site does not require any disturbance to coastal habitats. The area is also free of any mapped areas of offshore eelgrass or other sensitive habitats in the nearshore area. Mapped eelgrass resources are shown in Figure 6.4-1.

6.4.2 Potential Impacts of the Project

Table 6.4-1 Impact-Producing Factors for Coastal Habitat

Impact-Producing Factors	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Direct alteration of coastal habitat	x	x	

6.4.2.1 Construction and Installation

Depending on the Landfall Site eventually chosen for the Project, some disturbances to coastal habitat may be required. Although unlikely, some potential also exists for coastal habitat impacts resulting from accidental fuel spills or release of drilling mud used in the HDD operations.

6.4.2.1.1 Direct Alteration of Coastal Habitat

No direct coastal habitat impacts are associated with the Landfall Site at Covell's Beach. On the other hand, direct alterations to coastal habitats may be required at New Hampshire Avenue.

Covell's Beach

The Landfall Site at Covell's Beach will be completed by HDD. All construction operations and staging will be performed within a paved road surface and adjacent parking area. As such, no disturbance to the adjacent dune or beach habitats will occur. A relatively small area of eelgrass located offshore in the vicinity of Spindle Rock has recently been identified and was surveyed to determine the extent of eelgrass (see Section 3.3 of the COP Addendum). Avoidance of this area will be a priority.

New Hampshire Avenue

The Landfall Site at New Hampshire Avenue may be completed by HDD or by a conventional open cut trench. If HDD is employed, all construction operations and staging would take place within a paved road surface and adjacent parking area with no disturbance to the beach area. If the conventional method is used, approximately 140 square meters (m^2; 1,500 square feet [ft^2]) of beach would be temporarily impacted from the

G:\Projects2\MA\MA\4903\MXD\COP\2018_October\Eelgrass_Locations_20180921.mxd

Data Source: Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

This product is for informational purposes and may not be suitable for legal, engineering, or surveying purposes. Map Projection: NAD83 UTM Zone 19

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VINEYARD WIND

Figure 6.4-1

Eelgrass Locations

construction of a temporary, three-sided sheetpile cofferdam.[14] Some riprap removal will be required at the existing seawall at the Landfall Site to accommodate sheet pile installation close to shore; this riprap and seawall will be restored to original dimensions after the sheet piles are removed.

6.4.2.1.2 Avoidance, Minimization, and Mitigation Measures

The Landfall Sites have been selected because they are located in previously disturbed areas and have sufficient work space that can be effectively segregated from any nearby coastal habitats. In addition, the New Hampshire Avenue Landfall Site is located in an area that is free of offshore eelgrass habitats, and only a relatively small area of eelgrass is located offshore of the Covell's Beach Landfall Site. Avoidance of the eelgrass will be a priority. Vessel anchors will be required to avoid known eelgrass beds (including those near Spindle Rock) and will avoid other sensitive seafloor habitats (hard/complex bottom) as long as it does not compromise the vessel's safety or the cable's installation. Thus, potential impacts to coastal habitats have been avoided or minimized.

Best management practices will be used during refueling and lubrication of equipment to protect coastal habitats from accidental spills. For further information on spill prevention, refer to the Oil Spill Response Plan in Appendix I-A.

6.4.2.1.3 Summary

By implementing the above avoidance, minimization, and mitigation measures, all impacts to coastal habitats will be avoided at Covell's Beach Landfall Site. At the New Hampshire Avenue Landfall site, impacts to coastal habitats will be avoided unless the conventional open cut trench method is used, in which case impacts to coastal habitats would be short-term and highly localized. Additionally, the site will be restored in consultation with local officials. Consequently, population level impacts to any species within the coastal habitat at New Hampshire Avenue are unlikely.

6.4.2.2 Operations and Maintenance

6.4.2.2.1 Direct Alteration of Coastal Habitat

The Project's normal operations and maintenance activities will not result in further habitat alteration or involve activities that are expected to have a negative impact on wildlife. It is anticipated that there may be some required maintenance or repairs at the Landfall Site or transition vault over the up to 30 year life of the Project. Such work would typically occur within the vault, which will be located beneath paved surfaces and accessed through manholes. This would allow such work to be completed within previously-installed onshore infrastructure and without additional impact to coastal habitat.

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[14] The cofferdam is expected to be approximately 604 m^2 (6,500 ft^2); of this total, approximately 140 m^2 (1,500 ft^2) will be on the beach.

6.4.2.3 Decommissioning

As described in Section 4.4.3 of Volume I, no decommissioning work is planned for the Project's onshore facilities, although removal of Project cables via existing manholes may occur if required. The splice vaults, duct bank, and onshore substation will likely remain as valuable infrastructure that would be available for future offshore wind projects developed within the Vineyard Wind Lease Area or elsewhere.

6.5 Benthic Resources

This section describes benthic resources in the Offshore Project Area.

6.5.1 Description of the Affected Environment

This section describes the benthic resources present in and adjacent to the Offshore Project Area. A review of regional benthic resources is presented, including a summary of benthic habitat and shellfish in the Wind Development Area ("WDA") and along the Offshore Export Cable Corridor ("OECC"). Data used to describe benthic resources in the Offshore Project Area came from a robust dataset and previous studies conducted within or near the Project Area between 2012-2018. Primary sources included, BOEM Revised Environmental Assessment, Massachusetts Coastal Zone Management Survey, and site-specific data collected by Vineyard Wind (see Volume II for details of site-specific sampling). The non-Project specific (i.e., samples not collected by Vineyard Wind) datasets consist of a mix of grab and imagery data collected within the Project Area, covering both spring and fall seasons, over a two-year period, and enabled characterization of seasonal and inter-annual variability. These resources, in addition to the Vineyard Wind sampling, allowed for the characterization of abundance, diversity, community composition, and percent cover of benthic macrofauna and macroflora, both within the Project Area and surrounding area.

6.5.1.1 Benthic Habitat (hard bottoms, living bottoms) in WDA

As discussed in Section 2.1.2.1 of Volume II, seafloor conditions within the WDA are very homogenous, dominated by fine sand and silt-sized sediments that become finer in deeper water. These homogenous conditions were identified by multi-beam echo sounding and side scan sonar imaging techniques that have been ground-truthed via benthic grab samples, borings, and CPTs, and further verified via historic grab sample and still photo data (Stokesbury, 2013; Stokesbury, 2014). There are localized patches of sand ripples and small mega-ripples randomly distributed throughout the WDA, and these patches provide the only relief as compared to the relatively flat seafloor that gradually slopes offshore. While these features within the WDA provide less than one-meter ("m") (3.2 feet ["ft"]) relief, they can be as much as 200 m (656 ft) wide and 500 m (1,640 ft) long and more than 1,000 m (3,280 ft) in length.

No state-managed artificial reefs have been documented within the WDA; other types of potentially sensitive or unique benthic habitat types, such as live bottom, are not present based on the Shallow Hazards Assessment discussed in Section 3 of Volume II. Two shipwrecks were identified in the WDA (see Volume II-C), which may provide artificial reef habitat for benthic resources in the area.

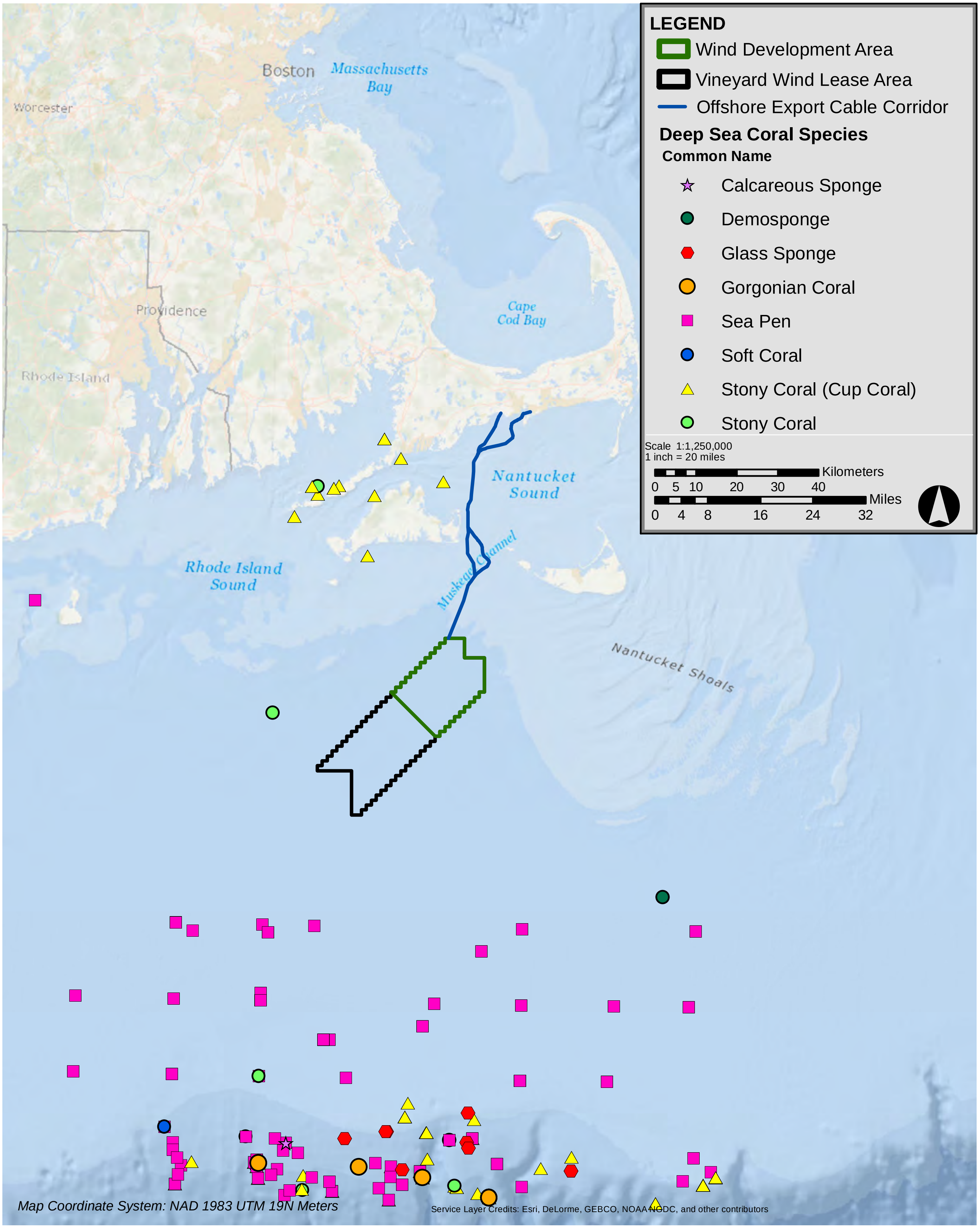
There have been no observations of living bottom made within the WDA based on data available on the National Oceanic and Atmospheric Administration ("NOAA") Deep-Sea Coral Data Portal (NOAA, 2017c; Figure 6.5-1). However, it is important to note that this database does not include "observations of absence" for corals and sponges. Few areas have actually been surveyed for corals or sponges, so by showing no observations in the database, this does not necessarily indicate no taxa are present (Hourigan et al., 2015). To help fill the gap between surveyed areas often due to the logistical difficulty and expense of surveying the deep ocean, NOAA National Centers for Coastal Ocean Science (NCCOS) uses statistical modeling techniques, which take into account known deep-sea coral locations and other contributions with environmental and oceanographic data, to predict areas that are capable of supporting deep-sea corals. The NOAA NCCOS model results indicate that the area within the WDA has a low habitat suitability index for all soft and hard coral species analyzed (Figure 6.5-2; Kinlan et al., 2016).

According to known observations within the NOAA Deep-Sea Coral Data Portal database, the closest live bottom to the WDA is a patch of stony coral (cup coral [*Astrangia* sp.]) approximately 28 kilometers ("km") (17 mi ["mi"]) to the northwest of the WDA, while the closest unspecified stony coral (Scleractinia) is approximately 30 km (19 mi) to the southwest of the WDA. Farther offshore of the Massachusetts Wind Energy Area ("MA WEA"), designated by BOEM, are patches of Sea Pens (*Stylatula elegans*), stony coral, sponges, soft coral, and gorgonian coral as shown in Figure 6.5-1.

6.5.1.2 Benthic Epifauna, Infauna and Macrofauna in WDA

The benthic community in the WDA, as a subset of New England waters in depths from approximately 40-58 m (131-190 ft), includes amphipods and other crustaceans, lobster, crabs, gastropods, polychaetes, bivalves, sand dollars, burrowing anemones, brittle stars, sea squirts, tunicates, and sea cucumbers (BOEM, 2014; Provincetown Center for Coastal Studies, 2005). These organisms are important food sources for many commercially important northern groundfish species.

Video surveys of benthic epifauna conducted by the University of Massachusetts School of Marine Science and Technology ("SMAST") in 2010-2013 indicate that the Common Sand Dollar (*Echinarachnius parma*) is abundant within the MA WEA, with this species occurring

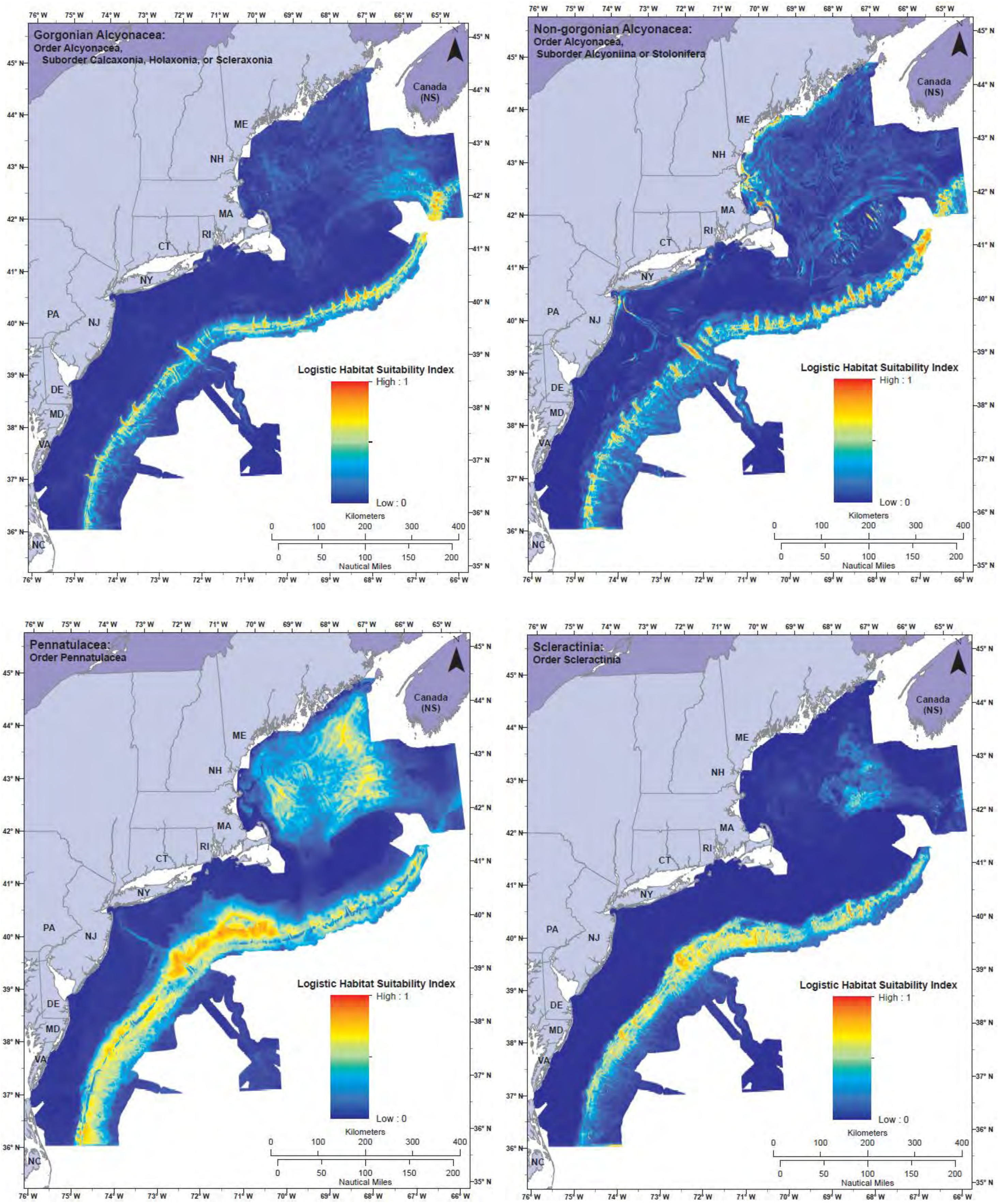


Map Coordinate System: NAD 1983 UTM 19N Meters

Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Figure 6.5-1

Locations of Observed Deep-Sea Coral in the Offshore Project Area (NOAA, 2017a)



National Centers for Coastal Ocean Science,
Center for Coastal Monitoring and Assessment, Biogeography Branch
Map Projection: WGS84 UTM Zone 18N

NCCOS

Vineyard Wind Project

VINEYARD WIND

Figure 6.5-2

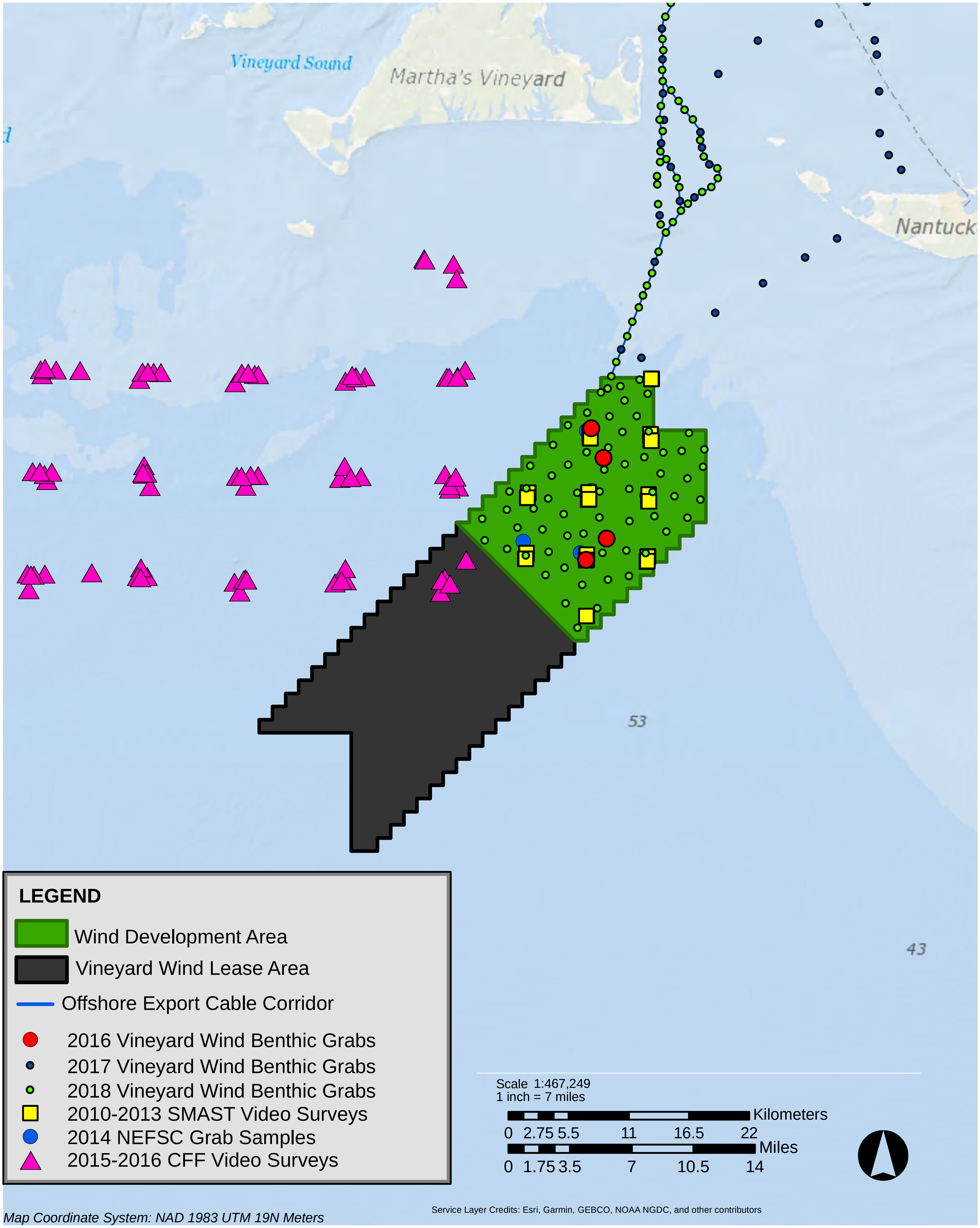
NOAA NCCOS Logistic Habitat Suitability Indices for Soft Coral (Alcyonacea), Hard Coral (Scleractinia) and Sea Pens (Pennatulacea) in approximately 70% of a total of 216 samples collected in the WDA (SMAST, 2016). Similar patterns of Sand Dollar abundance were observed during video surveys conducted by the Coonamessett Farm Foundation, Inc. (CFF) as part of a southern New England juvenile fish study between December 2015 and early April 2016 throughout the BOEM Rhode Island and MA WEAs (Siemann and Smolowitz, 2017). In this survey, including video surveys and scallop dredge tows, high abundances of sand dollars were found in areas, such as the WDA, in which sandy substrates predominated. The sampling locations for the SMAST and CFF surveys are provided in Figure 6.5-3.

As part of the 2010-2013 SMAST video survey, two sampling events occurred within the WDA in May 2012 and September 2013 (SMAST, 2016). The differences in numbers of species collected during the two seasons is provided in Table 6.5-1. From this sampling program, more benthic organisms were collected in the spring than fall. Hydrozoans and bryozoans were present in approximately 18% of the 216 samples within the WDA, while hermit crabs, euphausids, sea stars, and anemones, combined, were present in 9% of the samples (SMAST, 2016). It is important to note, however, that none of these benthic epifauna, infauna, or macrofauna have a designated conservation status as they are typically found in the Nantucket Shelf Region.

Table 6.5-1 Seasonal Results of SMAST Video Survey Samples Collected in Wind Development Area in May 2012 and September 2013 (107 samples from 9 locations)

Common name	Number of Organisms Collected in Spring	Number of Organisms Collected in Fall
Hermit Crab	3	0
Euphausids	11	0
Sea Stars	4	0
Sand Dollars	89	63
Anemones	2	0
Hydrozoans	23	17

Numerous benthic trawl and grab samples were also collected in the MA WEA during a shipboard survey conducted by the Northeast Fisheries Science Center ("NEFSC"), Integrated Statistics, Inc., and Woods Hole Oceanographic Institution from April to May 2014 (NEFSC, 2014). This survey, which consisted of 32 grab samples locations with three replicate grabs for grain size and benthic infauna at each location and 23 benthic trawls within the MA WEA, focused on sea birds, cetaceans, and sea turtles. The aim of this survey was to document the relationship between the abundance of these organisms and the biological and physical environment. The grab samples were analyzed to identify benthic infaunal and epifaunal assemblages, as well as sediment textures. Within the 23



Vineyard Wind Project

Figure 6.5-3

Benthic Sampling Locations In and Surrounding the Wind Development Area trawls conducted in the MA WEA, 59 taxa were identified with Sand Shrimp (*Crangon septemspinosa*), sand dollars, Pandalid Shrimp (*Pandalidae*), and Monkey Dung Sponge (*Suberites ficus*) as the top four species by percent count, weight, and frequency (see Table 6.5-2).

Table 6.5-2 Beam Trawl Summary for Epibenthic and Demersal Fauna within the Massachusetts WEA (23 trawls, 59 taxa)

Common name	Taxonomic name	% count	% weight	% frequency
Sand Shrimp	*Crangon septemspinosa*	70.5	5.7	95.7
Sand Dollar	*Echinarachnius parma*	17.4	47.6	39.1
Pandalid Shrimp	Pandalidae	0.5	0.1	52.2
Monkey Dung Sponge	*Suberites ficus*	0.1	15.4	26.1

For the WDA specifically, 21 benthic grabs from the NEFSC Shipboard Habitat Survey were collected from 7 sampling locations in March 2014 (Figure 6.5-3). Within these samples, benthic infaunal assemblages were dominated by polychaete worms (at 49% as a combined taxa) and amphipod crustaceans (at 33%; Figure 6.5-4).

Similar results were found in infaunal sampling performed in areas south of Martha's Vineyard and Nantucket in September 2011. Oligochaetes, polychaetes, and nemertean ribbon worms were the most widely distributed taxa (AECOM, 2012). This survey included benthic grabs at a total of 214 stations, 95 of which were located south of Cape Cod and the Islands, in the vicinity of the Offshore Project Area. A total of 128 different families were identified from the samples collected at these 95 stations with an average of 23 (standard deviation ["SD"] ± 7) taxa per location. Organism density ranged from 12 to over 1,000 individuals per sample, with an average density of 599.5 (SD ± 712.1) organisms per 0.04 square meter ("m^2") (4.3 square feet ["ft^2"]). Nut clams, small bivalves in the family Nuculidae, were the most abundant taxon, and comprised over 24% of all organisms. Capitellid polychaetes and four-eyed amphipods (Ampeliscidae) were also abundant, comprising 16.0% and 9.0% of organisms, respectively.

In addition to the prior studies, ESS Group Inc. and RPS, on behalf of Vineyard Wind, analyzed four and 67 samples, respectively, collected from benthic habitats within the WDA (ESS Group, Inc., 2017; RPS, 2018; included in Appendix H of Volume II-A). The 2016 sampling survey involved collecting four grab samples for ground-truthing side-scan sonar imagery and corresponding benthic analysis. The 2018 survey involved more comprehensive coverage and included 67 samples for benthic analysis. The grab sampling locations from both the 2016 and 2018 surveys are also shown in Figure 6.5-3. The primary target of this analysis was benthic macroinvertebrates, or organisms greater than

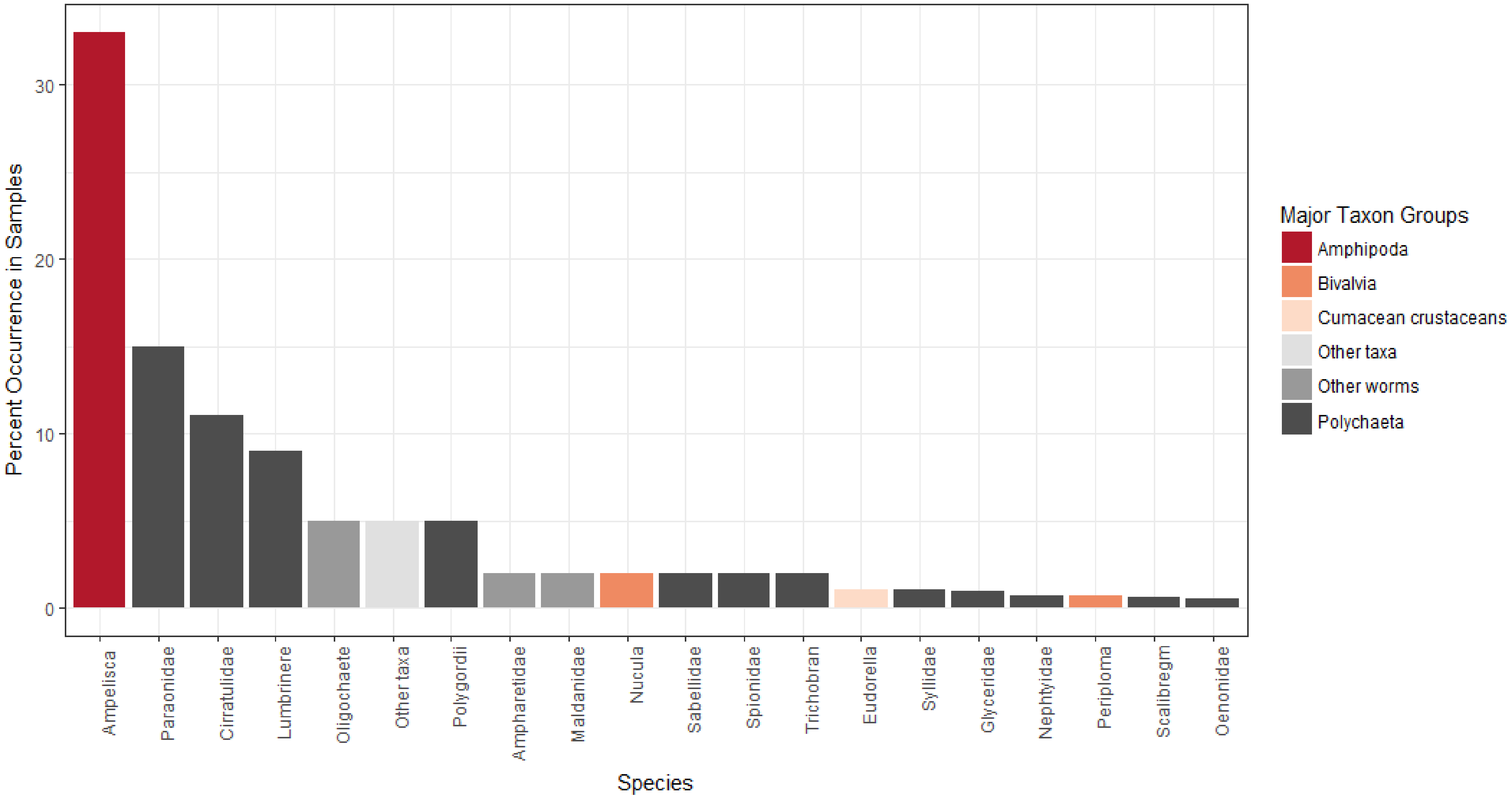


Figure 6.5-4

2014 NEFSC Shipboard Habitat Survey Grab Sample Catch by Percentage of Total Catch Numbers, Color-coded by Major Taxonomic Group

500 microns (μm) in length that either live on or in aquatic sediments, including mollusks, primitive (unsegmented) worms, annelids (segmented worms), crustaceans, and echinoderms. Measures of benthic macrofaunal diversity, abundance, and community composition were recorded to describe the existing condition of benthic resources within the WDA. In the 2016 survey, there were 32 total taxa identified from the four samples examined. Taxa richness per sample ranged from six taxa to 19 taxa per grab, with a mean taxa richness of 15 taxa per grab. The mean macrofaunal density for the analyzed samples was 12,449 individuals per m^2 [15]. The highest macrofaunal density found in the four grab samples was 23,4440 individuals per m^2, and the lowest was 4,823 individuals per m^2. In the 2018 survey, taxa richness per sample ranged from nine to 32 taxa per grab, with a mean richness of 21 taxa. Mean density per m^2 across all samples was 36,539 organisms per grab sample with a range of 119,125 organisms per m^2 at station 210 and 7,625 organisms per m^2 at station 230.

Of the four samples analyzed in 2016, three were characterized by densities of 9,000 individuals per m^2 or more (Appendix A in Appendix H of Volume II-A). The benthic macrofaunal assemblage in the analyzed samples consisted of polychaete worms, crustaceans, mollusks, echinoderms, nematode roundworms, and nemertean ribbon worms. The most speciose taxonomic group was polychaete worms, which contributed approximately 45% of the taxa documented in the analyzed samples. The taxonomic group with the highest density was polychaete worms, followed by nematode roundworms and crustaceans. The most abundant taxa observed were nematode roundworms (Nematoda), the lumbrinerid polychaete (*Scoletoma* sp.), and a paranoid polychaete (Paraonidae). Together, these taxa accounted for more than 50% of all individuals identified in this study. For the 67 samples collected in the WDA in the 2018 survey, the most abundant taxonomic groups included polychaete worms (Polygordiidae, Paraonidae, Lumbrineridae, and Cirratulidae) and nut clams (Nuculidae). Organisms in these families accounted for about 75% of the total abundance in all samples. Results from multivariate analyses of the benthic grab data collected in 2018 indicated overall similarity and homogeneity between the taxonomic assemblages in the WDA (RPS, 2018, see Appendix H of Volume II).

BOEM is also conducting an on-going study designed to assess and characterize benthic habitat and the epibenthic macroinvertebrate community in existing and proposed WEAs from Massachusetts to North Carolina via multibeam sonar, and optical (still and video) imaging of the seafloor. While this study is ongoing, BOEM has provided Vineyard Wind with preliminary data results to incorporate into the evaluation of benthic resources within the Offshore Project Area. NOAA's NEFSC provided an initial small subset of the benthic

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[15] Data from the 2016 survey was originally reported as meters cubed (m^3), however to allow for comparison between the 2017 and 2018 datasets, the 2016 data was converted to square meters (m^2), which is typically the metric used to report taxonomic density in benthic grab samples.

grab data to assist in the evaluation of benthic resources for the Offshore Project Area. The results of these preliminary grab data are relatively similar to those from the ESS Group Inc. (2017) and RPS (2018) studies with the most abundant species being tube-dwelling amphipods (*Ampelisca agassizi*), Oligochaete worms, and marine polychaete worms from the families Cirratulidae, Lumbrinere, and Paraonidae.

For benthic macrofauna, species of commercial or recreational importance within the WDA include Atlantic Sea Scallop (*Placopecten magellanicus*), Ocean Quahog (*Artica islandica*), Atlantic Surfclams (*Spisula solidissima*), American Lobster (*Homarus americanus*), Jonah Crab (*Cancer borealis*), and Horseshoe Crab (*Limulus polyphemus*). The immobile, attached egg masses (egg mops) of the Longfin Squid (*Doryteuthis pealeii*) is another species of commercial or recreational importance with a benthic life stage within the WDA, and is discussed in more detail in Section 6.6. The NEFSC Seasonal Trawl data from 2003-2016 indicate that the catch of sea scallops is typically higher in the fall than in spring months, with the only catch of this species in the WDA occurring in the fall (Figure 6.5-5). Juvenile and adult Atlantic Surfclams (*Spisula solidissima*) are typically found in well-sorted, medium sand (Dames and Moore, 1993), but they also occur in fine sand (MacKenzie et al., 1985) and silty-fine sand (Meyer et al., 1981; Cargnelli et al., 1999a) such as is found in the WDA. Ocean Quahogs are usually found in dense beds over level bottoms, typically just below the surface in medium to fine grain sand sediments (MAFMC, 1997; Cargnelli et al., 1999b). Ocean Quahog (*Artica islandica*) have been qualitatively observed within the northern portion of WDA and throughout the MA WEA based primarily on bottom grab samples (Guida et al., 2017). The NOAA NEFSC has also been conducting Atlantic Surfclam-Ocean Quahog Surveys within the vicinity of the WDA since 1999. The region-wide survey has involved five-minute tows at a speed of 1.5 knots with a hydraulic jet dredge at randomly-selected sites (NEFSC, 2018). The survey has not always sampled within this specific area; however, both Atlantic Surfclam and Ocean Quahog have been collected within the vicinity of the WDA as outlined in Table 6.5-3.

Table 6.5-3 Catch Numbers of Atlantic Surf Clam and Ocean Quahog in NOAA Fisheries Service-NEFSC Surfclam/Ocean Quahog Survey at Sampling Locations in Vicinity of the WDA (NEFSC, 2018)

Year	Catch Number of Atlantic Surf Clam	Catch Number of Ocean Quahog
1999	59	12
2002	0	1,136
2005	0	36
2008	1	80
2011	0	46
2013	0	171

NEFSC Seasonal Trawl Survey Data
Sea Scallop Catch Number by Season
2003-2016

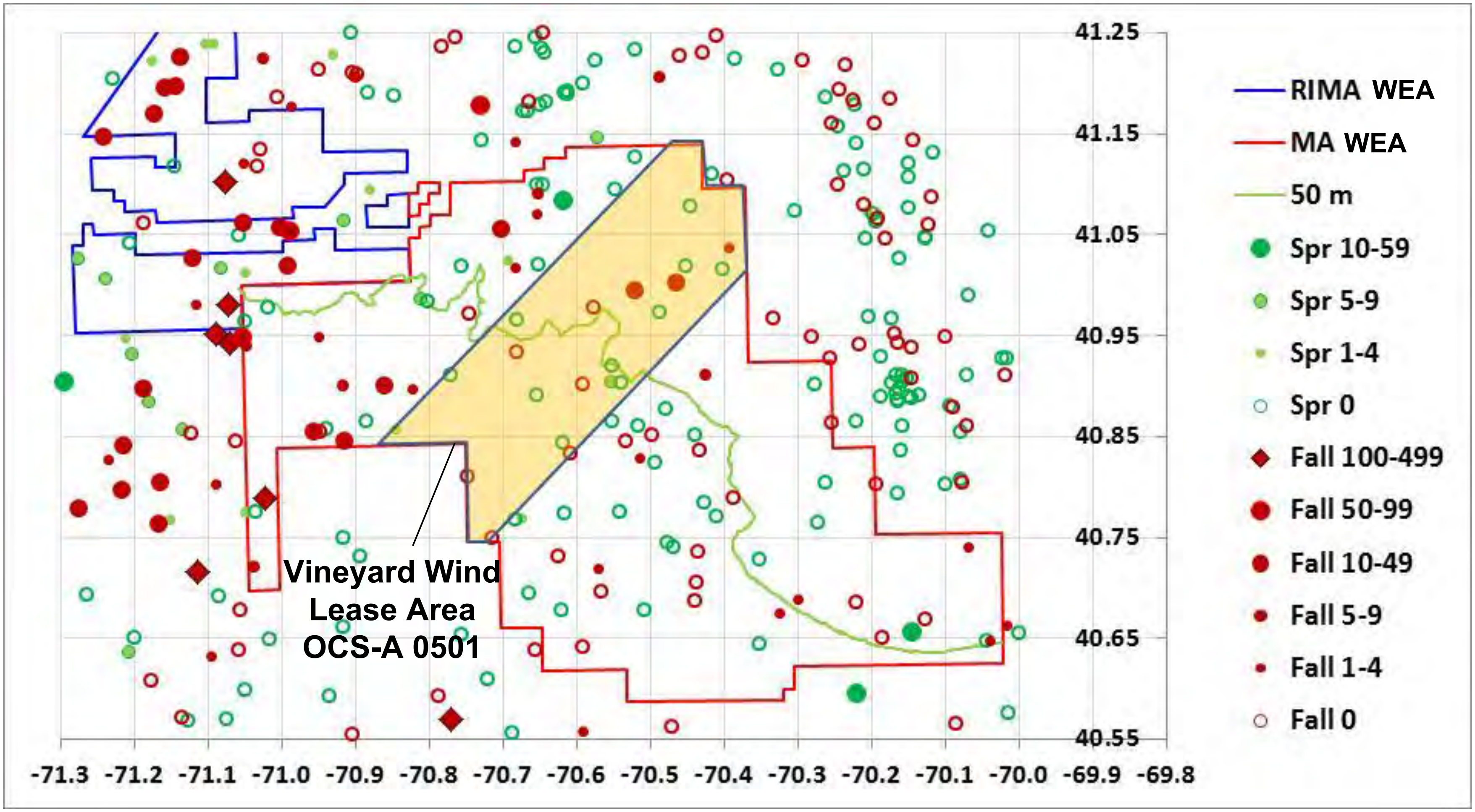


Figure 6.5-5

Sea Scallops Numbers Caught by NEFSC Seasonal Trawl Survey: 2003-2016 (Guida 2017)

NEFSC Fall and Spring Bottom Trawls have also caught American Lobster (*Homarus americanus*) within the WDA (Figure 6.5-6). Spatial analyses by the NOAA NEFSC of their bottom trawl survey data between 2004 and 2014 indicate that the fall and spring distribution of Atlantic Lobster in the vicinity of the WDA is less than 0.8 individuals per tow (NEFSC, 2017b). Jonah Crab have been infrequently encountered in the Massachusetts inshore state water trawl surveys, which are focused primarily on finfish (ASMFC, 2015). Spatial analyses by the NOAA NEFSC of their bottom trawl survey data indicate that the fall distribution of Jonas Crab within the vicinity of the WDA from 2004 to 2014 ranged from approximately 0.03 to 0.1 individuals per tow (NEFSC, 2017b). This same analysis indicated that the spring distribution of Jonah Crab within the WDA was lower (at approximately <0.02 individuals per tow) than during the fall. Little data exists on the distribution of Horseshoe Crab within the vicinity of the WDA; however, older juvenile and adult Horseshoe Crabs could occur in the area, though NMFS NEFSC bottom trawl data suggest they prefer depths less than 30 m (ASMFC, 1998). Figure 6.5-7 provides an overview of the occurrence of Jonah Crab, Horseshoe Crab and American Lobster within the Project Area during fall sampling by the Massachusetts Division of Marine Fisheries (MA DMF) and NOAA NEFSC between 2005-2014. In summary, though these species are present within the WDA, based on available data, they have been only observed in relatively low numbers. For a broader description of the primary mobile benthic invertebrates within the WDA, refer to Section 6.6.1.2.

In terms of the organisms present in the localized patches of sand ripples and small mega-ripples randomly distributed throughout the WDA (see Section 2.1.2.1 of Volume II), mobile sand environments, such as sand ripples, are quite variable with the fauna being often sparse (Jennings et al., 2013).

6.5.1.3 Benthic Habitat (hard bottoms, living bottoms) Along Offshore Export Cable Corridor

As described in Volume II, the majority (75%) of the video transect samples along the Offshore Export Cable Corridor ("OECC") recorded bottom habitats with low complexity, mostly comprised of flat sand/mud, sand waves, and biogenic structure. Areas of shell aggregate, specifically common Atlantic Slipper Shell (*Credula fornicate*) reefs, were observed along the OECC in the northern Nantucket Sound. A number of locations within Muskeget Channel, contained coarse deposits and hard bottom habitats consisting of pebble-cobble habitat with Sulfur Sponge (*Cliona celata*) communities.

There are no artificial reefs directly along the OECC; however, there are two artificial reef locations outside the Project Area, as shown in Figure 6.5-8 (NEODP, 2017).

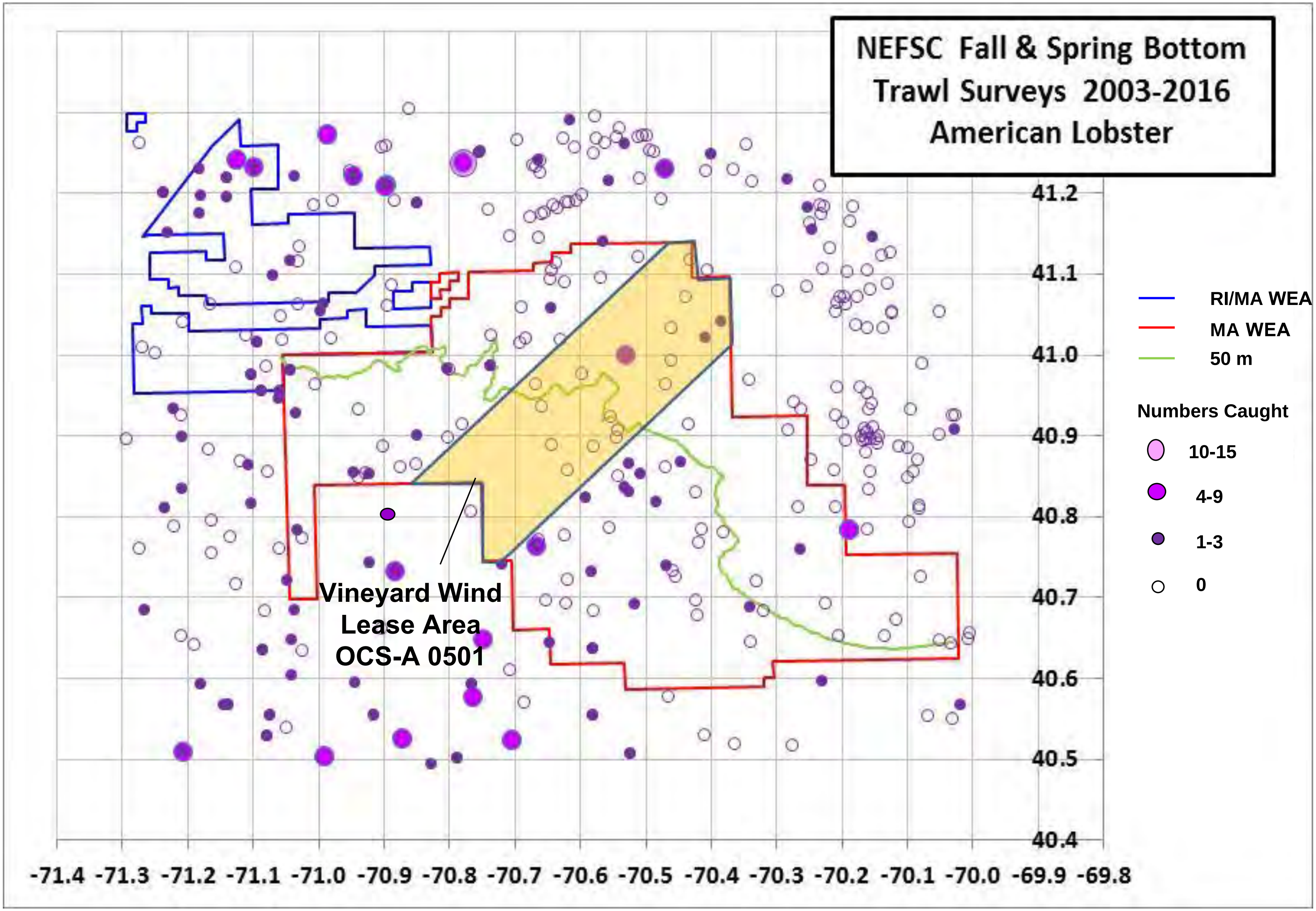
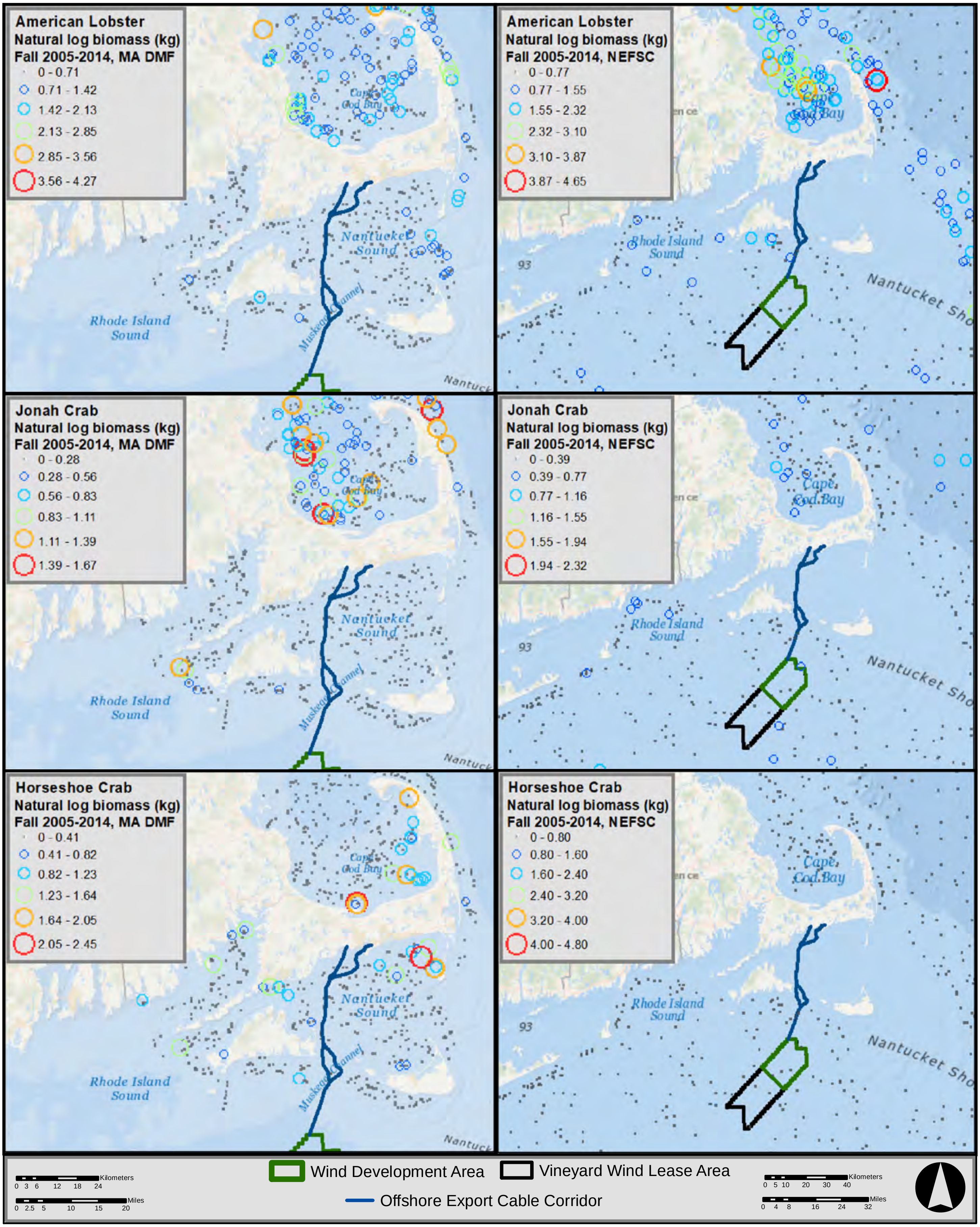


Figure 6.5-6

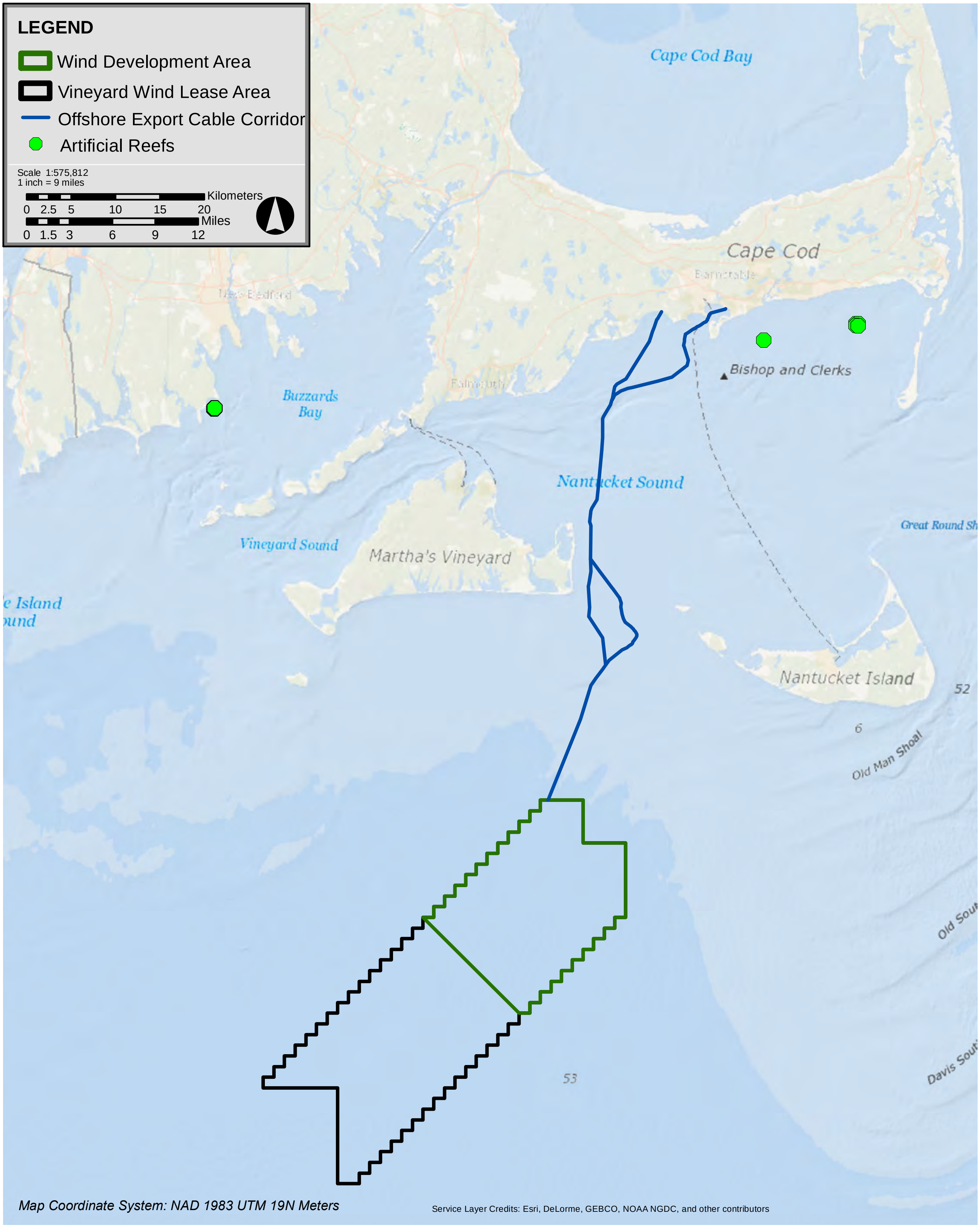
American Lobster Numbers Caught by NEFSC Fall & Spring Trawl Surveys: 2003-2016 (Guida 2017)



Vineyard Wind Project

Figure 6.5-7

Natural log-transformed biomass (kg) per tow for MA DMF and NEFSC Fall Sampling of Horseshoe Crab, Jonah Crab and Atlantic Lobster (NEODP, 2017)



Map Coordinate System: NAD 1983 UTM 19N Meters

Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

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Figure 6.5-8

Locations of Artificial Reefs in Relation to Two Potential Landfall Sites for the Project's Export Cables (NEODP, 2017)

6.5.1.4 Benthic Epifauna, Infauna and Macrofauna Along Offshore Export Cable Corridor

As described in Section 5.1.1.2 and Appendix H of Volume II, surveys of epifauna and infauna along the OECC were conducted via underwater video transects and sediment grab samples, respectively. The results of the underwater video imagery, which are fully described in the CR Environmental, Inc. final report (2017) and summarized in Table 5.1-4 of Volume II, demonstrate that the epifauna communities vary between habitat type, as expected. The areas of flat sand/mud, sand waves, and biogenic structure were dominated by sand dollars and burrowing anemones in some areas and amphipods, slipper limpets, whelks, sponges, polychaetes and spider crabs in other areas. While areas containing hard bottom, particularly the pebble-cobble habitat, contained Sulfur Sponge (*Cliona celata*), Breadcrumb Sponge (*Halichondria panicea*) and bryozoans.

The results of the 31 grab samples collected in September 2017, as documented by Normandeau Associates (2017) and RPS (2018) and provided in Appendix H of Volume II, indicate the predominate infaunal organisms along the OECC include amphipods, polychaete worms, nematodes, and snails (e.g., slipper limpets, pyram shells, and dove snails). In addition to the 31 benthic grab samples collected along the OECC in 2017, more extensive sampling occurred in June and July of 2018 and included 64 benthic grabs and 42 underwater video transects. Results of the benthic grabs collected in 2018 indicated some dissimilarity in the abundance and predominant infaunal organisms between the two surveys. While samples from both 2017 and 2018 had consistently high occurrence rates and abundances of nematodes, the most abundant organisms collected in 2018 were slightly different than in 2017 and included polychaete worms, nematodes, barnacles, hooded shrimp, and tellins (RPS, 2018. Differences in the taxonomic assemblages between the surveys could be due to seasonal, interannual, or natural environmental variability; increased sampling effort in different and unique habitats in 2018; or other causes. In general, samples along the OECC had lower abundance and highly variable taxonomic assemblages composed of more unique taxa than those in the WDA.

Areas of suitable shellfish habitat have also been observed along the coast of Massachusetts since the mid-1970s with information provided by the Massachusetts Division of Marine Fisheries, local shellfish constables, commercial fisherman, maps, and studies (NEODP, 2017). According to these data (limited to Massachusetts state waters), the OECC will transverse over suitable shellfish habitat for Atlantic Surf Clam (*Spisula solidissima*), Ocean Quahog (*Artica islandica*), Blue Mussel (*Mytilus edulis*), Bay Scallop (*Argopecten irradians*), and Atlantic Sea Scallop (*Placopecten magellanicus*) (see Figure 6.5-9 and Figure 6.5-10; NEODP, 2017). As indicated by Figure 6.5-10, the OECC with a potential landing site in Lewis Bay would transverse over an area of suitable habitat for Bay Scallop. It has also been reported that species of large gastropod whelks (*Busycon carica* and *Busycotypus canaliculatum*) are abundant in Nantucket Sound coastal waters (Davis & Sisson, 1988; USDOE MMS, 2009).

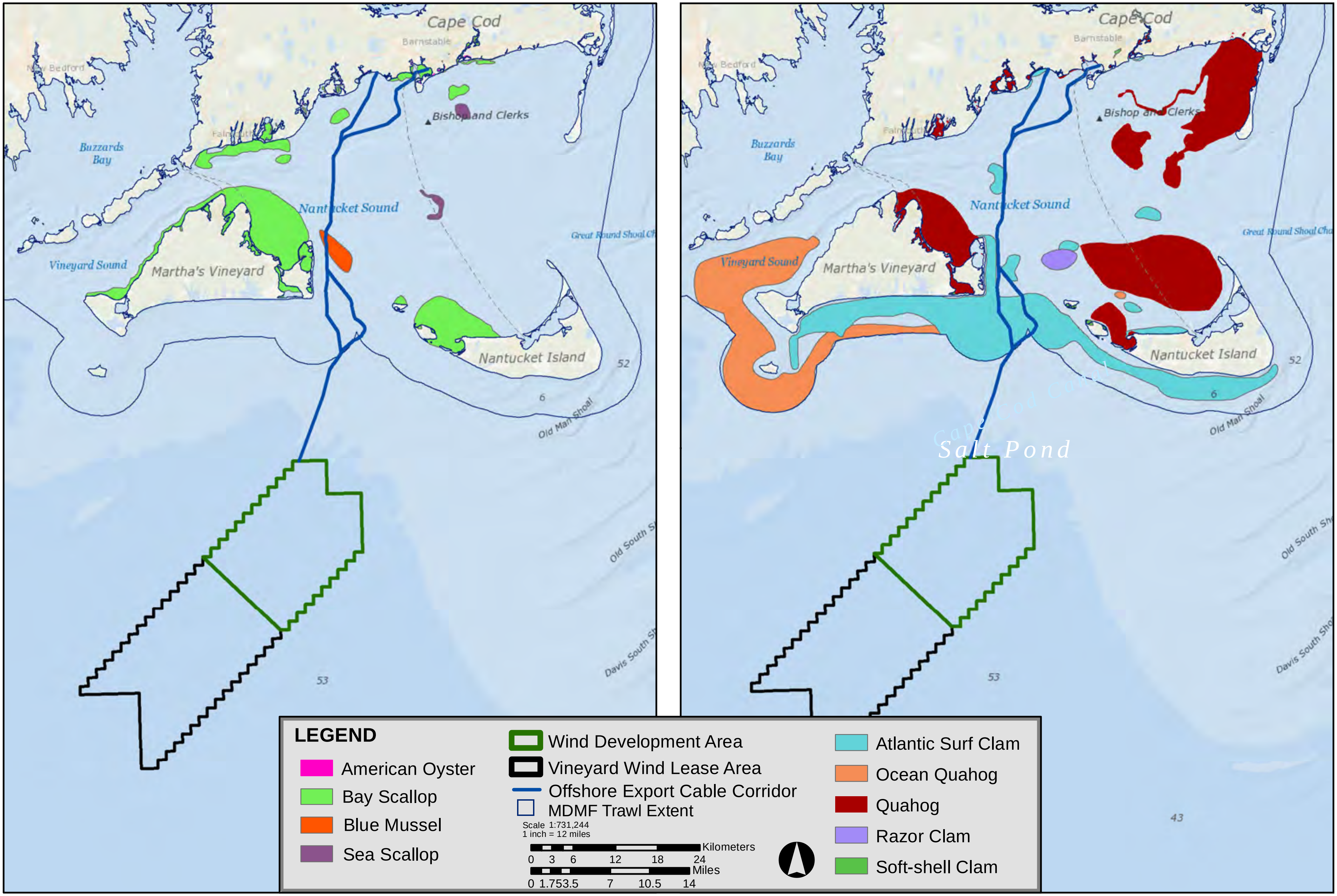

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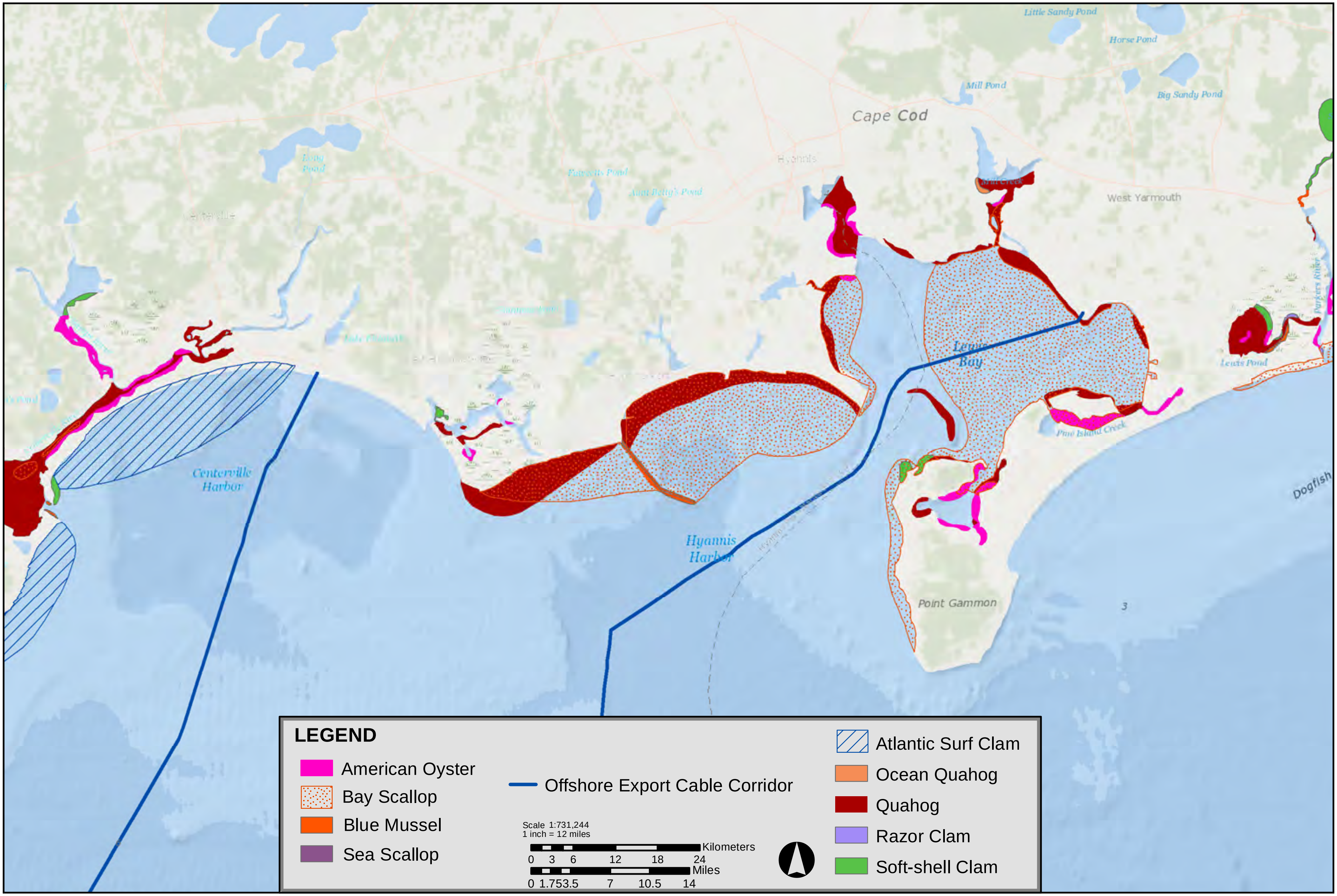
Figure 6.5-9

Suitable Shellfish Habitat Along the Offshore Export Cable Corridor in Massachusetts State Waters Only (NEODP, 2017)



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Vineyard Wind Project

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Figure 6.5-10

Suitable Shellfish Habitat In the Vicinity of the Two Potential Landfall Sites of the Offshore Export Cable Corridor (NEODP, 2017)

In addition to the information provided by the Massachusetts Division of Marine Fisheries, local shellfish constables, commercial fisherman, and maps, and studies as available geospatially within the Northeast Ocean Data Portal ("NEODP"), five separate comprehensive benthic field surveys were conducted from 2001 through 2005 in Nantucket Sound as part of the Cape Wind project development process. The results of these surveys overlap the areas of the OECC.

Between 2001 and 2005, 90 benthic samples were collected from Horseshoe Shoal to Lewis Bay and Popponesset Bay, during a variety of seasons, and analyzed to provide insight into the nature and general characteristics of the benthic communities in the area and allow for characterization of potential effects (USDOE MMS, 2009). Overall, the benthic community composition documented from these surveys is consistent with the results of earlier studies (Pratt, 1973; Sanders, 1956; Theroux and Wigley, 1988; Wigley, 1968), that indicate the Nantucket Sound benthic community has a lower than average invertebrate density when compared with the rest of the southern New England Shelf, even though biomass and density are relatively high (USDOE MMS, 2009). Additionally, there is a high sample-to-sample variability in total invertebrate abundance, which supports conclusions from previous research indicating that the Nantucket Sound benthic community is highly variable from one location to the next and from one season to another. This is likely due to the patchy nature of "microhabitats" related to parameters such as depth, currents, sediment types, availability of food, etc. (Wigley, 1968; USDOE MMS, 2009). Data from these surveys show the microhabitat variable that significantly affects macroinvertebrate abundance is the presence or absence of sand waves.

As described in Section 5.3 and Volume II, bedforms from ripples up to sand waves have been identified locally along the OECC with larger bedforms in deeper waters in which the fast-flowing tidal water masses are located. The sizes of these ripples and sand waves range from two to three meters (6.6-9.8 ft) with a maximum of four meters (13.1 ft) northeast of Muskeget Channel; two to four meters (6.6-13.1 ft) with a maximum of six to seven meters (19.7-22.9 ft) in the Muskeget Channel and vicinity; one to one and half meters (3.3-4.9 ft) with a maximum of five meters (16.4 ft) in the wider Muskeget Region, and one to two meters (3.3-6.6 ft) with a maximum of three to four meters (9.8-13.1 ft) in the Nantucket Sound area. Faunal abundance and composition varies based on where sampling occurs on the sand wave. Fauna tend to be most dense in the trough between sand waves where organic matter accumulates, while mobile species such as amphipods are prevalent on the slope of the sand wave (Jennings et al., 2013; Shepherd, 1983). Previous studies of the species composition within sand waves have found the species present tend to be robust filter feeders, such as mussels and bivalves, as compared to more delicate deposit feeders, such as feather dusters and sea cucumbers, which tend to be found within the more sedimentary areas (Warwick & Uncles, 1980).

6.5.2 Potential Impacts of the Project

The impact-producing factors for benthic resources are provided in Table 6.5-4 and will be discussed in more detail in this section.

Table 6.5-4 Impact-Producing Factors for Benthic Resources

Impact-producing Factors	Wind Development Area	Offshore Export Cable Corridor	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Pile driving for WTG and ESP foundations	X		X		
Cable installation	X	X	X		
Cable maintenance	X	X		X	
Scour protection	X		X	X	
Dredging	X	X	X		X
Geotechnical sampling surveys	X	X	X	X	X
Water withdrawals	X	X	X	X	X
WTG maintenance	X			X	
Use of jack-up barges or anchored vessels	X	X	X	X	x

6.5.2.1 Construction and Installation

6.5.2.1.1 Wind Turbine Generator ("WTG") and Electrical Service Platform ("ESP") Foundation Installation

Wind Development Area

Temporary impacts to the seafloor would be expected in the vicinity of the proposed WTGs and ESPs as a result of the placement of jack-up vessels that will be used for the installation of each WTG and ESP. The impacts from jack-up vessels are quantified in Table 6.5-5; total impacts will be 265,320 m^2 (66 acres), which is 0.09% of the WDA. Soft bottom habitat and benthic fauna, such as the polychaete worms, Oligochaete worms, amphipods, sand dollars, and sea scallops observed in surveys discussed in Section 6.5.1.2, in the direct path of the jack-up barge pads will be crushed and organisms killed. Indirect mortality may occur as disturbed sediments resettle onto nearby areas and smother organisms, as explained below in Section 6.5.2.1.3 Cable Installation.

6.5.2.1.2 Scour Protection and Cable Protection Installation

Wind Development Area

All WTG foundations will have scour protection. Scour protection would involve the use of rock or stone placed around a WTG or ESP foundation. This design may promote deposition of a sand/silt matrix in the interstices of the boulder framework with the eventual burial of all the rock armor (USDOE MMS, 2009). Tidal currents may expose portions of the scour protection at the surface for short periods of time. However, the bi-directional nature of these currents should lead to establishment of a dynamic equilibrium, allowing the average condition of the scour-protected zone to be buried by sand. The scour protection dimensions are provided in Table 3.1-3 and 3.1-4 in Volume I. As listed in Table 6.5-5, the maximum extent of scour protection for WTGs and ESPs is expected to cover an area of 215,000 m^2 (53 acres), or 0.07% of the WDA. Benthic fauna, such as the polychaete worms, Oligochaete worms, amphipods, sand dollars, and sea scallops observed in surveys discussed in Section 6.5.1.2, directly under these scour protection areas will be buried and killed; however, the presence of these structured habitats can also lead to colonization of other organisms.

Since the majority of the WDA is comprised of homogeneous fine sand and silt-sized sediments, the addition of the stone scour protection will alter the nature of the seabed in the immediate vicinity of the Project, thus contributing to higher complexity in the three-dimensional scale. Scour protections have the potential to turn exposed, biodiversity poor soft bottoms into species rich ecosystems (Langhamer, 2012). Under ideal conditions (i.e., sufficient number of larvae and suitable environmental condition), colonization to the areas of scour protection would be by organisms abundant in the water mass or nearby hard bottom habitat. Several examples, such as the Danish Horns Rev, exist in which scour protection has been colonized by species inhabiting rocky substrata, e.g., anemones, crabs, lobsters, barnacles, and sponges (Langhamer, 2012).

There will be bottom disturbance due to cable protection (rock, concrete mattresses, etc.) for cable sections within the WDA that are installed in too shallow of a depth (i.e., when sufficient burial depth cannot be achieved). Based on the parameters provided in Table 6.5-5, which conservatively estimate that up to 10% of the route may require protection, the total area of cable protection for the inter-link cable and inter-array cables would be up to 256,500 m^2 (63 acres) or approximately 0.08% of the WDA.

Offshore Export Cable Corridor

As noted above for the WDA, there will be bottom disturbance due to cable protection for cable sections within the OECC that are installed in too shallow of a depth, or when sufficient depth cannot be achieved. Based on the parameters provided in Table 6.5-5, along the OECC, total area of cable protection for the offshore export cables would be up to 142,200 m^2 (35 acres). Note that the Project's goal is to minimize the extent of cable protection to the greatest extent possible through careful route assessment and selection of the most appropriate cable burial tool for each segment of the cable route; therefore, these values represent worst case scenarios.

6.5.2.1.3 Cable Installation

Wind Development Area and Offshore Export Cable Corridor

As described in Section 4.2.3.3 of Volume I, cable laying for inter-array cables (in the WDA) or offshore export cables (in the OECC) will be done by either jet plowing, mechanical plowing, mechanical trenching, or other techniques. Table 6.5-5 quantifies cable-laying impacts. Within the WDA, inter-array and inter-link cable laying may impact up to 855,000 m^2 (211 acres), which is less than 0.3% of the WDA. Within the OECC, installation of up to two export cables may impact 474,000 m^2 (117 acres).

To facilitate cable installation, anchoring may occur along the OECC. It is currently anticipated that anchoring may occur through Muskeget Channel or in the shallower waters of Lewis Bay near the New Hampshire Avenue Landfall Site, though anchoring may occur at any point along the OECC. Additionally, while anchored vessels will not be used as primary construction and installation vessels within the WDA, there may be potential anchoring within the WDA. Any anchoring that does occur within the WDA will occur within the Area of Potential Effect (APE) defined in Volume II-C. If used, anchored vessels will avoid sensitive seafloor habitats to the greatest extent practicable. The processes of positioning, anchoring, and moving cable installation barges are expected to result in impacts occurring along the paths of cable installation. Anchors would disturb the substrate and leave a temporary irregularity in the seafloor resulting in localized mortality of infauna. In addition, portions of the seafloor would be swept by an anchor cable as the installation equipment moves along the cable. The use of mid-line anchor buoys would minimize potential impacts; however, it would not completely eliminate them. The impacts from anchor use and anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the Project planning stage.

Organisms that may be subject to impacts from anchor line sweep include mollusks such as Soft Shell Clams (*Mya arenaria*), sea scallops, surf clams, whelks, echinoderms, such as sea stars and sand dollars, and sessile species, such as tube dwelling polychaetes or mat forming amphipods, which make up a relatively large portion of the taxa occurring in the area of the proposed action. The level of impact for these organisms could vary seasonally and by species group. For example, the Atlantic Sea Scallop appears to be more abundant within the WDA during the fall months according to NEFSC Seasonal Trawl data (Figure 6.5-5); however, according to the SMAST Video Survey (Table 6.5-1), sand dollars and sea stars may be more prevalent in the spring. Organisms that are mobile, such as certain polychaete species, amphipods, lobsters and crabs may be able to avoid impacts from the anchor line sweep because sediment vibrations would cause avoidance behaviors as the cable laying equipment moves across the seafloor (USDOE MMS, 2009). However, Jonah Crab and Ocean Pout (*Zoarces americanus*) may also be susceptible to impacts if they use the anchor lines as refuge during cable laying disturbance to nearby benthic habitat. Such use will depend upon the length of time the anchoring lines are deployed.

Indirect impacts of cable installation include water withdrawals for jetting or jet plowing and resettlement of sediments. Water withdrawals for the jet plow entrain planktonic larvae of benthic species and result in 100% mortality of the entrained organisms because of the stresses associated with being flushed through the pump system (DOE MMS, 2009). Assuming that 90% of the offshore cable system is installed at a rate of 200 m/hr (656 ft/hr), 10% of the cable system is installed at a rate of 300 m/hr (984 ft/hr), and a jet plow uses 11,300 – 30,300 liters per minute (3,000 – 8,000 gallons per minute) of water, water withdrawal volumes are expected to be approximately 1,700 – 4,540 million liters (450 – 1,200 million gallons). In addition, the resettlement of sediments disturbed during cable installation may smother and cause mortality of benthic fauna in nearby areas.

Taxonomic groups react differently and have varying levels of tolerance for sedimentation, with sessile and attached organisms having the lowest tolerance and highest mortality rate during sedimentation events (Gates & Jones 2012; Wilber et al., 2005). Benthic suspension feeders are also particularly sensitive to deposition because suspended particles can remain suspended in the water column for weeks and interfere with feeding and growth (Smit et al., 2008; Wilber et al., 2005). For example, in the WDA, attached/sessile organisms, such as sea squirts, will likely be the most sensitive to burial, as these taxa are immobile filter feeders. However, some attached bivalve species, such as mussels and oysters, have survived deposition levels of several millimeters ("mm") (Wilber et al., 2005). Organisms that burrow or feed in subsurface sediments, such as sand dollars which are prevalent within the WDA, will likely be less sensitive to burial as they can unbury themselves.

Suspended sediment impacts increase as a function of sediment concentration and duration of exposure, or dose (the product of concentration and exposure time) (Newcombe & Jensen, 1996). Historically, the effects of suspended sediment on marine and estuarine organisms were viewed only as a function of concentrations (Wilber & Clarke, 2001). Therefore, in most experimental studies, concentration was used as the sole variable of interest, and exposure durations were not varied, or in some cases not reported (LaSalle et al., 1991; Sherk & Cronin, 1970; Wilber & Clarke, 2001). However, exposure duration has since been recognized as an important factor, and has been included in most experiments (Newcombe & MacDonald, 1991; Wilber & Clarke, 2001). For benthic organisms, the minimum effects threshold (i.e., the level at which life stages of organisms may be negatively affected either sublethally or lethally) varies by organism group and life stage. The minimum effects threshold for suspended sediment within the water column for mollusk eggs is assumed to be 200 mg/L for 12 hours, as this is the concentration and duration at which sublethal effects were observed to the development of Eastern oyster eggs (Cake, 1983; Wilber and Clarke, 2001). On the other hand, the minimum effects threshold for mollusk juveniles and adults and all stages (egg, larvae and juveniles/adults) of crustaceans is assumed to be 100 mg/L for 1 day based on sublethal effects (i.e., reduced growth and reduced respiration) observed in northern quahog (Murphy, 1985; Turner and Miller, 1991; Wilber and Clarke, 2001) and copepods and euphausiids (Anderson and Mackas, 1986), respectively. For other invertebrates, such as worms, the minimum effects threshold is assumed to be 650 mg/L[16] (Read et al. 1982, 1983; Rayment, 2002). For coral, the minimum effects thresholds are 50 mg/L for 24 hours for eggs (causing prevented fertilization), 10 mg/L for 24 hours for larvae (altering larval settlement) and 25 mg/L for 24 hours for adults (causing reduced calcification rate; Rogers, 1990; Gilmour, 1999; Fabricius, 2005; Erftemeijer et al. 2012).

Modeling of sediment and transport potential in the WDA (see Appendix III-A) indicate that under typical cable installation methods, the maximum anticipated suspended sediment concentrations that persisted for at least 60 minutes would be greater than 200 milligrams per liter ("mg/L") but less than 300 mg/L and would occur in <0.02 km^2 (5 acres). These concentrations would drop rapidly and would be below 50 mg/L after two hours. Concentrations of suspended sediments with lower concentrations (10 mg/L) would extend up to 3.1 km (1.2 mi) from the inter-array cable centerline and be suspended at any given location for less than six hours. Therefore, these concentrations and durations of exposure are below those causing sublethal or lethal effects to benthic organisms.

Installation along the OECC requires additional pre-installation sediment removal to remove sand waves and achieve safe burial depths; as described in Appendix III-A, this will likely be accomplished with a trailing suction hopper dredge (TSHD) on its own or through a combination of a TSHD and a jetting technique. Sediment dispersion modeling of sand wave removal via TSHD along the OECC indicated that concentrations of suspended sediments above 10 mg/L extended up to 16 km (10 mi) from the cable trench centerline. Most of the sediment settles out in less than three hours; however, suspended sediments at this concentration can persist for six-twelve hours in smaller areas (0.06 km^2 [15 acres]). In addition, high concentrations (>1000 mg/L) occurred at distances up to 5 km (3.1 mi) from the dredge dumping site for short periods of time (less than two hours) due to the TSHD overflow and hopper dumping of sediments. After removing sand waves, a jet plow, mechanical plow, or one of the other techniques listed in Section 4.2.3.3 of Volume I will be used to install cables. The plume from jet plow installation as delineated by excess suspended sediment concentrations greater than 10 mg/L typically extended less than 200 m (656 ft) from the route centerline, though did extend up to 2 km (1.2 mi) in some

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[16] For worms, no exposure time was indicated, but they are able to tolerate a large range of suspended sediments, as they inhabit areas of high TSS concentrations.

places. Further, the excess concentrations were confined to the lower portion of the water column, and resettled rapidly (within four-six hours) due to the high proportion of coarse sand throughout the route (see Appendix III-A). Therefore, these concentrations and durations of exposure are below those causing sublethal or lethal effects to benthic organisms.

Sediment deposition may also impact benthic organisms. Two thresholds of concern have been identified: one for demersal eggs and one for shellfish. The most sensitive lifestage of those analyzed for the Project is demersal eggs. For demersal eggs (fish [e.g., Atlantic Wolffish (*Anarhichas lupus)*, Atlantic Herring, and Winter Flounder], squid [e.g., Longfin Inshore Squid (*Doryteuthis pealeii*)]), and and whelk species), deposition greater than one millimeter ("mm") can result in the burial and mortality of that life stage (Berry et al., 2011). Although the early lifestages of some warm, shallow water coral species can be sensitive to deposition levels of 0.2 mm (0.008 in), the coral species observed in Project waters, Star Coral [*Astrangia poculata*], is a cold-water species that is less sensitive to sedimentation (Peters and Pilson, 1985; Erftemeijer et al. 2012). In addition, cold-water corals tend to form in areas with strong bottom currents, which keep corals free of sediment and prevent local deposition (Freiwald et al., 2004; Rogers, 2004). Therefore, greater than one mm of deposition is the lowest threshold of concern for the Project.

For shellfish, reported thresholds for the lethal burial depths of bivalves vary among species, but currently it is understood that the most sensitive species are those that are sessile or surface-oriented, such as blue mussel (*Mytilus edulis*), soft-shell clam (*Mya arenaria*), and oysters (*Ostrea* spp.; Essink 1999). One of the more comprehensive studies available is an early lab and field experiment of the effect of sudden burial on 25 species of bivalves from eight different "life habit types" defined by habitat (infaunal, epifaunal), feeding method (suspension, deposit), and burrowing behavior (Kranz 1974). The author determined that epibenthic suspension-feeders that use byssal attachments (i.e., lack a digging foot) are less capable of escaping deposition via traveling through the sediment, while many deposit feeder mollusks (e.g., *Macoma* clams and others within the Tellinacea or Nuculacea superfamilies) and infaunal mucus tube feeders (e.g., Lucinidae family bivalves) can escape burial thicknesses in native sediment up to 400 mm by rapidly burrowing and/or better tolerating anoxic conditions (Kranz 1974).

In a recent mesocosm experiment by Colden and Lipcius (2015), the authors concluded that oysters are highly tolerant to short-term partial and shallow total burial. The study determined that adult oyster survival declined significantly only when 90% of more of the oyster (as measured relative to total shell height) was buried for 28 days. The authors concluded that the overall low mortality rates in their study for durations less than 28 days indicated that oysters are highly tolerant to partial and shallow total burial on weekly time scales. They also found that increased mortality occured at burial depths of 108% shell height, which for oysters with shell heights between 25 – 90 mm in size would occur at burials of 27 – 97 mm.

Most subtidal shellfish in the genera Ostrea (oysters), Mytilus (mussels), Petricola (Venus clams), Chlamys (scallops) displayed lethal responses to deposition of either fine sand or mud at thicknesses greater 50 mm, with oysters and mussels sensitive to around 20 mm of deposition; while some less sensitive bivalves did not display a lethal response until sedimentation reached thicknesses of 200 – 500 mm (Essink 1999). Conclusions regarding burial thresholds for individual species that can be drawn from the literature cited in the Essink (1999) study are somewhat limited because the studies did not always define "sensitive" or explain the level of effects (i.e., lethal vs. sublethal). For community-level effects, Essink (1999) reported that after the dumping of dredged materials, decreases in species richness and abundance of major species in the benthic community were greatest in areas where the thicknesses of deposited sediments were > 300 mm.

Several studies have indicated that many benthic species can tolerate deposition by coarser sediment sizes more than finer mud/silt sediment sizes and by sediments more similar to their native sediment type than by sediments of very different grain size (Kranz 1974, Essink 1999). However, burial tolerance thresholds are difficult to generalize as they are highly species-specific as well as substrate-specific. For example, large percentages of Gemma gemma, a species of Venus clam, can cope with 230 mm thick burial by sand or a 57 mm thick burial by silt for up to 6 days (Shulenberger 1970, as cited in Kranz 1974). Meanwhile, Venus clams in the genus Petricola appear unable to survive burial of either sediment type greater than 50 mm (Essink 1999).

Research into the survival of Queen scallops (Aequipecten opercularis) to sedimentation indicated depth of burial and sediment type significantly affected emergence ability and therefore survival of individuals (Hendrick et al. 2016). The highest emergence and survival rates for Queen scallops occurred with burials of coarse sediment that were less than 20 mm (0.8 in) deep while the highest mortality occurred with fine sediment at depths of 70 mm (Hendrick et al. 2016). Mortality increased with duration of burial; however, scallops can be highly mobile and may escape burial by rapidly opening and closing their shells to jettison water, unless deposition is very sudden and deep. Similarly, other mobile benthic species such as lobsters, crabs, and demersal fish would be temporarily displaced by sedimentation events, but would likely be able to avoid burial. For example, Dungeness crab (Cancer magister) are able to survive burial depths over 120 mm (5 in) through escape responses and other adaptive behaviors (Vavrinec et al. 2007).

While the literature has shown sensitivity of bivalves to sedimentation varies greatly among species and can range up to several hundred mm of deposition, a sedimentation threshold of 20 mm was used as the general threshold for shellfish. This threshold is inclusive of most shellfish and life stages, including more sensitive subtidal mussel and oyster beds, and is conservatively based on the work of Colden and Lipcius (2015), Essink (1999), and Hendrick et al. (2016). While Kranz (1974) reported an escape potential thickness of 0 cm for the group of attached epifauna least capable of burrowing through sediment, he also noted that mussels can withstand burial for several months, so the escape potential thickness is not synonymous with a sedimentation tolerance threshold. Therefore, while attached shellfish may be unable to escape burial by burrowing up to the sediment surface similar to other bivalve groups (Kranz 1975), they have other adaptive responses that enable survival under sedimentation. For example, oysters can clear themselves of sediment (Wilber and Clarke 2010) and partial burial can lead to increased shell growth rates in order to reach the sediment surface (Colden and Lupcius 2015). Thus, based on these findings and on the wide range of sedimentation thicknesses and durations tolerated by bivalves in general, a 20 mm threshold is a reasonably conservative threshold for assessment of impacts. In addition, sedimentation in the Project area will be subject to currents and tidal flushing over time that may remove sediment before it can affect benthic organisms.

Simulations of typical cable installation methods (without sand wave removal) in the WDA and OECC indicate that deposition of 1 mm (0.04 in) or greater (i.e., the threshold of concern for demersal eggs) were primarily constrained to within 80 m (262 ft) up to 100 m (328 ft) from the route centerline (see Appendix III-A). In areas along the OECC where sand wave dredging was simulated to have occurred, the deposition greater than 1 mm (0.04 in) associated with the TSHD drag arm is mainly constrained to within 80 m (262 ft) from the route centerline, whereas the deposition greater than 1 mm (0.04 in) associated with overflow and disposal extends to greater distances from the source, mainly within 1 km (0.62 mi), though such deposition can extend up to 2.3 km (1.43 mi) in isolated patches when subject to swift currents through Muskeget Channel. However, specifically in relation to potential impacts to beds of shellfish along the complete route of the OECC, the sediment dispersion modeling (see Appendix III-A) results indicate that there will be minimal areas of deposition greater than 5 mm (0.20 in) for cable installation activities and none above 10 mm (0.39 in); therefore, cable installation is not anticipated to affect shellfish. For dredging and disposal activities, which only occur along the OECC and not in the WDA, the largest area of seafloor to be affected by 20 mm (0.79 in) of deposition would be within an area of 0.14 km^2 (34.6 acres).

Recolonization and recovery to pre-construction species assemblages is expected given the similarity of nearby habitat and species. Nearby, unimpacted areas will likely act as refuge areas and supply a brood stock of species, which will begin recolonizing disturbed areas post-construction. Recovery timeframes and rates in a specific area depend on disturbance, sediment type, local hydrodynamics, and nearby species virility (Dernie et al., 2003). Previous research conducted on benthic community recovery after disturbance found that recovery to pre-construction biomass and diversity values took two to four years (Van Dalfsen & Essink, 2001). Other studies have observed differences in recovery rates based on sediment type, with sandy areas recovering more quickly (within 100 days of disturbance) than muddy/sand areas (Dernie et al., 2003).

Operational offshore wind farms in Europe provide insight into potential impacts to the benthic environment. A report for the Barrow offshore wind farm located in the eastern Irish Sea describes post-construction monitoring after the farm became operational in July 2006 (BOWind, 2008). Bathymetry remained consistent between pre- and post-construction surveys, except for remnants of inter-array cable installation and localized scour around some of the individual monopiles ranging from one m (three feet [ft]) – six m (20 ft) deep that increased horizontally over time. Changes in benthic communities did occur, with main differences due to high numbers of *Ophiura* (Large Brittle Star) present post-construction versus more frequent occurrence of *Nephtys* (Cat Worm) and higher abundance of *Amphirua* (Brittle Star) pre-construction. There was also higher abundance and diversity of intertidal species in post-construction surveys. These changes correspond with differences in sediment grain size to coarser sediment post-construction; however, these changes may be due to natural fluctuation in the area as changes were also observed over time pre-construction and at reference sites unlikely to be affected by construction (BOWind, 2008). Similarly, monitoring along the export cable route for the North Hoyle offshore wind farm in Wales determined that sediment deposition, grain size, and benthic community changes to be within the natural variation at the site (English et al., 2017; NWP Offshore Ltd, 2007).

A comprehensive BOEM review of several monitoring reports from European offshore wind construction noted that changes in subtidal benthic habitat and communities were recorded to some extent, but were not attributed to wind farm development due to high environmental variability and insufficient evidence to link cause and effect (English et al., 2017). Monitoring programs in Belgium indicate that the main effects are due to infrastructure modifying sediment and benthic communities around the turbines due to scour, sediment enrichment, and artificial reef effects; but effects remain localized within 50 m (164 ft) of turbines and thus are minor or negligible (English et al., 2017).

6.5.2.1.4 Dredging

Offshore Export Cable Corridor

At isolated locations where large sand waves exhibit greater than 1.5 m (4.9 ft) of relief above the bedform troughs to either side, dredging of the top portion of the sand wave may be necessary to allow the cable installation tool to reach the stable sediment layer under the base of the mobile sand unit/habitat. Pre-dredging for cable installation along the OECC may impact up to 279,400 m^2 (69 acres). Benthic organisms can be affected during the dredging activities required for cable laying activities in areas of sand waves. The effects are a consequence of the physical acts of dredging and the resulting mobilization and subsequent settling of sediments. The dredging techniques under consideration are described in Section 4.2.3.3.2 of Volume I.

Dredging directly impacts organisms in the footprint of the dredging activity (i.e., stationary benthic communities). This includes polychaete worms, amphipods, and shellfish that live in the sediment, and the more motile benthic organisms (e.g., crustaceans), which are unable to escape the dredge, or find suitable unoccupied refuge. Additionally, if a TSHD is used, periodic bottom dumping of sediments will occur within the OECC and there may be temporary areas of accumulated sediments. (At this stage of Project planning, these areas are not quantified separately.) Outside the footprint of the dredging and disposal, impacts may be caused by remobilized and resettled sediments. Although many benthic organisms have developed behavioral and physiological mechanisms to deal with the resuspension of sediments that often follows natural events (i.e., storms, tidal flows, and currents), the scope, timing, duration, and intensity of dredging-related suspended sediment plumes may create an environment that resident and transient species are not able to tolerate. Sedimentation from suspended sediments can bury benthic organisms, and can clog the gills and/or filter feeding apparatus of infaunal invertebrates (USACOE, 2001). The results of the sediment dispersion modeling for dredging and cable installation are provided in Appendix III-A, and, for ease of discussion, are summarized above with the cable installation impacts in Section 6.5.2.1.3.

Table 6.5-5 Vineyard Wind Maximum Area of Seafloor Impacts

BOTTOM DISTURBANCE DUE TO ROCK OR STRUCTURES								
Foundations and Scour Protection	Maximum Number WTG/ESP Foundations		Max Area of Scour Protection per Foundation (m^2)		Total Area of Scour Protection			
					m^2	ft^2	km^2	acres
WTG Foundations and Scour Protection	100		2,100		210,000	2,260,419	0.21	52
ESP Foundations and Scour Protection	2		2,500		5,000	53,820	0.01	1
Cable Protection for Cable Section Installed Too Shallow	Maximum Length of Cable (m)	Percentage of Cable Too Shallow	Length of Cable to be Protected (m)	Width of Scour Protection (m)	Total Area of Cable Protection			
					m^2	ft^2	km^2	acres
Export Cables	158,000	0.1	15,800	9	142,200	1,530,627	0.14	35
Inter-link Cable	10,000	0.1	1,000	9	9,000	96,875	0.01	2
Inter-array Cables	275,000	0.1	27,500	9	247,500	2,664,065	0.25	61
					TOTAL SCOUR + CABLE PROTECTION			
					m^2	ft^2	km^2	acres
TOTAL SCOUR PROTECTION + CABLE PROTECTION IN THE WIND DEVELOPMENT AREA					**471,500**	**5,075,179**	**0.47**	**117**
TOTAL CABLE PROTECTION ALONG THE OFFSHORE EXPORT CABLE CORRIDOR					**142,200**	**1,530,627**	**0.14**	**35**
BOTTOM DISTURBANCE DUE TO CABLE INSTALLATION, JACK-UP VESSELS, AND DREDGING								
Cable Installation	Maximum Number (No.) of Trenches	Max Length of Cable[1] (m)	Trench Width (m)	Skid/track Width (m)	Total Area of Cable Installation Disturbance			
					m^2	ft^2	km^2	acres
Export Cables	2	158,000	1	2	474,000	5,102,089	0.47	117
Inter-link Cable	1	10,000	1	2	30,000	322,917	0.03	7
Inter-array Cables	N/A	275,000	1	2	825,000	8,880,218	0.83	204
TOTAL					**1,329,000**	**14,305,223**	**1.33**	**328**
Jack-up Vessels	No. of Jack-up Legs	Area Impacted by Each Leg (m^2)	No. of Jack-ups per WTG/ESP	Max No. of WTGs/ESPs	Total Area of Jack-up Disturbance			
					m^2	ft^2	km^2	acres
WTG Installation	4	165	4	100	264,000	2,841,670	0.26	65
ESP Installation	4	165	1	2	1,320	14,208	0.00	0.3
TOTAL					**265,320**	**2,855,878**	**0.27**	**66**
Dredging	Corridor Where Maximum Dredging Occurs		Max Length of Dredging (m)	Width (m)	Total Area of Dredging Disturbance[2]			
					m^2	ft^2	km^2	acres
Dredging Prior to Cable Install	Western Corridor West thru Muskeget to New Hampshire Ave.		N/A	N/A	279,400	3,007,434	0.28	69
					TOTAL CABLE INSTALL + DREDGING +JACK-UP			
					m^2	ft^2	km^2	acres
TOTAL CABLE INSTALL + JACK-UP IMPACT IN THE WIND DEVELOPMENT AREA					**1,120,320**	**12,059,012**	**1.12**	**277**
TOTAL CABLE INSTALL + DREDGING ALONG THE OFFSHORE EXPORT CABLE CORRIDOR					**753,400**	**8,109,522**	**0.75**	**186**

Notes

1. Maximum length for export cable includes length for two export cables.
2. To avoid double-counting impacts, the total area of dredging disturbance does <u>not</u> include a two-meter-wide-export cable installation corridor. Dredging volume and area are for two cables.
3. Vertical extent of impacts is presented in Appendix II-C.

In general, dredging of material from the top of the bedforms in a limited swath along the OECC is anticipated to have limited impact to the benthic habitat. This is due to the mobility of the surficial sand layer which migrates daily with the tidal currents, and the fact that the surrounding area is mostly homogeneous sand bottom habitat. There will be an evolution of the disturbed bedform back to its original morphology over time dependent upon the tidal forces and resulting sand migration rates for that specific location (Roos and Hulscher, 2003; Lichtman et al., 2018).

6.5.2.1.5 Avoidance, Minimization, and Mitigation Measures

Several mitigation measures will be employed to avoid and minimize potential impacts to benthic resources within the WDA and OECC. One of the most important measures is that the MA WEA has been sited to avoid the most sensitive areas for benthic and other resources. Other measures include the following:

- Utilize widely-spaced WTGs, so that the foundations (and associated scour protection) for the WTGs, along with the ESPs, inter-link cables, and inter-array cables, only occupy a minimal portion of the WDA, leaving a huge portion of the WDA undisturbed.
- Conduct post-construction monitoring to document habitat disturbance and recovery (see Benthic Habitat Monitoring Plan in Appendix III-D).
- Where feasible and considered safe, use mid-line buoys on anchor lines to minimize impacts from anchor line sweep.
- As described in Section 4.2.3.8 of Volume I, horizontal directional drilling ("HDD") will be used to minimize impacts to benthic habitat at the Covell's Beach Landfall Site, unless future site investigations determine that HDD is technically infeasible. At the New Hampshire Landfall Site, HDD or a conventional trench will be used.

6.5.2.1.6 Summary of Impacts

In summary, impacts to benthic habitat due to installation of WTG and ESP foundations is expected to result in short-term loss of habitat within a localized area, such that population level impacts are unlikely. Potential impacts will be minimized or offset through the use of scour protection.

While mortality of benthic organisms is expected in the location of the WDA where temporary disturbance of the seafloor would occur due to cable and foundation installation, the impacts are expected to be localized and unlikely at the population level due to the following factors:

1) The surrounding vicinity of the proposed Project has an abundant area of similar habitat type;

2) The portion of the WDA that will be disturbed is relatively small (the total area of alteration within the WDA due to foundation and scour protection installation, jack-up vessel use, inter-array and inter-link cable installation, and potential cable protection installation is 1.59 km^2 [393 acres], which is 0.5% of the entire WDA), given the size of adjacent similar habitat; and

3) The sandy bottom community typical to the area has adapted to frequent natural sediment movement that already creates temporary impacts. Previous scientific research indicates that certain benthic invertebrate species will opportunistically invade substrate areas that are unoccupied once disturbances have occurred (Howes et al. 1997; Rhoads et al. 1978; Rosenberg & Resh, 1993; USDOE MMS, 2009).

Overall, impacts from the alteration of habitat in the WDA and along the OECC are expected to be minimal and recovery of natural assemblages likely.

6.5.2.2 Operations and Maintenance

The possible activities associated with the operation and maintenance activities over the lifetime of the Project that could have an effect on benthic resources include scour protection installation, cable maintenance or repair (including associated dredging, if required), geotechnical sampling surveys, WTG maintenance, use of anchored vessels, and use of jack-up barges (if required for repairs).

6.5.2.2.1 WTG and ESP Foundations

Wind Development Area

The installation of WTGs and ESPs in the WDA introduces structures that would be a source of new hard substrate with vertical orientation, and these structures would be present for the entire time of operation of the proposed action. Since Horseshoe Shoal and Nantucket Sound have limited amounts of this type of habitat, this would be considered a direct impact of operation. Organisms that may settle on the wind turbine towers could include algae, sponges, tunicates, anemones, hydroids, bryozoans, barnacles, and mussels. These organisms are known to occur on other hard substrate areas in Nantucket Sound including substrates such as navigation buoys or pier pilings. Organisms including polychaetes, oligochaetes, nematodes, nudibranchs, gastropods, and crabs are expected to be present on or near the towers as growth of fouling organisms develops.

A 2005 Macroinvertebrate Survey of the Meteorological Tower (ESS Group, 2006) indicated that a benthic macroinvertebrate community similar to the surrounding sea floor community had colonized the support pilings. It was noted that these new taxa were likely to be in the site of the proposed action, but would be expected to inhabit hard substrates such as rocky shoals or boulders (ESS Group, 2006). Therefore, it is expected that the piling would support more taxa because they may attract organisms from both sandy substrate habitats and those that would be attracted to fixed structures. Impacts due to the scour protection will be as discussed above under Construction and Installation.

The presence of the ESP and pilings may affect the soft-bottom benthic invertebrate communities in its immediate vicinity due to shading. However, these possible effects would be dependent upon the approximate height of the structure above the water and the fact that the shadow from the structure would move rapidly across the seafloor during daylight hours.

6.5.2.2.2 Cable Maintenance

Wind Development Area and Offshore Export Cable Corridor

Impacts associated with cable repair would include a temporary increase in turbidity and some localized deposition of sediment during the repair process. The increase in turbidity would be caused by the removal of sediments to uncover the damaged portion of the cable, hoisting of the cable after it is cut, laying the cable back down, and then jetting or otherwise removing sediments for reburial of the repaired cable. Temporary impacts would also occur in the area where anchors are deployed or anchor cable sweeps the bottom.

6.5.2.2.3 Other Impacts

Wind Development Area and Offshore Export Cable Corridor

Benthic sampling is to be conducted in WDA and OECC before and after Project construction. The Benthic Habitat Monitoring Plan (see Appendix III-D) provides the specific details of this sampling. Other geotechnical or geophysical surveys may also occur, which may have highly localized impacts to benthic organisms.

Anchoring of Crew Transfer Vehicles or other accommodation vessels may occur within the WDA during normal operations. If repair work is required, both anchoring (within the WDA or along the OECC) and the use of jack-up vessels (within the WDA) may occur.

The impacts of electromagnetic fields (“EMF”) on marine organisms are unclear. Although there is no evidence of negative impacts on benthic fauna, little is known of the abilities of benthic fauna to sense EMF (Normandeau et al., 2011). The electrosensitive invertebrate species, such as sea slugs and sea urchins, that have thus far identified have sensitivity thresholds above the modeled level of induced electric fields from undersea cables (Normandeau et al., 2011), and are therefore not expected to be impacted by those fields. As is the case with fish (discussed in more detail in Section 6.6), invertebrate species that use the geomagnetic field to guide their movements through an area with an undersea cable may be confused as they encounter the magnetic field from the cable (Gill and Kimber, 2005). The species could change their direction of travel or alter their homing capabilities if they rely on a magnetic sense for these actions; however, these potential effects above the threshold known to cause an effect would be restricted within the close proximity of certain cable systems (Normandeau et al., 2011). Modeling of EMF from Project-specific submarine cables indicated magnetic fields from both AC and DC cables would be much lower than the Earth's magnetic field and likely only able to be sensed, if at all, directly over the cable centerline (Gradient, 2017). Modeling also confirmed that EMF from cables decreases with distance and therefore, because cables in the WDA and OECC will be buried below approximately 2 m (6.6 ft) of sediment, it is unlikely that benthic organisms will be impacted by EMF produced by the cables in Project Area.

6.5.2.2.4 Avoidance, Minimization, and Mitigation Measures

The mitigation measures would be the same as discussed previously for construction and installation. However, there will be no HDD occurring during operation and maintenance activities.

6.5.2.2.5 Summary of Impacts

Impacts to benthic resources due to the introduction of WTGs and ESPs as structured habitat will be direct, long-term (over the operation lifetime of the Project), and localized. It is possible the pilings will support more taxa than the surrounding primarily homogenous sand habitats. Impacts due to the scour protection will be as discussed above under Construction and Installation.

Impacts to benthic resources as a result of cable repair or vessel anchoring would be anticipated to be short-term and localized to a very small area of the seafloor.

Impacts to benthic resources from EMF are expected to be unlikely and mitigated by cable burial.

6.5.2.3 Decommissioning

6.5.2.3.1 Overall Impacts

Wind Development Area and Offshore Export Cable Corridor

The removal of the WTG and ESP foundations would result in a local shift in the habitat from being structure-oriented to the original type of habitat present prior to installation of the proposed action. Therefore, this would be a return to pre-construction conditions. The decommissioning activities would also include potential removal of the export cables, the network of inter-array cables, and the inter-link cable. This action would result in temporary resuspension of bottom sediments along each cable path, and the anchor line impacts associated with any required vessel anchoring would be similar to those previously described for the construction phase of the Project.

6.5.2.3.2 Avoidance, Minimization, and Mitigation Measures

The avoidance, minimization, and mitigation measures would be the same as discussed previously for Construction and Installation.

6.6 Finfish and Invertebrates

This section describes finfish and invertebrate resources in the Project Area. Essential Fish Habitat ("EFH") is discussed in Appendix III-F.

6.6.1 Description of the Affected Environment

The Project Area is located within southern New England. Specifically, the Wind Development Area ("WDA") is located south of Martha's Vineyard in the northern Mid-Atlantic Bight of the Northeast US Shelf Ecosystem. The Offshore Export Cable Corridor ("OECC") extends from the WDA, through Muskeget Channel, to landfall in south-central Cape Cod. This region has a very diverse and abundant fish assemblage that is generally categorized according to life habits or preferred habitat associations, such as pelagic, demersal, and highly migratory.

This discussion of finfish and invertebrates is based on the review of existing literature. Existing data support characterization of distribution, abundance, and composition of fish species within the area potentially affected by Project activities. The most relevant data sources are the Northeast Fisheries Science Center multispecies bottom trawl surveys, the Massachusetts Department of Marine Fisheries Trawl surveys, the Northeast Ocean Data Portal, the School of Marine Science and Technology ("SMAST") Survey of the WDA (2012, 2013), and the BOEM Environmental Assessment ("EA"). Additional studies that contribute to the available fisheries information in the region of southern New England include but are not limited to:

- Southern New England Industry-Based Yellowtail Flounder Survey (2003-2005), and
- Northeast Area Monitoring and Assessment Program ("NEAMAP").

A list of major fish assemblages is presented in Table 6.6-1 and described in more detail below. Additional information, including Federal listing, presence of EFH in the Project Area, habitat association, and fishery importance, is also noted in the table.

Table 6.6-1 Major Fish and Invertebrate Species Potentially Occurring in the Project Area (BOEM, 2014)

Species	EFH	Listing Status	Commercial / Recreational Importance	Habitat Association
Acadian Redfish (*Sebastes fasciatus*)			●	Demersal
Alewife (*Alosa pseudoharengus*)		C/S	●	Pelagic
American Lobster (*Homarus americanus*)			●	Benthic
American Sand Lance (*Ammodytes americanus*)			●	Demersal
Atlantic Albacore Tuna (*Thunnus alalonga)*	●		●	Pelagic
Atlantic Bluefin Tuna (*Thunnus thynnus*)	●	S	●	Pelagic
Atlantic Butterfish (*Peprilus triacanthus*)	●		●	Demersal / Pelagic
Atlantic Cod (*Gadus morhua*)	●		●	Demersal
Atlantic Mackerel (*Scomber scombrus*)	●		●	Pelagic
Atlantic Sea Herring (*Clupea harengus*)	●		●	Pelagic
Atlantic Sea Scallop (*Placopecten magellanicus*)			●	Benthic
Atlantic Surf Clam (*Spisula solidissima*)	●		●	Benthic
Atlantic Yellowfin Tuna (*Thunnus albacares*)	●		●	Pelagic
Basking Shark (*Cetorhinus maximus*)	●	C		Pelagic
Bay Scallops (*Argopecten irradians*)			●	Benthic
Beardfish (*Polymixia lowei*)				Demersal
Black Sea Bass (*Centropristis striata*)	●		●	Demersal
Blue Mussels (*Mytilus edulis*)			●	Benthic
Blue Shark (*Prionace glauca*)	●			Pelagic
Bluefin Tuna (*Thunnus thynnus*)			●	Pelagic
Bluefish (*Pomatomus saltatrix*)	●		●	Pelagic
Channeled Whelk (*Busycotypus canaliculatus*)			●	Benthic
Cobia (*Rachycentron canadum*)	●			Pelagic
Common Thresher Shark (*Alopias vulpinus*)	●			Pelagic
Dusky Shark (*Carcharhinus obscurus*)	●	S		Pelagic
Fourspot Flounder (*Hippoglossina oblonga*)			●	Demersal
Golden Tilefish (*Lopholatilus chamaeleonticeps*)			●	Demersal
Haddock (*Melanogrammus aeglefinus*)	●		●	Demersal
Horseshoe Crab (*Limulus Polyphemus)*			●	Benthic
Jonah Crab (*Cancer borealis*)			●	Benthic
King Mackerel (*Scomberomorus cavalla*)	●			Pelagic
Knobbed Whelk (*Busycon carica*)			●	Benthic
Lightning Whelk (*Busycon contrarium*)			●	Benthic
Little Skate (*Leucoraja erinacea*)			●	Demersal
Long-Finned Squid (*Loligo pealeii*),	●		●	Pelagic
Monkfish (*Lophius americanus*)	●		●	Demersal
Northern Quahog (*Mercenaria mercenaria*)			●	Benthic
Northern Sand Lance (*Ammodytes dubius*)			●	Demersal
Northern Sea Robin (*Prionotus carolinus*)			●	Demersal
Ocean Pout (*Macrozoarces americanus*)	●			Demersal
Ocean Quahog *(Artica islandica)*	●		●	Benthic
Pollock (*Pollachius pollachius*)			●	Demersal
Porbeagle Shark (*Lamna nasus*)	●	S		Pelagic
Red Hake (*Urophycis chuss*)	●		●	Demersal
Round Herring (*Etrumeus teres*)			●	Pelagic
Sand Tiger Shark *(Carcharias taurus)*	●	S		Pelagic
Sandbar Shark (*Carcharhinus plumbeus*)	●			Pelagic

Table 6.6-1 Major Fish and Invertebrate Species Potentially Occurring in the Project Area (BOEM, 2014) (Continued)

Species	EFH	Listing Status	Commercial / Recreational Importance	Habitat Association
Scup (*Stenotomus chrysops*)	●		●	Demersal/ Pelagic
Shortfin Mako (*Isurus oxyrinchus*)	●		●	Pelagic
Short-Finned Squid (*Illex illecebrosus*)	●		●	Pelagic
Shortnose Greeneye (*Chlorophthalmus agassizi*)				Demersal
Silver Hake (*Merluccius bilinearis*)			●	Demersal
Spanish Mackerel (*Scomberomorus maculatus*)	●			Pelagic
Spiny Dogfish (*Squalus acanthias*)	●		●	Demersal
Striped Bass (*Morone saxatilis*)			●	Pelagic
Summer Flounder (*Paralichthys dentatus*)	●		●	Demersal
Swordfish (*Xiphias gladius*)			●	Pelagic
Tautog (*Tautoga onitis)*			●	Demersal
Tiger Shark (*Galeocerdo cuvier*)	●			Pelagic
White Hake (*Urophycis tenuis*)			●	Demersal
Weakfish (*Cynoscion regalis*)			●	Demersal
Windowpane Flounder (*Scopthalmus aquosus*)	●		●	Demersal
Winter Flounder (*Pseudopleuronectes americanus*)	●		●	Demersal
Winter Skate (*Leucoraja ocellata*)			●	Demersal
Witch Flounder (*Glyptocephalus cynoglossus*)	●		●	Demersal
Yellowtail Flounder (*Limanda ferruginea*)	●		●	Demersal

*C= candidate, S= species of concern

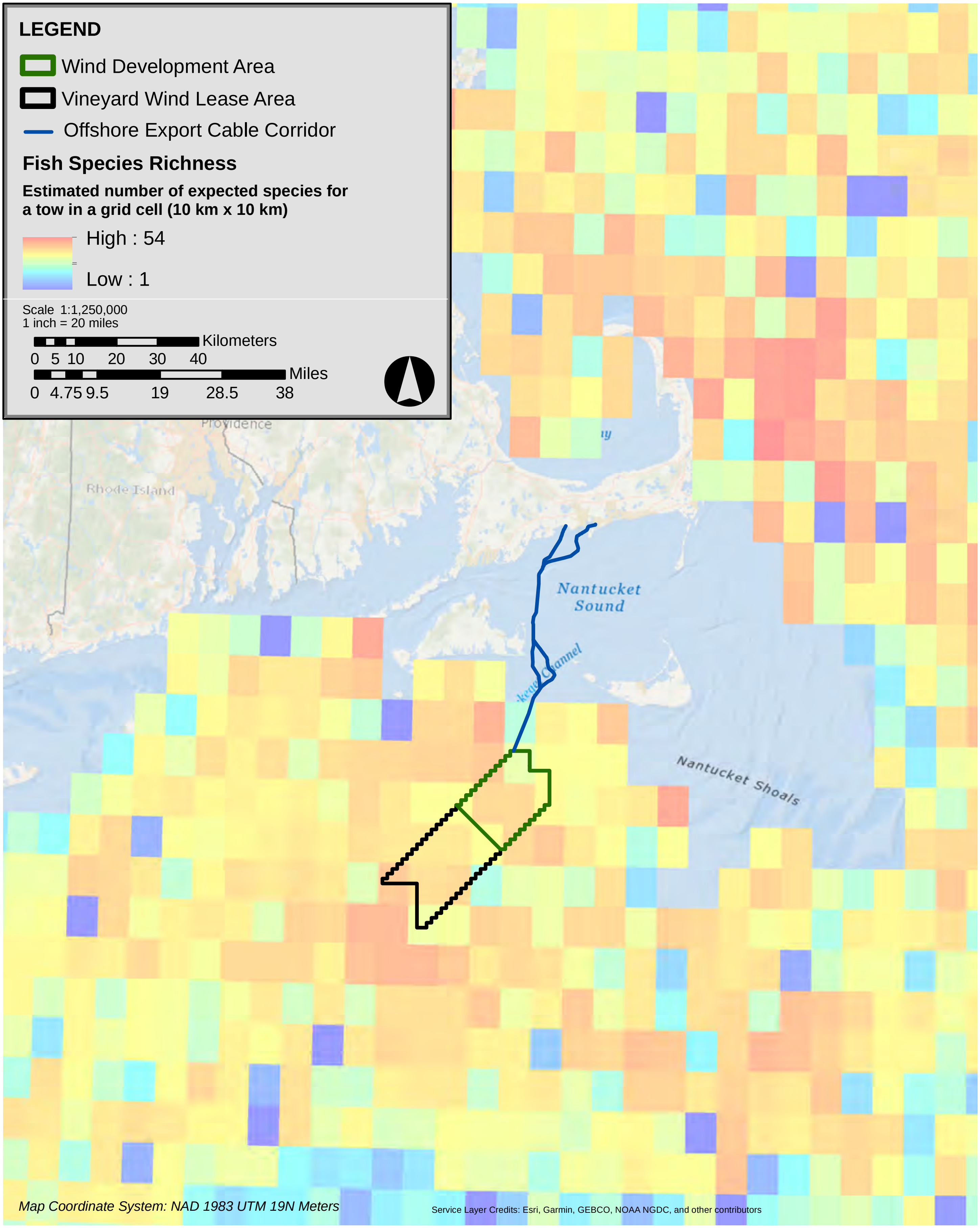
The Northeast Fisheries Science Center ("NEFSC") has been conducting fishery-independent autumn bottom trawl surveys annually since 1963. Two metrics, total biomass and species richness, derived from this survey show the distribution of fish assemblages in the Project Area relative to surrounding locations (Figure 6.6-1 to Figure 6.6-5). Total biomass of fish is low across the Project Area, while species richness is relatively high. High species richness has been linked to increased ecosystem resilience or the ability of an ecosystem to recover from disturbance (MacArthur, 1955).

Additional information on habitat and forage preferences and life stage presence in the Project Area for finfish and invertebrate species with EFH designations is provided in Appendix F.

6.6.1.1 Finfish

Pelagic Fishes

Pelagic species spend most of their lives swimming in the water column rather than occurring on or near the bottom. Many coastal pelagic species rely on coastal wetlands, seagrass habitats, and estuaries to provide habitat for specific life stages and many of these species migrate north and south along the Atlantic Coast during some periods of the year

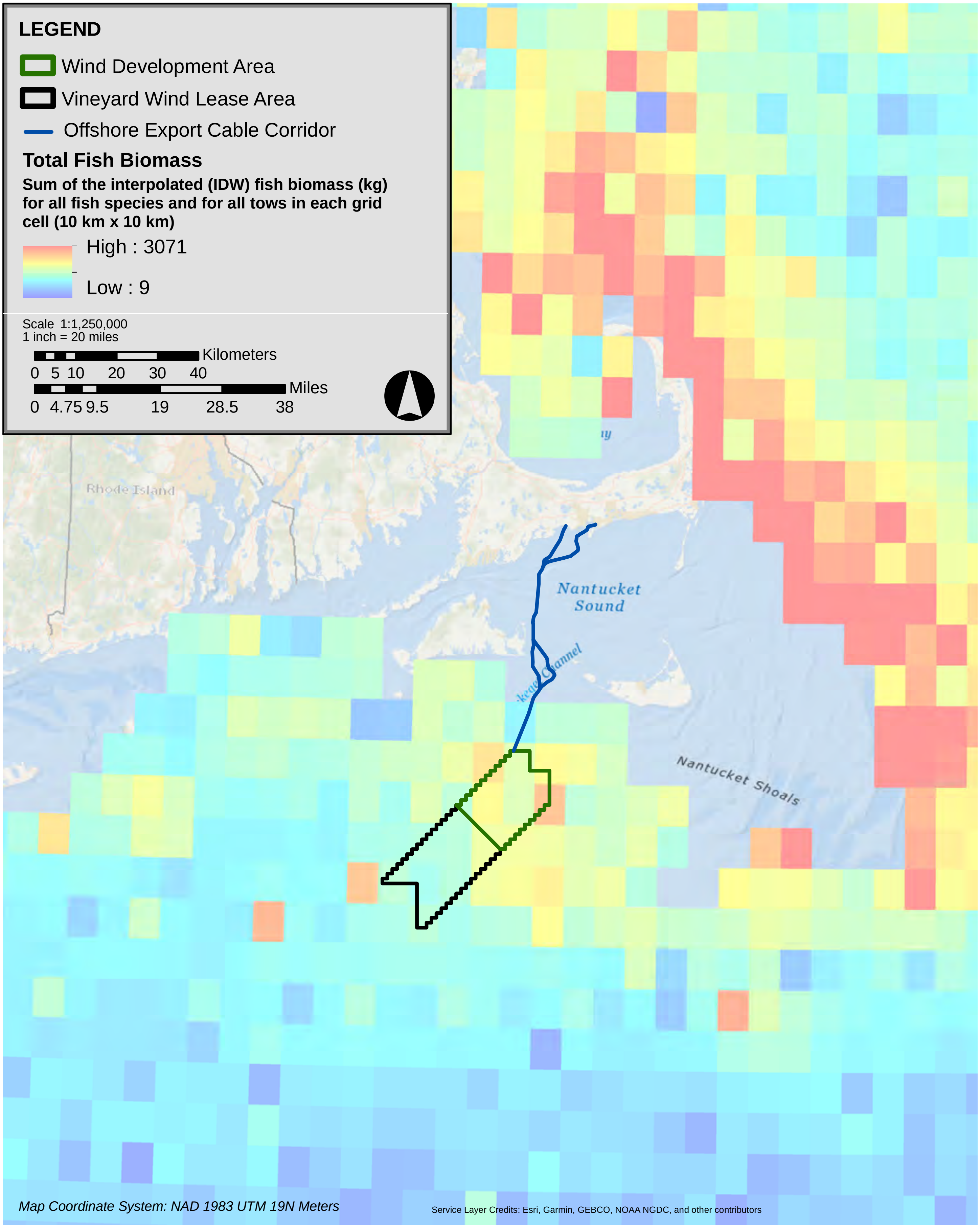


Map Coordinate System: NAD 1983 UTM 19N Meters

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Figure 6.6-1

Expected Species Richness of the Fish Captured in Fall NEFSC Bottom Trawl Surveys (NEODP, 2017)



Map Coordinate System: NAD 1983 UTM 19N Meters

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Figure 6.6-2

Expected Biomass of the Fish Captured in Fall NEFSC Bottom Trawl Surveys (NEODP, 2017)

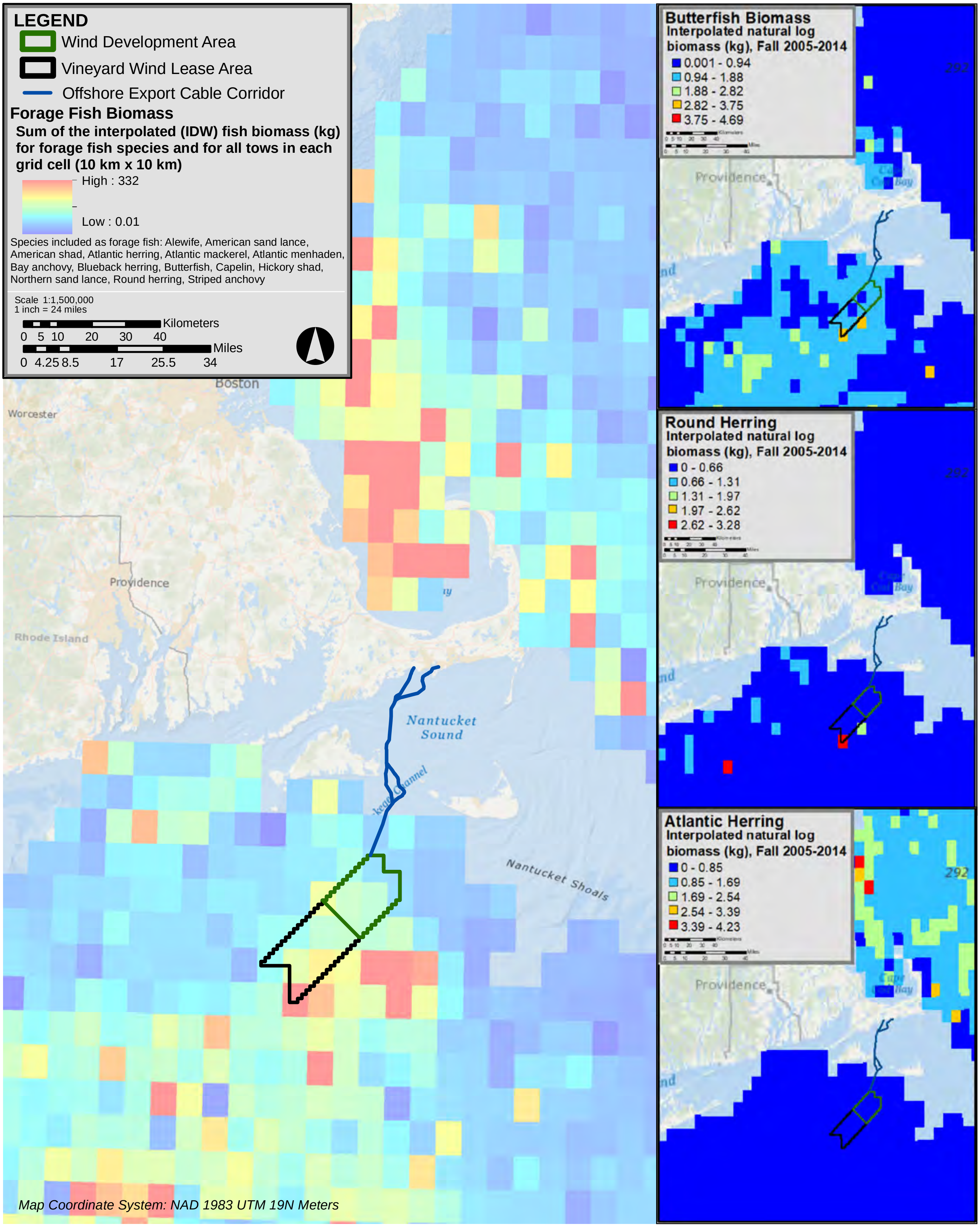


Figure 6.6-3

Expected Forage Fish Biomass and Individual Biomass for Butterfish, Round Herring, and Atlantic Herring Captured in Fall NEFSC Bottom Trawl Surveys (NEODP, 2017)

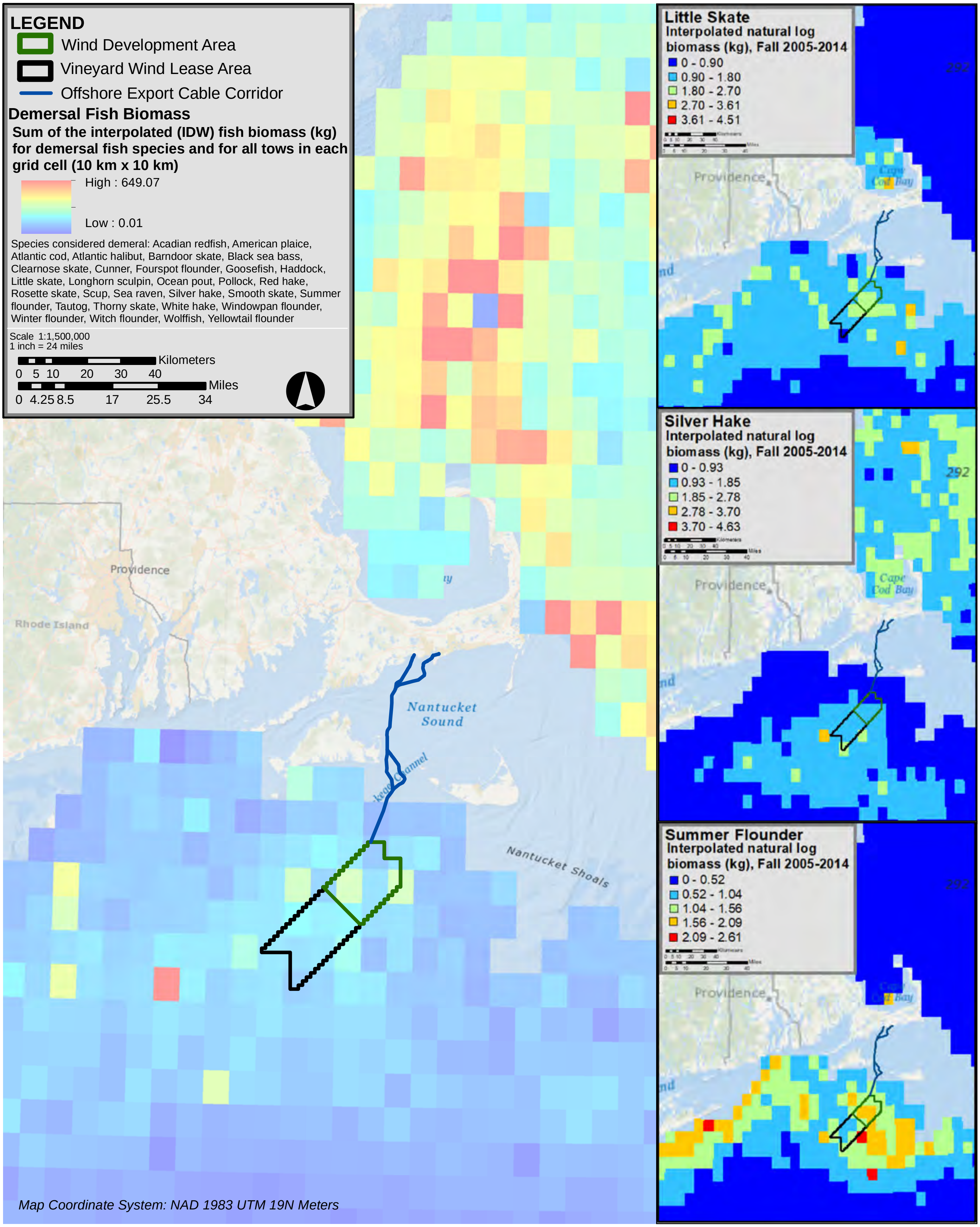
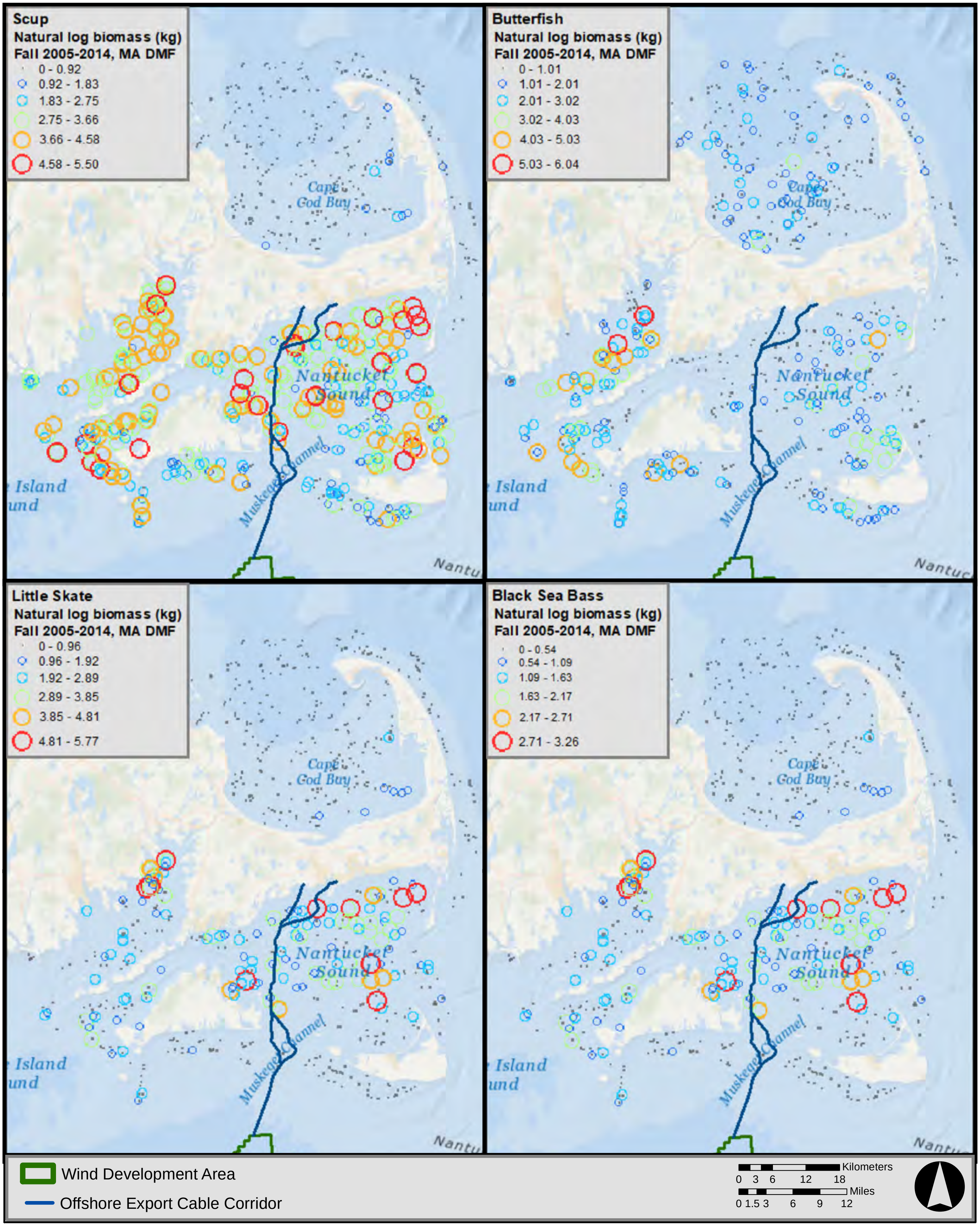


Figure 6.6-4

Demersal Fish Biomass and Individual Biomass for Little Skate, Silver Hake, and Summer Flounder Captured in Fall NEFSC Bottom Trawl Surveys (NEODP, 2017)



Vineyard Wind Project

VINEYARD WIND

Figure 6.6-5

Biomass (natural log) of Commonly Caught Fish in the MA DMF Fall Trawl Surveys (2005-2014). Species included: Scup, Butterfish, Little Skate, Black Sea Bass (NEODP, 2017).

(see Figure 6.6-3). In general, movement is related to sea surface temperature. These fish use the highly productive coastal waters within the Atlantic region during the summer months and migrate to deeper and/or more distant waters during the rest of the year. Important pelagic finfish with ranges that overlap the Project Area, include forage species, such as Atlantic Herring (*Clupea harengus*) and Atlantic Mackerel (*Scomber scombrus*), and predatory fish, such as Yellowfin Tuna (*Thunnus albacares*) and Whiting (*Merluccius bilinearis*). Trawl surveys conducted seasonally by NEFSC from 2003-2016 found that Atlantic Herring, Butterfish, and Round Herring had the highest biomass of forage fish across all seasons in the Massachusetts Wind Energy Area ("MA WEA"). Seasonal variations in biomass were apparent for all three species, with Atlantic Herring primarily caught in the colder seasons (spring/winter) and Butterfish and Round Herring primarily caught in the warmer seasons (fall/summer; Figure 6.6-3; NEFSC, 2016).

Demersal Fishes

Demersal fish (groundfish) are those fish that spend at least a portion of their life cycle in association with the ocean bottom. Demersal fish are often found in mixed species aggregations that differ depending upon the specific area and time of year (see Figure 6.6-4). Many demersal fish species have pelagic eggs or larvae that are sometimes carried long distances by oceanic surface currents. The Project Area supports both the intermediate and shallow demersal finfish assemblages defined by Overholtz & Tyler (1985). Many of the fish species in these assemblages are important because of their value in the commercial and/or recreational fisheries. Important demersal fish in the area include Winter Flounder (*Pseudopleuronectes americanus*), Yellowtail Flounder (*Limanda ferruginea*), and Monkfish (*Lophius americanus*). According to bottom trawl surveys conducted by the Massachusetts Department of Marine Fisheries (DMF) from 1978-2007 in Massachusetts waters within and surrounding the OECC, the most common demersal species captured in the spring included, Little Skate, Winter Flounder, and Windowpane Flounder and in the fall included, Scup, Little Skate, and Black Sea Bass (Figure 6.6-5). Year-round trawl surveys conducted by NEFSC from 2003-2016 found that Little Skate, Winter Skate, Silver Hake, and Spiny Dogfish were consistently dominant in catches from the MA WEA (Figure 6.6-4; NEFSC, 2016; Guida et al., 2017).

Highly Migratory Fishes

Highly migratory fish often migrate from southern portions of the South Atlantic to as far north as the Gulf of Maine. Migrations are correlated with sea surface temperature and these species generally migrate to northern waters in the spring where they remain to spawn or feed until the fall or early winter (NOAA, 2016a). Examples of these species with ranges that overlap the Project Area include Atlantic Bluefin Tuna (*Thunnus thynnus*) and Basking shark (*Cetorhinus maximus*).

Threatened and Endangered Fish

Three federally-listed threatened or endangered fish species may occur off the northeast Atlantic coast, including the Shortnose Sturgeon (*Acipenser brevirostrum*), Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*), and Atlantic Salmon (*Salmo salar*) (see Table 6.6-2). A further description of these species is provided herein. Additional species that have been proposed for endangered status and not deemed candidates (or are currently candidates for listing and the status determination has not yet been made) are known as "Species of Concern" and are included in Table 6.6-2.

Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus)

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

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

There are five distinct population segments (DPS) of Atlantic Sturgeon (*Acipenser oxyrinchus*) along the Atlantic coast including: Gulf of Maine, New York Bight, Chesapeake Bay, and South Atlantic, all of which are listed as federally endangered except for the Gulf of Maine DPS which is listed as threatened (ASSRT, 2007; NMFS, 2013). Currently, there are no published population abundance estimates for any of the five DPSs. Population abundance estimates of mature or spawning adults only exist for two rivers, the Hudson River in New York and the Altamaha River in Georgia. Kahnle et al. (2007) estimated there to be 863 mature adult sturgeon from the Hudson River using fishery-dependent data collected between 1985-1995 and Schueller and Peterson (2006; as cited in NMFS, 2013) estimated 343 adults spawning annually using fishery-independent data collected in 2004 and 2005. Based on these estimates, and the presumption that these stocks are the most robust, the other spawning populations are likely less than 300 individuals per year (ASSRT, 2007; NMFS, 2013).

The National Marine Fisheries Service (NMFS) presumed that Atlantic Sturgeon in the Massachusetts Wind Energy Area (MA WEA) would most likely be from the New York Bight DPS; however, genetic analyses and tagging studies indicated that the range of all five DPSs overlaps and extends from Canada to Florida (ASSRT, 2007; NMFS, 2013).

Of the New York Bight DPS, spawning is only known to occur in the Delaware and Hudson rivers, with some habitat utilization also occurring in the Connecticut and Taunton rivers (ASSRT, 2007; NMFS, 2013). Federally-regulated Critical Habitat for Atlantic Sturgeon is assigned in the freshwater and coastal estuarine regions of the known spawning rivers, none of which overlap with the Offshore Project Area (GARFO, 2016). Primary threats to Atlantic Sturgeon include bycatch in trawl and gillnet fisheries, habitat degradation and loss, ship strikes, and general depletion from historical fishing. Very few Atlantic Sturgeon have been captured as bycatch in fisheries or in fisheries-independent surveys in the MA WEA, with no recorded catches within the Vineyard Wind WDA (Stein et al., 2004b; Dunton et al., 2011).

Shortnose Sturgeon (Acipenser brevirostrum)

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

The Shortnose Sturgeon was listed as endangered in 1967 because the US Fish and Wildlife Service concluded that the fish had been eliminated from the rivers in its historic range (except the Hudson River) and was in danger of extinction because of pollution, loss of access to spawning habitats, and direct and incidental overfishing in the commercial fishery for Atlantic Sturgeon (NOAA, 2015). DPSs are currently identified in North Carolina, South Carolina, Georgia, and northern Florida river systems (NOAA, 2015).

Atlantic Salmon (*Salmo salar*)

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

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

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

Table 6.6-2 List of Northeast Atlantic Threatened and Endangered Species and Species of Special Concern with ranges that may overlap the BOEM Massachusetts Wind Energy Area (BOEM, 2014)

Species (Scientific Name)	ESA Status
Atlantic Salmon (*Salmo salar*)	Endangered
Shortnose Sturgeon (*Acipenser brevirostrum*)	Endangered
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Endangered/ Threatened
Atlantic Bluefin Tuna (*Thunnus thynnus*)*	Species of concern
Atlantic Halibut (*Hippoglossus hippoglossus*)	Species of concern
Atlantic Wolfish (*Anarhichas lupus*)*	Species of concern
Dusky Shark (*Carcharhinus obscurus*)*	Species of concern
Porbeagle Shark (*Lamna nasus*)*	Species of concern
Rainbow Smelt (*Osmerus mordax*)	Species of concern
Sand Tiger Shark (*Carcharias taurus*)*	Species of concern
Thorny Skate (*Amblyraja radiata*)	Species of concern
Alewife (*Alosa pseudoharengus*)	Candidate species/ species of concern
Blueback Herring (*Alosa aestivalis*)	Candidate species/ species of concern
Cusk (*Brosme brosme*)	Candidate species/ species of concern
American Eel (*Anguilla rostrata*)	Candidate species
Basking Shark (*Cetorhinus maximus*)*	Candidate species
Great Hammerhead Shark (*Sphyrna mokarran*)	Candidate species
Scalloped Hammerhead Shark (*Sphyrna lewini*)	Candidate species

*Indicates species with EFH in Project Area

Note that there are differences between the species listed in Table 6.6-1 and those listed in Table 6.6-2. Those species in Table 6.6-1 are known to have a range and/or habitat overlapping the Project Area, while the species in Table 6.6-2 are those listed as either threatened, endangered, candidate species and/or species of concern in the entire Northeast Atlantic. Those species in Table 6.6-2 that have designated EFH within the Project Area are designated with an asterisk (*).

Commercially and Recreationally-Important Fish

Many of the fish species found off the Massachusetts coast are important due to their value as commercial and/or recreational fisheries.

A detailed description of fishing activities and the economic value of fisheries is provided in Section 7.6, Commercial and Recreational Fisheries.

6.6.1.2 Invertebrates

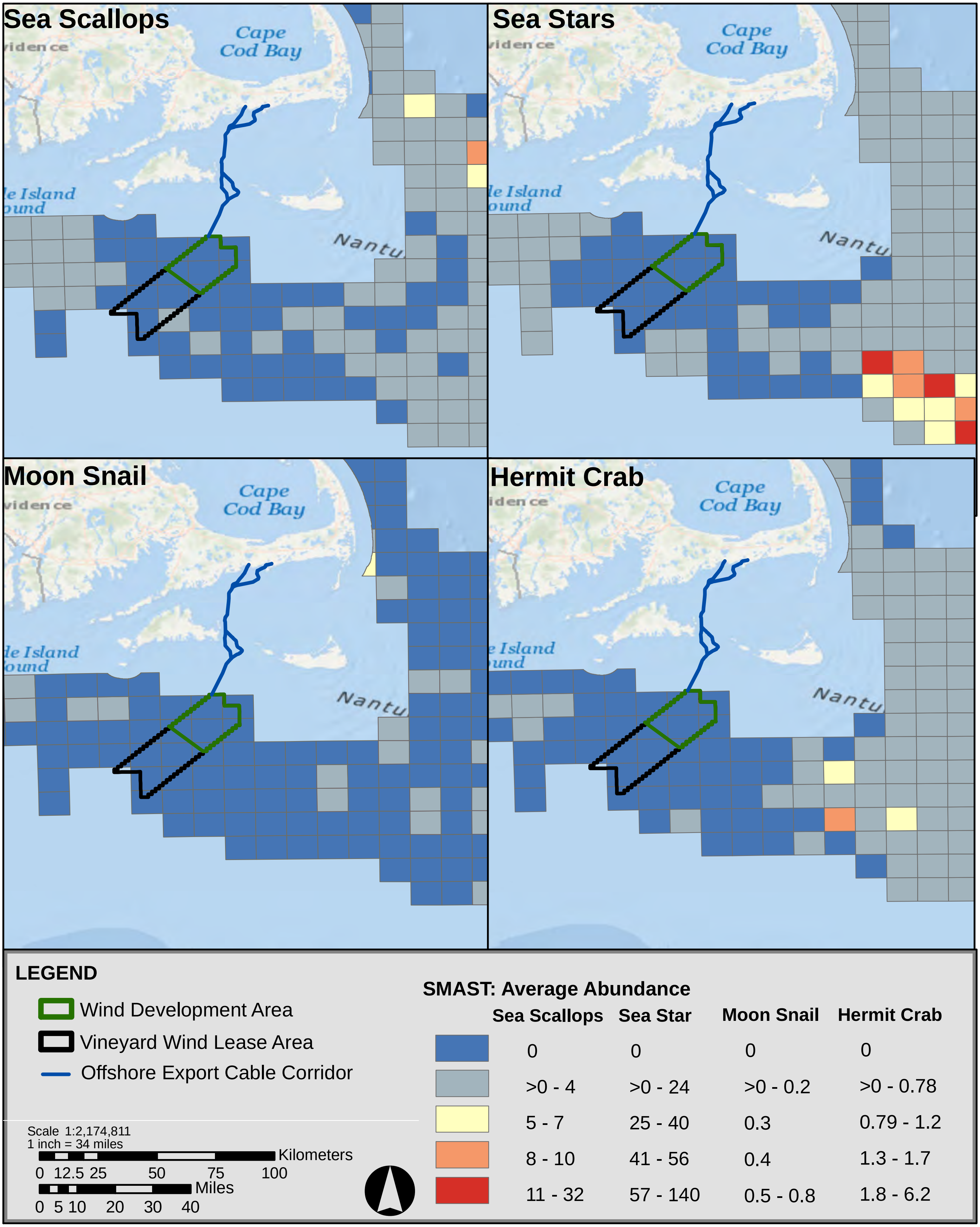
Important managed invertebrates with ranges that overlap the Project Area include Atlantic Sea Scallop (*Plactopecten magellanicus*), Long-finned Squid (*Loligo pealeii*), Short-finned Squid (*Illex illecebrosus*), Atlantic Surf Clam (*Spisula solidissima*), whelks, American Lobster (*Homarus americanus*), Ocean Quahog (*Artica islandica*), Jonah Crab (*Cancer borealis)*, and Horseshoe Crab (*Limulus polyphemus)*. While several of these species (e.g., Long-finned and Short-finned Squid, Atlantic Surf Clam, and Ocean Quahog) have designated EFH in the area (to be discussed in more detail in Appendix III-F), there are some species, such as the American Lobster, Jonah Crab, Horseshoe Crab, and whelks, that are managed in the area but do not have designated EFH.

American Lobster, Jonah Crab, and Horseshoe Crab are ecologically and commercially important crustacean species within the MA WEA. The American Lobster is distributed in coastal rocky habitats and muddy burrowing areas with sheltering habitats offshore in submarine canyon areas along the continental shelf edge. This species has been found to use the following substrates: mud/silt, mud/rock, sand/rock, bedrock/rock, and clay (Cooper & Uzmann, 1980). However, firm, complex, rocky substrate is the preferred habitat for all life stages of lobster. Post-larval and juvenile lobsters tend to stay in shallow, inshore waters (Lawton & Lavalli, 1995), but adolescent and adult lobster are highly adaptable in their choice of substrate and can be found in nearly all substrate types. The life history and habitat preferences of Jonah Crab are poorly understood. Large adults are commonly encountered in offshore rocky habitats; however, they are caught in both hard and soft sediments (ASMFC, 2015, 2018). Seasonal movement to nearshore habitats during the later spring and summer have been observed though motivation for migrations are unclear (ASMFC, 2018). Horseshoe Crabs inhabit sandy beach areas to spawn and juveniles reside in nearshore habitats close to those beaches for two years upon hatching (ASMFC, 2010). Little data exists on adult distribution upon spawning, with trawl sampling data from NMFS NEFSC suggesting they prefer depths less than 30 m (ASMFC, 1998). Refer to Section 6.5 and Figure 6.5-6 for more detailed species distribution within the Vineyard Wind Project Area.

The term "conch" is the generic classification for a variety of whelks found in southern New England waters, including Knobbed Whelk (*Busycon carica*), Channeled Whelk (*Busycotypus canaliculatus*), and Lightning Whelk (*Busycon contrarium*). Channeled Whelk tend to be the most prevalent in the commercial catches. Other shellfish with important commercial fisheries in the vicinity of the Massachusetts Wind Energy Area ("MA WEA") include Bay Scallops (*Argopecten irradians*), Atlantic Sea Scallops, Blue Mussels (*Mytilus edulis*), Ocean Quahogs, sea clams (various species), and Soft Shell Clams (*Mya arenaria*). Bay Scallops are found in the subtidal zone, sandy and muddy bottoms, and offshore in shallow to moderately deep water. Atlantic Sea Scallops are generally found in water depths of 25-200 m (82-650 ft) south of Cape Cod, mainly on sand and gravel where bottom temperatures remain below 68°F (20°C) (Hart, 2006). Blue Mussels are most common in the littoral and sublittoral zones (<99 m [325 ft] depths) of oceanic and polyhaline to mesohaline estuarine environments; however, the species can also be found in deeper and cooler waters (100-499 m [328-1,637 ft depths) (Newell, 1989). Adult Softshell Clams (*Mya arenaria*) live in sandy, sand-mud, or sandy-clay bottoms, with their highest densities at depths of three to four meters (10-13 ft) (Abraham and Dillon, 1986).

Video surveys conducted by SMAST within the MA WEA between 2003-2012, indicated low abundances of most benthic invertebrates in the WDA (Figure 6.6-6, Figure 6.6-7). The most common benthic invertebrate in the WDA were sand dollars, which were found, on average, in 75-100% of samples collected in the area (Figure 6.6-7; SMAST, 2016). Project specific underwater video sampling conducted within the northern section of the WDA also observed sand dollars frequently (Section 5.1.1.1 in Volume II).

The Massachusetts Division of Marine Fisheries (MDMF) has been sampling Longfin Squid and squid egg mops in Massachusetts waters as part of their Spring and Fall Bottom Trawls since 1978. Figure 6.6-8 and Figure 6.6.-9 provide the distribution of Longfin Squid (as number per tow) and squid egg mops (as kg per tow) in the Project Area between the years 2007 and 2017. The highest concentrations of Longfin Squid occurred just south of Nantucket Island in the Fall and south of Martha's Vineyard in the spring. Adult Longfin Squid were present along the OECC in both the spring and the fall with concentrations highest along the route through Nantucket Sound. Although Longfin Squid spawn year-round and egg mops can be found throughout the year, spawning typically peaks in the spring and eggs hatch in the summer (as reviewed in Jacobson, 2005). In Massachusetts state waters, squid egg mops were observed along the OECC in both the spring and fall; however, they were much more frequent in the spring through Nantucket Sound and northwest of Martha's Vineyard.



	Sea Scallops	Sea Star	Moon Snail	Hermit Crab
🟦	0	0	0	0
⬜	>0 - 4	>0 - 24	>0 - 0.2	>0 - 0.78
🟨	5 - 7	25 - 40	0.3	0.79 - 1.2
🟧	8 - 10	41 - 56	0.4	1.3 - 1.7
🟥	11 - 32	57 - 140	0.5 - 0.8	1.8 - 6.2

Vineyard Wind Project

VINEYARD WIND

Figure 6.6-6

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

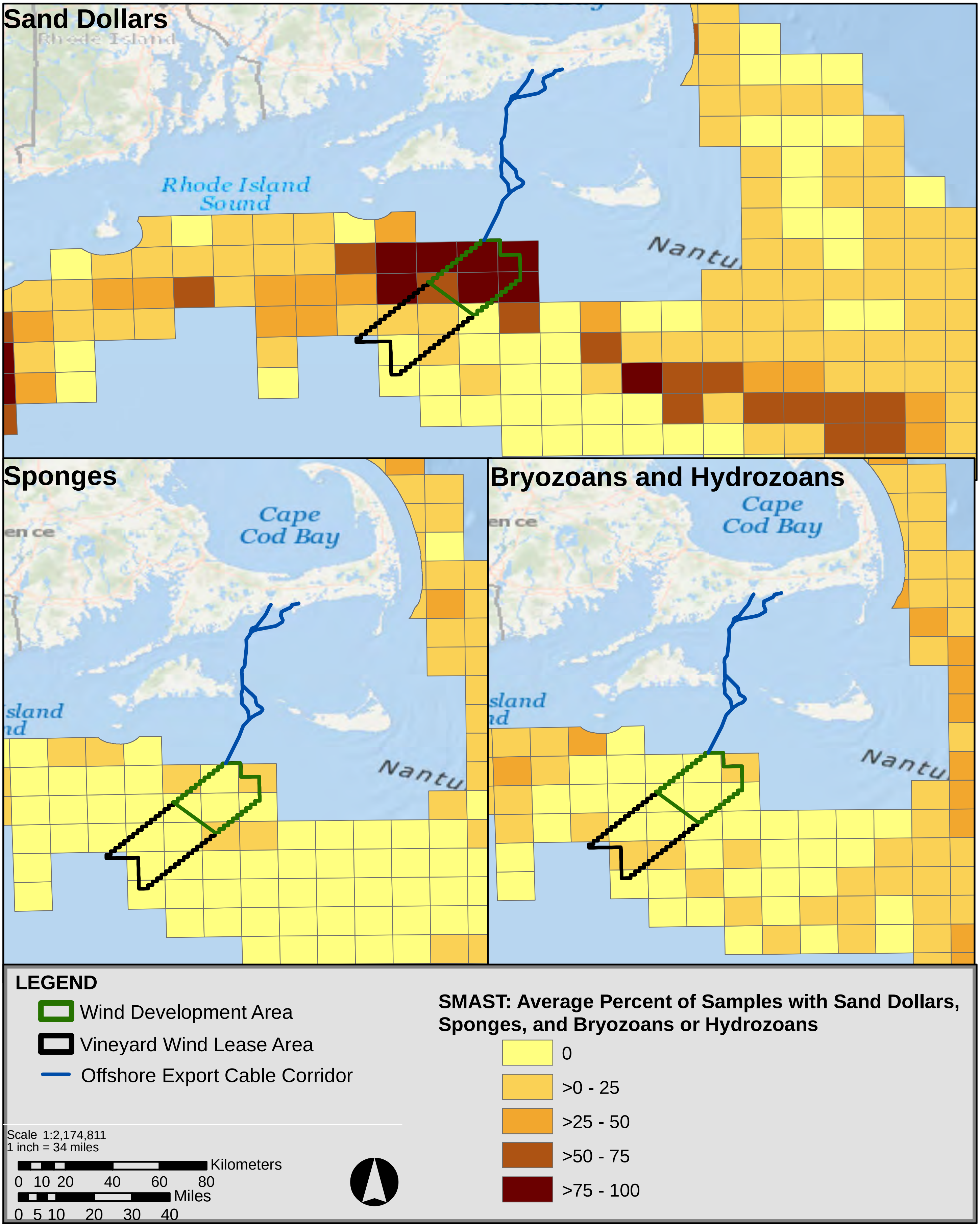
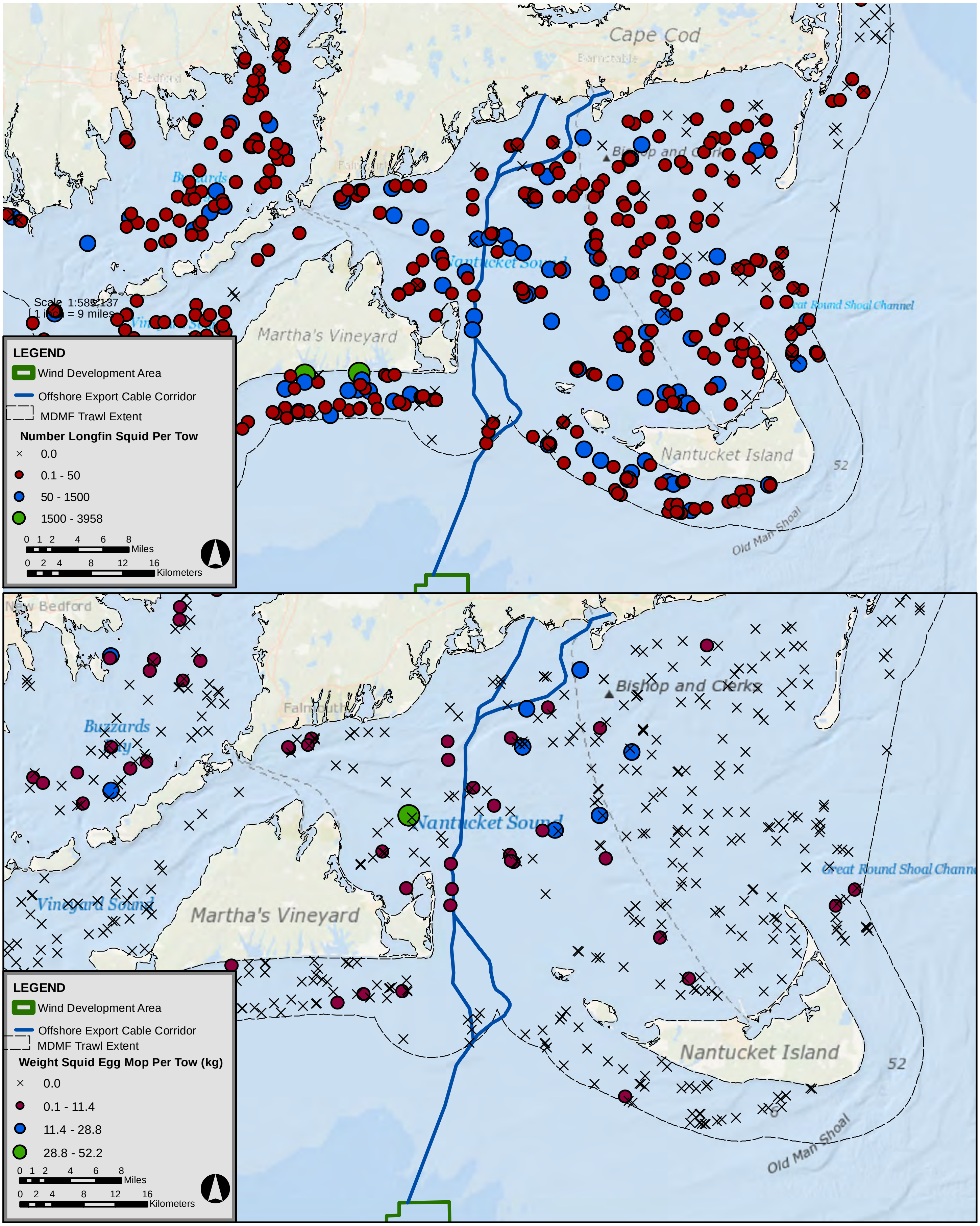


Figure 6.6-7

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



Vineyard Wind Project

VINEYARD WIND

Figure 6.6-8

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

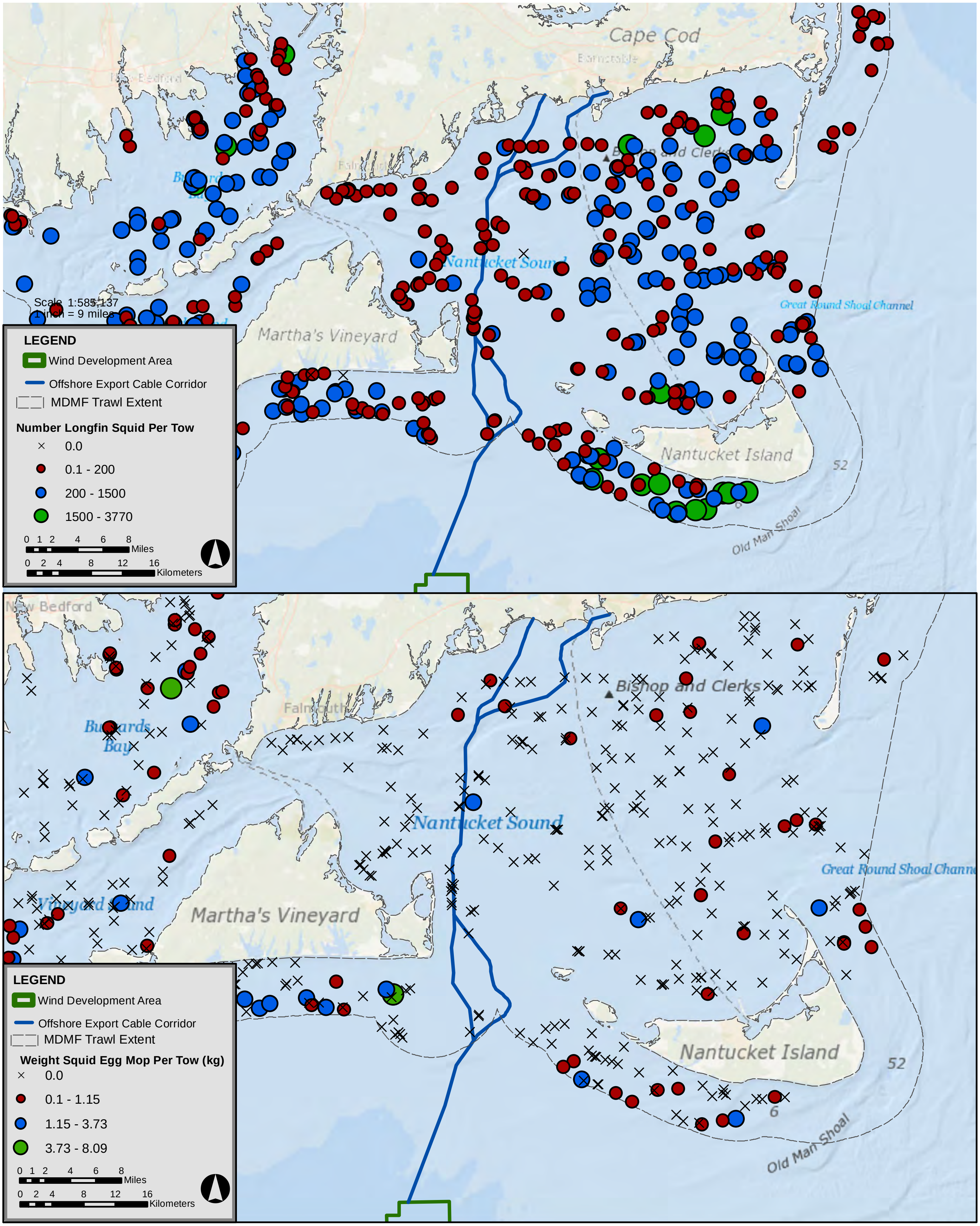


Figure 6.6-9

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

6.6.1.3 Essential Fish Habitat

Essential Fish Habitat is designated in both benthic substrate and water column habitats for 40 fish and invertebrate species within the WDA and OECC. The primary goal of EFH is to identify and protect important fish habitat from certain fishing practices and coastal and marine development. EFH is generally assigned by egg, larvae, juvenile and adult life stages and defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. § 1802(10)). A detailed assessment of EFH and potential project-related impacts is included in Appendix III-F.

6.6.2 Potential Impacts of the Project

The impact-producing factors for finfish and invertebrate resources are provided in Table 6.6-3 and will be discussed in more detail in this section.

Table 6.6-3 Impact- producing Factors for Finfish and Invertebrates

Impact-producing Factors	Wind Development Area	Offshore Export Cable Corridor	Construction & Installation	Operations & Maintenance	Decommiss-ioning
Pile driving for WTG and ESP foundations	X		X		
Cable installation	X	X	X	X	X
Scour protection installation	X		X		
Increased vessel traffic	X	X	X	X	X
Increased noise	X	X	X	X	X
Water Withdrawals	X	X	X	X	X
Dredging		X	X	X	X
Electromagnetic fields	X	X		X	

6.6.2.1 Construction and Installation

6.6.2.1.1 Habitat Loss or Alteration

Wind Development Area

During the construction/installation of the Project, temporary and permanent habitat loss or alteration is expected for both demersal and pelagic fish. Demersal fish species are expected to be the most affected by bottom habitat loss and alteration because of their strong association with benthic environments. Within the WDA, bottom habitat primarily consists of fine sand and silt-sized sediments. Soft bottom habitat would be permanently lost from the installation of Wind Turbine Generators ("WTGs") and Electrical Service Platforms ("ESP") foundations (monopile or jacket) and associated scour protection. The soft bottom habitat at each WTG and ESP would be altered to hard substrate from addition of the foundation and scour protection. As listed in Table 6.5-5, the amount of permanent soft bottom habitat lost would be less than 0.22 square kilometers ("km^2") (53 acres).

Additional bottom habitat loss and alteration is expected from embedment of the inter-array cables and placement of the jack-up legs from construction vessels/barges. The jack-up leg impact is quantified in Table 6.5-5 as an additional 0.27 km^2 (66 acres). Bottom habitat in the direct path of the inter-array and inter-link cables will be disturbed from the surface to a target burial depth of 1.5-2.5 meters (5-8 ft). In areas where the cable cannot reach a sufficient burial depth, protective measures (as described in Section 3.1.5.3 of Volume I) will be used to cover and protect cables. The addition of rock or concrete protection may alter habitat from soft to hard bottom substrate, though it is likely that some of the protective measures will be placed in areas of existing hard bottom habitat. As listed in Table 6.5-5, the additional area of alteration due to inter-array and inter-link cable installation is 0.86 km^2 (211 acres), and the area potentially requiring cable protection measures is 0.26 km^2 (63 acres). The total area of alteration within the WDA due to foundation and scour protection installation, jack-up vessel use, inter-array and inter-link cable installation, and potential cable protection installation is 1.59 km^2 (393 acres), which is 0.5% of the entire WDA.

Additionally, while anchored vessels will not be used as primary construction and installation vessels within the WDA, there may be potential anchoring within the WDA. Any anchoring that does occur within the WDA will occur within the Area of Potential Effect (APE) defined in Volume II-C. The impacts from anchor use and anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the Project planning stage.

Temporary increases in suspended sediments in the water column during construction are also expected and will affect demersal and pelagic fish species and benthic invertebrates. Increased suspended sediment can impair the visual abilities of fish species and impact foraging, navigation, and sheltering behaviors. For mollusks, such as Softshell Clams and Northern Quahog (*Mercenaria mercenaria*), suspended sediments can reduce oxygen consumption and filter feeding abilities and lead to reduced growth (reviewed in Wilber & Clarke, 2001). Concentration and duration of sediment suspension dictate severity of affect to fish and benthic organisms. Sublethal affects (i.e., fine sediment coating gills and cutting off gas exchange with water and resulting in asphyxiation) were observed for White Perch (*Morone americana*) when 650 milligrams per liter ("mg/L") of suspended sediments persisted for five days (Sherk et al., 1974). Lethal effects were observed for other sensitive fish species at concentrations <1,000 mg/L that persisted for at least 24 hours (Sherk et al., 1974; Wilber & Clarke, 2001). Reduced growth and oxygen consumption of some mollusk species has been observed when sediment concentrations of 100 mg/L persisted for two days (Wilber & Clarke, 2001). According to sediment transport modeling of the inter-array cables installation using typical cable burial parameters (see Appendix III-A), the maximum anticipated suspended sediment concentrations that persisted for at least 60 minutes would be greater than 200 milligrams per liter ("mg/L") but less than 300 mg/L and would occur in <0.02 km^2 (5 acres). These concentrations would drop rapidly and would be below 50 mg/L after two hours. Concentrations of suspended sediments with lower concentrations (10 mg/L) would extend up to 3.1 km (1.2 mi) from the inter-array cable centerline and would be suspended at any given location for less than six hours, which is below known sublethal thresholds.

Life stages (eggs and larvae), demersal fish species, and benthic invertebrates with limited or no motility would be the most at risk of injury or mortality during construction and installation in the WDA. Mobile demersal/benthic and pelagic fish and invertebrates would be temporarily displaced by increased turbidity and underwater construction, but would likely be able to escape harm and move away from construction/installation areas. Because the avoidance responses of demersal fish species are slower, these species would be more likely to experience some injury or mortality during construction and installation. Additionally, construction activities conducted in the winter may further reduce the avoidance ability of some benthic organisms as movement is delayed when water temperatures are low.

Immobile life stages of fish species in or on benthic sediment (i.e., demersal eggs) and sessile benthic organisms in the direct path of foundations and associated scour protection or inter-array cables may experience direct mortality. The resettling of disturbed sediments may cause additional mortality or injury to these immobile species or life stages through burial and smothering. For demersal eggs (fish [e.g., Atlantic Wolffish (*Anarhichas lupus)*, Atlantic Herring, and Winter Flounder], squid [e.g., Longfin Inshore Squid (*Doryteuthis pealeii*)]), and whelk species), deposition greater than one millimeter ("mm") can result in the burial and mortality of that life stage (Berry et al., 2011). Sediment dispersion modeling (see Appendix III-A) indicates that deposition of 1 mm (0.04 in) or greater (i.e., the threshold of burial for demersal eggs) occurred primarily within 80 m (262 ft) up to 100 m (328 ft) from the cable centerline with a total area of up to 2.42 km^2 (598 acres).

As mentioned in Section 6.5, many benthic bivalve species can withstand deposition levels up to 300 mm [12 in] (Essink, 1999). However, sessile or surface dwelling species, such as Blue Mussels and Queen Scallops, are more sensitive to deposition levels and lethal effects have been observed with burial depths between 20-100 mm [0.8 – 4 in] (Essink, 1999; Hendrick et al., 2016). According to sediment dispersion modeling conducted in the Project Area (see Appendix III-A), there will be minimal areas of deposition greater than 5 mm (0.2 in) for cable installation activities and none over 10 mm (0.39 in); therefore, cable installation is not anticipated to affect shellfish.

Offshore Export Cable Corridor

Up to approximately 158 km (98 mi) of offshore export cables would be installed for the Project. In certain areas, dredging will be required prior to the installation of the offshore export cable. In addition, a maximum of two cables could be installed separately within an 810 m-1,000 (2,657-3,280 ft) wide cable corridor. Benthic habitat in the direct path of the cable installation vessels, dredging vessels, vessel anchors, and anchor sweep zone will be disturbed while cables are being installed along the OECC. As described in Volume II, the OECC will pass through a variety of sediment types including sand/mud, pebble-cobble, and dispersed boulders. Most of the OECC is considered low complexity bottom habitat and 75% of video transect samples taken along the OECC recorded flat sand/mud, sand waves, or biogenic structures (see Volume II). Coarser substrates, like pebble-cobble and boulders, were found mainly in Muskeget Channel and are important for habitat for the juveniles of some fish species, like Atlantic Cod (*Gadus morhua*) (Lindholm et al., 2001).

Once cable installation is complete, permanent habitat alteration may occur due to the resettling of disturbed finer-grained sediment over gravel substrate. For a small portion of the OECC, permanent alteration may also occur where sufficient burial depth cannot be reached. In these areas, some of which already consist of hard bottom, rock protection or concrete mattresses will be placed over the cables. As listed in Table 6.5-5, the amount of permanent bottom habitat altered by rock protection or concrete mattresses would be less than 0.14 km^2 (35 acres). OECC installation and sand wave dredging along the route will result in temporary disturbance of a maximum of 0.47 km^2 (117 acres) and 0.28 km^2 (69 acres) of bottom habitat, respectively.

To facilitate cable installation, anchoring may occur along the OECC. It is currently anticipated that anchoring may occur through Muskeget Channel or in the shallower waters of Lewis Bay near the New Hampshire Avenue Landfall Site, though anchoring may occur at any point along the OECC. The impacts from anchor use and anchor sweep are not quantified at this time due to the difficulty of estimating potential anchoring practices at the Project planning stage.

As would be the case with the WDA, construction and installation of the offshore export cable will increase suspended sediment in the water column. Installation along the OECC requires additional pre-installation sediment removal to remove sand waves and achieve safe burial depths; as described in Appendix III-A, this will likely be accomplished with a trailing suction hopper dredge (TSHD) on its own or through a combination of a TSHD and a jetting technique. Sediment dispersion modeling of sand wave removal via TSHD along the OECC indicated that concentrations of suspended sediments above 10 mg/L extended up to 16 km (10 mi) from the cable trench centerline. Most of the sediment settles out in less than three hours; however, suspended sediments at this concentration can persist for six-12 hours in smaller areas (0.06 km^2 [15 acres]). In addition, high concentrations

(>1000 mg/L) occurred at distances up to 5 km (3.1 mi) from the dredge site for short periods of time (less than two hours) due to the TSHD overflow and hopper dumping of sediments. After removing sand waves, a jet plow, mechanical plow, or one of the other techniques listed in Section 4.2.3.3 of Volume I will be used to install cables. The plume from jet plow installation as delineated by excess suspended sediment concentrations greater than 10 mg/L typically extended less than 200 m (656 ft) from the route centerline, though did extend up to 2 km (1.24 mi) in some places. Further, the excess concentrations were confined to the lower portion of the water column, and resettled rapidly (within four-six hours) due to the high proportion of coarse sand throughout the route (see Appendix III-A).

Suspension of sediments from dredging and cable installation operations would have little to no effect on motile pelagic organisms (fish and invertebrate larvae, juveniles, and adults, such as *Penaeus* sp. shrimp) or many burrowing invertebrates. This is because the mobility of pelagic species allows them to escape harm and move away from the construction path in areas with increased suspended sediment. The additional pre-installation sand wave sediment removal along the OECC could potentially impact any non-motile organisms, such as pelagic and demersal eggs and sessile invertebrates, because increased suspended sediment can result in egg abrasion and mortality and reduced feeding efficiency in filter-feeding organisms (Wilber & Clarke, 2001). However, according to the sediment transport modeling (see Appendix III-A), suspended sediment concentrations and sediment persistence in the water column will be below known sub-lethal thresholds (Sherk et al., 1974; Wilber & Clarke, 2001).

The resetting of suspended sediments after dredging and export cable installation may also impact fish via burial of demersal eggs (i.e., eggs on or attached to the bottom sediments). If the rate of deposition at any given location exceeds one millimeter over 2 to 21 days (the assumed egg duration for species of concern), demersal eggs could be buried resulting in reduced hatching success and increased mortality (Berry et al., 2011). For most of the cable installation, deposition of greater than 1 mm (0.04 in) was primarily constrained to within 80 m (262 ft) though up to 100 m (328 ft) from the route centerline with a total area of up to 10.3 km^2 (2,545 ares) for one cable. In areas along the OECC where sand wave dredging was simulated to have occurred, the deposition greater than 1 mm (0.04 in) associated with the TSHD drag arm is mainly constrained to within 80 m (262 ft) from the route centerline whereas the deposition greater than 1 mm (0.04 in) associated with overflow and disposal extends to greater distances from the source, mainly within 1 km (0.62 mi), though such deposition can extend up to 2.3 km (1.43 mi) in isolated patches when subject to swift currents through Muskeget Channel. Overall, along the OECC, sedimentation of 1 mm or greater could occur in a maximum area of 10.50 km^2 (2,595 acres) for dredging associated with one cable.

As mentioned in the section above, mortality of sensitive sessile or benthic shellfish species can occur with sedimentation levels of >20 mm (0.8 in). According to sediment dispersion modeling conducted in the Project Area (see Appendix III-A), there will be minimal areas of deposition greater than 5 mm (0.2 in) for cable installation activities and none above 10 mm (0.39 mm); therefore, cable installation is not anticipated to affect shellfish. For dredging and disposal activities, the largest area of seafloor to be affected by 20 mm (0.79 in) would be within an area of 0.14 km^2 (34.6 acres).

Direct mortality of pelagic planktonic life stages would also occur via water withdrawals for vessel functions and potentially from the cable installation and dredging vessels. Mortality of organisms entrained in the water withdrawal pumps is expected to be 100% because of the associated stresses with being flushed through the pump system and temperature changes (USDOE MMS, 2009). Assuming that 90% of the offshore cable system is installed at a rate of 200 m/hr (656 ft/hr), 10% of the cable system is installed at a rate of 300 m/hr (984 ft/hr), and a jet plow uses 11,300 – 30,300 liters per minute (3.000 – 8.000 gallons per minute) of water, water withdrawal volumes are expected to be approximately 1,700 – 4,540 million liters (450 – 1,200 million gallons).

Overall, the slower avoidance response of juvenile and adult demersal fish and benthic invertebrate species subjects them to increased injury or mortality during dredging and cable installation. As mentioned above, slow avoidance responses can be further exaggerated during the cold winter months for some species, such as Horseshoe Crab that bury into the sediment in the winter (Walls et al., 2002). Immobile benthic species or early life stages in the direct path of construction vessels would experience direct mortality or injury. Some displaced fish and invertebrates may be subjected to indirect injury or mortality through increased predation or competition in areas surrounding the construction site.

6.6.2.1.2 Increased Noise

Wind Development Area

During the construction/installation of the Project, related underwater noise would include repetitive, high-intensity sounds produced by pile driving, and continuous, lower-frequency sounds produced by vessel propellers. Ambient noise within the Lease Area was measured as, on average, between 76.4 and 78.3 decibels ("dB") re 1 $\mu Pa^2/Hz$ (Alpine Ocean Seismic Surveying Inc., 2017). Ambient noise can influence how fish detect other sounds as fish have localized noise filters that separate background noise and other sounds simultaneously (Popper & Fay, 1993).

All fish have hearing structures that allow them to detect sound particle motion. Some fish also have swim bladders near or connected to the ear that allows them to detect sound pressure as well, which increases hearing sensitivity and broadens hearing abilities (reviewed in Popper et al., 2014). In general, increased sound sensitivity and the presence of a swim bladder makes a fish more susceptible to injury from anthropogenic noises as these loud, often impulsive noises can cause swim bladders to vibrate with enough force to inflict damage to tissues and organs around the bladder (Halvorsen et al., 2011; Casper et al., 2012). The least sound-sensitive fish species include those that do not have a swim bladder, including flatfish like Winter Flounder and elasmobranchs. Fish, such as Atlantic Sturgeon, with swim bladders not connected or near inner-ear structures also primarily detect noise through particle motion, and are therefore less sensitive to noise. The most sensitive species are those with swim bladders connected or close to the inner ear, such as Atlantic Herring and Cod; these species can acquire both recoverable and mortal injuries at lower noise levels than other species (Thomsen et al., 2006; Popper et al., 2014). Most crustacean species lack swim bladders and are considered less sensitive to sound, though resolution of information on invertebrates and sound is coarse (Edmonds et al., 2016).

Specifically, although research is limited, noise generated from pile driving and intensified vessel traffic could impact fishes and invertebrates in the area as the high-intensity, pulse sounds of pile driving can produce noise over 200 dB re 1 μPa at the source and have been linked to mortality, ruptured gas bladders, damage to auditory processes, and altered behavior in some fish species (Casper et al., 2012; Popper & Hastings, 2009; Riefolo et al., 2016). Noise thresholds derived from Popper et al. (2014) indicate that pile driving sound above 207 dB peak can lead to mortality of the most sensitive fish species, such as Atlantic Herring, while noise above 186 dB can lead to impairment.

Vineyard Wind conducted acoustic modeling (see Appendix III-M and associated appendix) to estimate the noise propagation of pile driving with a target of approximately 12 dB noise reduction in relation to thresholds of mortality and recoverable injury for fish with different hearing structures (based on thresholds in Popper et al., 2014). Modeling results indicated that cumulative sound levels causing mortality or injury to fish without swim bladders, such as Winter Flounder, could extend up to 71 m (233 ft) from the source. Cumulative sound levels causing recoverable injury in fish without swim bladders could extend 71-79 m (233-259 ft). For fish, such as Atlantic Sturgeon, with swim bladders not involved in hearing, cumulative sound levels that potentially lead to mortality could extend 127-182 m (417-597 ft) from the source. Fish, such as Atlantic Cod and Herring, with swim bladders involved in hearing could be impacted by pile driving noises at the farthest distances from the source, with mortal impacts potentially occurring at 200-351 m (656-1,152 ft) from the source. Recoverable injury for all fish with swim bladders could occur between 451-691 m (1,480-2,267 ft) from the source. Although there is very little information on the impacts of pile driving to eggs and larvae, Popper et al. (2014) conservatively assigned the same thresholds for mortality or injury as fish with swim bladders not involved in hearing (Popper et al., 2014).

However, impairment from pile driving noise is unlikely to occur during the Project, as a soft-start technique will be employed and most mobile fish and invertebrates will be able to leave the area before full strength pile driving occurs.

In addition to pile driving noises, fish can be impacted by increased noise levels from the intensified vessel traffic and construction related-vessel positioning. Continuous noise above 170 dB root-mean-square (rms) for 48 hours can lead to injury, while noise ≥158 dB rms for 12 hours can lead to behavioral disturbance (Popper et al., 2014). Underwater vessel noise can cause avoidance behavior interferes with feeding and breeding, alter schooling behaviors and migration patterns, and mask important environmental auditory cues (Barber, 2017; CBD, 2012). Masking is of particular concern because although fish are generally not loud (120 dB re 1 μPa [at one meter] with the loudest on the order of 160 dB re 1 μPa), species make unique noises that allow for individual identification (Normandeau Associates, Inc., 2012). In addition, behavioral responses in fish differ depending on species and life stage, with younger, less mobile age classes being the most vulnerable (Gedamke et al., 2016; Popper & Hastings, 2009). Avoidance or flight behavior away from vessels has been observed for Atlantic Herring and Atlantic Cod and is likely the behavior exhibited by other species as well (Handegard et al., 2003; Vabø et al., 2002).

Although even less research has been conducted on the impact of anthropogenic noise on invertebrates, studies have observed acoustic trauma in some species, including adult squid and octopus, when exposed to high-intensity, low-frequency noise (André et al., 2011; Solé et al., 2013). In addition, research on the response of Blue Mussels to pile driving indicated that clearance or filtration rate increased with pile driving noise, likely in response to increased metabolic demands triggered by stress (Spiga et al., 2016). Similarly, feeding changes were observed in American Lobster exposed to high sound levels (seismic air gun) and persisted as long as several weeks post-exposure (Payne et al., 2007). Research has also found that larval scallops exposed to seismic noises showed delays in development and malformations (Aguilar de Soto et al., 2013). A lobster species (*Nephrops norvegics*) exposed to pile driving noises showed decreased burying, bioirrigation, and locomotion, which indicated alterations to overall behavior and habitat usage during pile driving activities (Solan et al., 2016). Lower frequency, more continuous noises, such as those from vessels, have been linked to changes in the behavior or recruitment of some benthic invertebrates (Nedelec et al., 2014). However, as described in the BOEM EA and the Alternative Energy Programmatic Environmental Impact Statement ("PEIS") that were prepared for the assessment and designation of WEAs by BOEM, vessel traffic in this area is already relatively high and thus implies that biological resources in the area are presumably habituated to this noise (BOEM, 2007; BOEM, 2014).

Offshore Export Cable Corridor

The principle noise from OECC construction/installation would be from tug and barge vessels used for cable installation. Fish in the OECC would be able to hear the tug and barge vessels; however, at sound levels below those that cause injury or stress (USDOE MMS, 2009). Cable installation is not expected to be a significant source of noise; if a jet plow is used, there will be the sound of water rushing from the nozzles (USDOE MMS, 2009).

6.6.2.1.3 Avoidance, Minimization, and Mitigation Measures

The Project Area is located in the MA WEA, and this area is less sensitive to important fish and invertebrate habitat and therefore reduces impacts.

To mitigate the potential impacts of injury to fish from pile driving, the Project will apply a soft-start procedure to the pile driving process, which delivers initial pile drives at a lower intensity, allowing fish to move out of the activity area before the full-power pile driving begins. In addition, Vineyard Wind will target approximately 12 dB of noise reduction. Therefore, the anticipated impact on fish in or near the WDA is temporary avoidance reactions. Although vessel presence in the WDA will be intensified, avoidance behaviors are expected to be similar to those already displayed by fish when near fishing or recreational vessels.

WTGs will also be widely spaced, leaving a huge portion of the WDA undisturbed by WTG and ESP installation.

Immobile life stages of fish species in or on benthic sediment (i.e., demersal eggs) and sessile benthic organisms in the direct path of construction may experience direct mortality. Impacts may be minimized through the use of mid-line buoys, if feasible and safe, and installation equipment that minimizes installation impacts, such as a jet plow. In nearshore areas where sensitive resources are located, horizontal directional drilling may be used to minimize impacts.

Vineyard Wind has developed a framework for a pre- and post-construction fisheries monitoring program to measure the Project's effect on fisheries resources. Vineyard Wind is working with the Massachusetts School for Marine Science and Technology ("SMAST") and local stakeholders to inform that effort and design the study. The duration of monitoring will be determined as part of the initial effort to determine the scope of the study, but it is anticipated to include the pre-construction period and at least one year of post-construction monitoring.

6.6.2.1.4 Summary

Overall, impacts to finfish and invertebrate species are expected to be short-term and localized during the construction and installation of the Project. The low total fish biomass and high species richness in the Project Area makes this location ideal for wind energy as it reduces impacts to individual organisms and targets an area which will likely be able to recover following any potential Project-related disturbances. In addition, the WEA was selected by BOEM to exclude most sensitive fish and invertebrate habitat and the Offshore Project Area is primarily composed of uniform sandy bottom habitat, which will likely begin recovering quickly after construction is completed. Previous research indicates that physical habitat recovers and communities begin to repopulate within a few months of disturbance (Dernie et al., 2003; Van Dalfsen & Essink, 2001). Some alteration of non-structured habitat to structured habitat in the WDA may change species assemblages in that area and attract more structure-oriented species.

Pelagic species will be able to avoid construction areas and are not expected to be substantially impacted by construction and installation. Impacts to mobile pelagic fish and invertebrate species include localized and short-term avoidance behavior. These impacts can be minimized or offset through mitigation consisting of a “soft-start” pile driving regime, sound reduction technologies, and efficient construction practices.

Direct mortality may occur to immobile benthic organisms that are in the direct path of construction processes. Mortality of immobile pelagic egg and larval life stages in the construction area (WDA and OECC) may occur through water withdrawals of the construction vessels. Although eggs and larvae may be entrained and will not survive, loss of many adult fish and population level impacts are not expected as most of these species produce millions of eggs each year and already have low adult survival rates. In addition, mortality of pelagic eggs due to increased suspended sediments is not likely as only low concentration sediment plumes are expected and resettlement will occur quickly (less than twelve hours in the water column).

Burial and mortality of some demersal eggs and sessile organisms is also expected during cable installation in the WDA and OECC, where deposition is greater than one millimeter. However, mortal deposition levels are only expected in small, localized areas in the direct vicinity of the cable routes and sediment discharge areas. Burrowing mollusks in the area, such as quahogs, will likely be able to avoid most lethal burial depths and are only expected to be slightly impacted and exhibit short-term avoidance of the area. Overall, although demersal sessile, or less active benthic organisms will incur the brunt of construction impacts, since the impacted area is only a small portion of the available habitat in the area, population level impacts are highly unlikely.

6.6.2.2 Operations and Maintenance

6.6.2.2.1 Habitat Changes, Artificial Reefs, and Fish Attracting Devices

Wind Development Area

The introduction of up to 100 WTG, up to two ESPs, and scour protection at the base of each foundation would change habitat from non-structure oriented to a structure-oriented system. The addition of foundations and scour protection, as well as rock or concrete cable protection measures in some areas, may act as an artificial reef and provide rocky habitat previously absent from the area. Increases in biodiversity and abundance of fish have been observed around turbine foundations due to attraction of fish species to new structural habitat (Raoux et al., 2017; Riefolo et al., 2016). However, within the WDA, the total area of impact from scour protection and cable protection is only 0.47 km^2 (117 acres) out of the 306 km^2 (75,614 acres). Cobble and boulder habitats have been identified as particularly important to lobsters, as it serves as both nursery grounds for benthic juveniles and as home substrata for adults (Linnane et al., 1999).

The addition of the turbine structure throughout the water column may also alter local food web dynamics and species distribution. Turbine foundations provide substrata for shellfish to attach and colonization by these species can change nutrient and plankton concentrations and provide a new food source and additional habitat complexity previously absent from the area (Norling and Kautsky, 2007; Slavik et al., 2017). For example, biofouling of Blue Mussels (*Mytilus edulis)*, a filter feeder, on turbine structures in wind farms located in the North Sea notably reduced the daily net primary productivity on a regional scale. However, reduction in primary production resulted in increased production and biodiversity of higher trophic levels (Slavik et al., 2017). Raoux et al. (2017) also observed that total ecosystem activity increased and that high trophic level organisms responded positively to increased biomass near monopiles after the construction of a wind farm. Other research on habitat changes associated with wind farms has observed that new communities of rocky habitat fishes establish near turbine foundations while communities remain unchanged in sandy areas between the turbines (Stenberg et al., 2015). In addition, increases in commercially important species, such as Atlantic Cod and Whiting, were observed near deep water wind farms (Hille Ris Lambers & ter Hofstede, 2009; Løkkeborg et al., 2002). There is also evidence that turbine reef habitats and the resources they provide increase the growth and condition of juvenile Atlantic Cod and Whiting-Pout (*Trisopterus luscus*; Reubens et al., 2014). Although reef habitat created by turbine foundations may increase biodiversity and ecosystem production, these introduced habitats could also act as a stepping-stone for the establishment and dispersal of nonindigenous species (Glasby et al., 2007).

The presence of the turbines in the WDA may also alter the local ocean circulation in the region, potentially changing current plankton distribution and dispersal patterns. Hydrodynamic modeling simulating larval transport around turbines in the MA WEA found that the presence of turbine structures would not have significant influence on southward larval transport during storm events (Chen et al., 2016).

Offshore Export Cable Corridor

As in the WDA, rock or concrete mattresses may be required along the OECC in areas where sufficient burial depths cannot be achieved. The addition of rock or concrete mattresses would permanently alter soft bottom habitat to hard bottom habitat in some areas. In other areas, rock protection would be placed on bottom habitat already classified as hard bottom substrate. The maximum amount of permanent bottom habitat altered by rock protection would be less than 0.14 km^2 (35 acres). As noted above for the WDA, the addition of hard bottom structure in these previously flat, soft sediment areas may attract different species and act as artificial reef habitat.

6.6.2.2.2 Increased Noise

Wind Development Area

The ability of fish to detect noise varies greatly among species. Fish with swim bladders involved in hearing, such as cod, are the most sensitive to anthropogenic noises (Popper et al., 2014; Wahlberg & Westerberg, 2005). Research on the impact of wind turbine operational noises is very limited due to the small number of farms in operation today. A review conducted on five offshore wind farms in the UK found that some wind farm areas produced enough noise to mildly disturb Atlantic Cod from up to 200 m (656 ft) (Cheesman, 2016).

Underwater noise level is also related to turbine power and wind speed, with increased wind speeds creating increased underwater sound (Wahlberg & Westerberg, 2005; Cheesman, 2016). At high wind speeds, Wahlberg & Westerberg (2005) estimated permanent avoidance by fish would only occur within a range of four meters (13 ft) of a turbine. In a study on fish near the Svante wind farm in Sweden, Atlantic Cod and Roach (*Rutilus rutilus*) catch rates were significantly higher near turbines when rotors were stopped, which could indicate fish attraction to turbine structure and avoidance to generated noise (Westerberg, 2000 *as cited in* Thomsen et al., 2006). Alternatively, no avoidance behavior was detected and fish densities increased around turbine foundations of the Lillgrund offshore wind farm in Sweden (Bergström et al., 2013). In addition, ambient noise can influence how fish detect other sounds and a change in background noise could alter how fish perceive and react to biological noise stimuli (Popper & Fay, 1993). Overall, current literature indicates noise generated from the operation of wind farms is minor and does not cause injury or lead to permanent avoidance at distances greater than one km [0.6 mi] (Cheesman, 2016; Stenberg et al., 2015; Wahlberg & Westerberg, 2005).

Sound would not be emitted from inter-array cables when the wind farm is in operation. Impacts of increased vessel traffic during maintenance activities would be similar to those described for vessels in the construction and installation phase.

6.6.2.2.3 Electromagnetic Fields

Wind Development Area and Offshore Export Cable Corridor

Electrosensitivity has been documented in elasmobranchs (sharks, skates, and rays) and some teleost fish species (ray-finned fishes), though research on the impact of anthropogenic electromagnetic fields ("EMF") on marine fish is limited. In general, elasmobranch species are present seasonally in the Project Area with varying annual abundances (NODP, 2017). The most commonly caught elasmobranchs in the Project Area include Little Skate and Winter Skate (NEFSC, 2016). EMF would be generated by inter-array cables connecting wind turbines in the WDA and from cables along the OECC. Fish use electromagnetic sense for orientation and prey detection and therefore, the function of key ecological mechanisms may be impacted by EMF generated by the cables (Riefolo et al., 2016). Because EMF produced by cables decreases with distance, and the target burial depth for the cables is 1.5-2.5 m (5-8 ft), the magnetic field at the seabed would be expected to be weak and likely only detectable by demersal species (Normandeau et al., 2011). A study by BOEM found that although there were changes in the behavior of Little Skate, an elasmobranch, and American Lobster in the presence of energized cables, EMF from cables did not act as a barrier to movement in any way (Hutchison et al., 2018). In addition, research investigating habitat use around energized cables found no evidence that fish or invertebrates were attracted to or repelled by EMF emitted by cables (Love et al., 2017). To date, there is no evidence linking anthropogenic EMF from wind turbine cables to negative responses in fish (Baruah, 2016; Normandeau et al., 2011).

Modeling of EMF from project specific submarine cables indicated magnetic fields from both AC and DC cables would be much lower than the Earth's magnetic field and likely only able to be sensed, if at all, directly over the cable centerline (Gradient, 2017). Modeling also confirmed that EMF from cables decreases with distance and therefore, because cables in in the WDA and OECC will be buried below ~2 m (6.6 ft) of sediment, it is unlikely that demersal or benthic organisms will be impacted by EMF produced by the cables in Project Area.

6.6.2.2.4 Cable Repair

Wind Development Area and Offshore Export Cable Corridor

Cable repair, as described in Volume I, may infrequently occur along limited segments of the cables. Procedures employed to repair segments of cable in the WDA and OECC will involve bringing the cable to the surface for repair, followed by re-installation of the cable.

Impacts to fish species would be similar to those explained above and are expected to include displacement of mobile juvenile and adult fish, injury to immobile or slower life stages or species, and temporary disturbance of benthic and pelagic habitat.

6.6.2.2.5 Avoidance, Minimization, and Mitigation Measures

The mitigation measures would be the same as discussed previously for construction and installation.

6.6.2.2.6 Summary

Impacts that may occur during operation and maintenance include alteration of habitat, increased noise, and maintenance construction. Limited habitat will be altered from non-structure to structure habitat in the WDA and may cause a change in fish assemblage in the area. Increased noise from the operation of the turbines will increase background noise and, as previous research indicates, may elicit avoidance responses in some species. Required maintenance of the turbines or cables may impact organisms in a similar manner as construction and installation.

In summary, impacts to finfish and invertebrates during operation and maintenance of the Project are expected to be localized and population level impacts are unlikely. Little to no direct mortality would occur, other than potentially during cable repair, which is expected to be rare and localized. The addition of hard structure habitat will add a complexity to the area that did not exist before and will likely attract species that prefer structured habitat. Overall, current literature indicates noise generated from the operation of wind farms is minimal and only localized avoidance behaviors are expected; acclimation to the noise over time may occur.

The addition of EMF from submarine cables will likely not have an impact on elasmobranchs or other electro-sensitive fish species, as cables will be buried in the substrate or covered with rock or concrete mattresses.

6.6.2.3 Decommissioning

6.6.2.3.1 Overall Impacts

Wind Development Area and Offshore Export Cable Corridor

Decommissioning activities would include removal of WTG and ESP foundations above the mudline. Scour protection will be removed. The offshore export cables could be retired in place or removed, subject to discussions with the appropriate regulatory agencies on the preferred approach to minimize environmental impacts. The decommissioning activities would be similar to those associated with construction. Removal of the scour protection from the WDA may result in a shift in the local finfish and invertebrate species assemblages to pre-construction, non-structure communities.

6.6.2.3.2 Avoidance, Minimization, and Mitigation Measures

The mitigation measures would be the same as discussed previously for construction and installation.

In summary, impacts will be very similar to construction and installation and are expected to be localized and short-term. Due to the long lifespan of the Project, it is also expected that technology will be enhanced by the time decommissioning occurs and impacts will be reduced.

6.7 Marine Mammals

6.7.1 Description of the Affected Environment

6.7.1.1 Overview

The Vineyard Wind Lease Area is south of Cape Cod and located within the Massachusetts Wind Energy Area ("MA WEA"), which was established by BOEM in 2012 through an intergovernmental renewable energy task force. More specifically, the Lease Area is located midway between Martha's Vineyard and Nantucket, just over 23 kilometers ("km") (14 miles ["mi"]) south of these islands. The Wind Development Area ("WDA"), a portion of the Vineyard Wind Lease Area and the Offshore Export Cable Corridor ("OECC") (see Figure 6.7-1[17]), is within the range of a variety of marine mammals. The description of the affected environment below reviews the distribution and use patterns of marine mammals in the WDA, OECC, and surrounding region. Species that occur within the US Atlantic (East Coast) Exclusive Economic Zone ("EEZ") are discussed generally with an evaluation of their likely occurrence in and near the Offshore Project Area (e.g., the WDA and/or the OECC). Species anticipated to potentially be affected by the Project are described in further detail.

This discussion of marine mammals is based on a review of existing literature. Existing data sources were also used to characterize the distribution, abundance, and composition of marine mammal species potentially affected by Project activities occurring within the WDA and the OECC. Some of the primary data sources for this review include the following:

Northeast Large Whale Pelagic Survey

The Northeast Large Whale Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles were conducted for the Massachusetts Clean Energy Center and BOEM by the Large Pelagic Survey Collaborative (comprised of the New England Aquarium, Cornell University's Bioacoustics Research Program, the University of Rhode Island and the Center for Coastal Studies) (Kraus et al., 2016). This study was designed to

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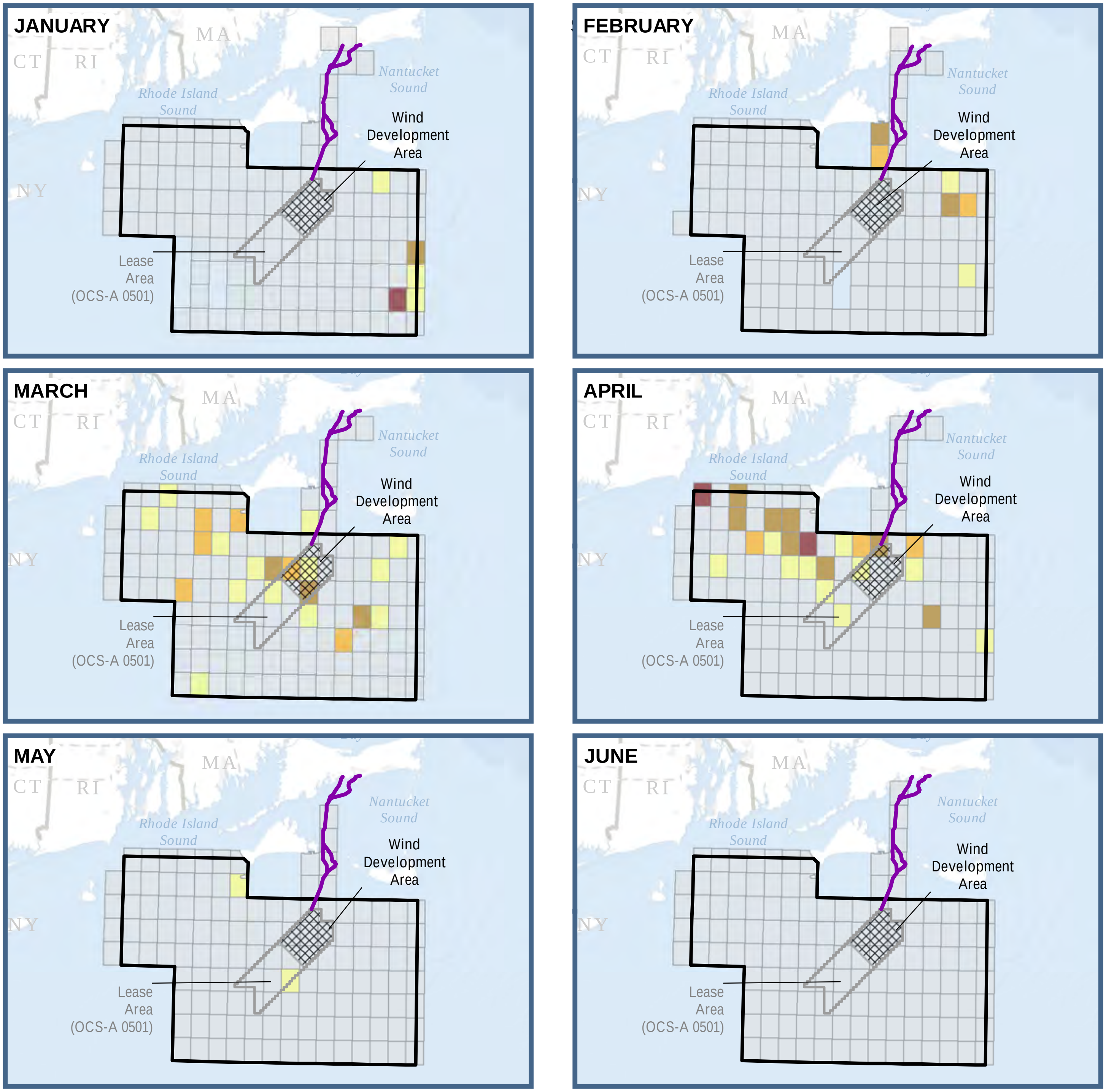
[17] All figures associated with this section depict the outline of the Offshore Export Cable Corridor.



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016.; ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*

N
W E
S

0 5 10 20 Nautical Miles

0 10 20 Kilometers

LEGEND

State Boundary

County Boundary

Lease Area

Wind Development Area

Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area

Offshore Export Cable Corridor

Right Whale

Sightings per Unit Effort (SPUE*)

⬜ 0

🟨 > 1 - 30

🟧 > 30 - 50

🟫 > 50 - 150

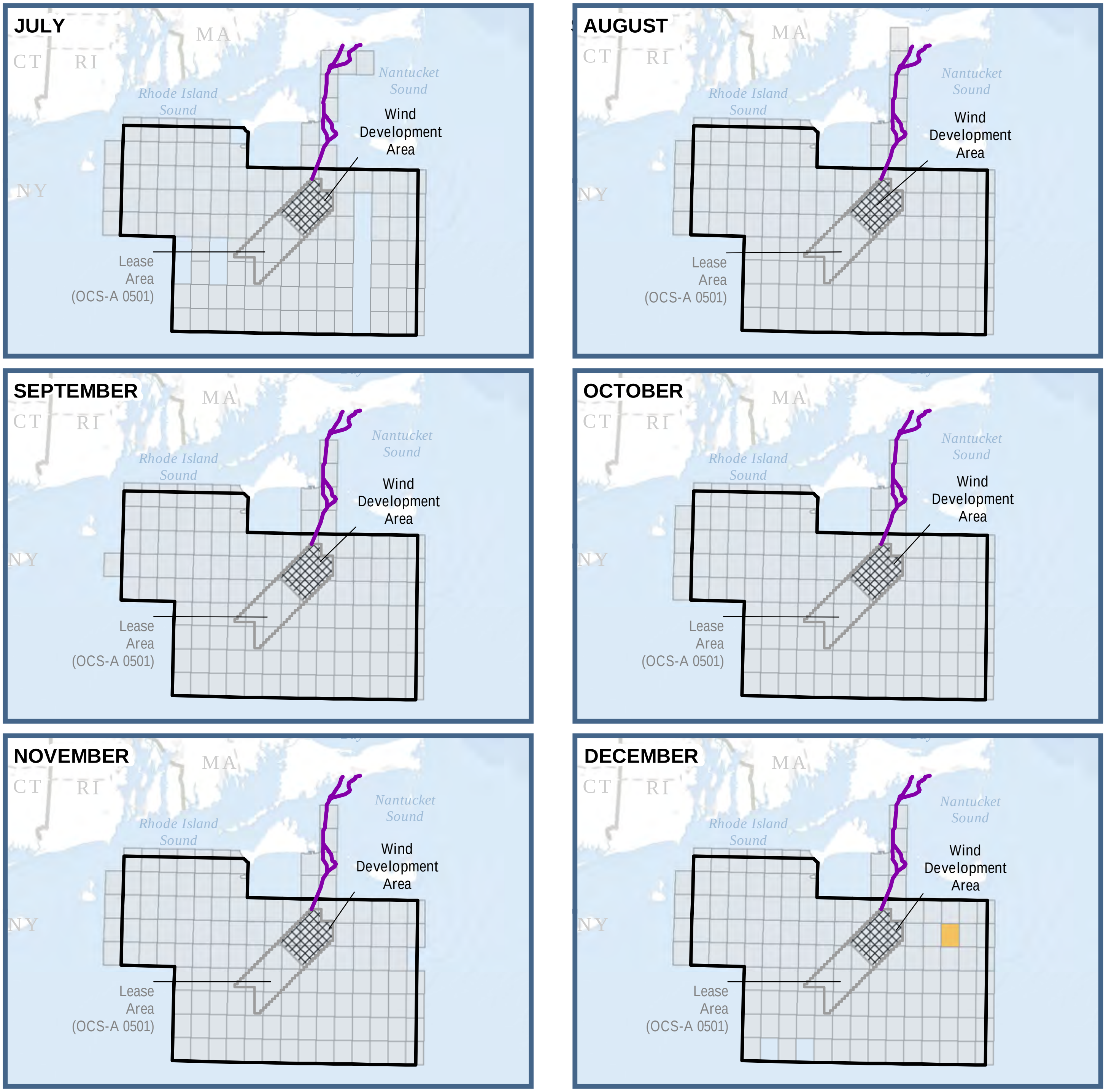
🟥 > 150 - 284

Vineyard Wind Project

VINEYARD WIND

Figure 6.7-1a

North Atlantic Right Whale Monthly Aerial Survey Sightings per Unit Effort 2011 to 2015 from Kraus et al. (2016) January to June



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016.; ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*

N
W E
S

0 5 10 20 Nautical Miles

0 10 20 Kilometers

LEGEND

- State Boundary
- County Boundary
- ☐ Lease Area
- ▨ Wind Development Area
- Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area
- Offshore Export Cable Corridor

Right Whale

Sightings per Unit Effort (SPUE*)

- ☐ 0
- 🟨 > 1 - 30
- 🟧 > 30 - 50
- 🟫 > 50 - 150
- 🟥 > 150 - 284

Vineyard Wind Project

VINEYARD WIND

Figure 6.7-1b

North Atlantic Right Whale Monthly Aerial Survey Sightings per Unit Effort 2011 to 2015 from Kraus et al. (2016) July to December provide a comprehensive baseline characterization of the abundance, distribution, and temporal occurrence of marine mammals, with a focus on large endangered whales and sea turtles, in the Massachusetts and Rhode Island Wind Energy Areas ("MA/RI WEA") and surrounding waters. Information was collected using line-transect aerial surveys and passive acoustic monitoring ("PAM") from October 2011 to June 2015 and from December 2012 to June 2015 in in the MA/RI WEA. Seventy-six aerial surveys were conducted, and Marine Autonomous Recording Units were deployed for 1,010 calendar days, during the study period. For survey methodologies and details please refer to Kraus et al., 2016.

Atlantic Marine Assessment Program for Protected Species ("AMAPPS") Surveys

AMAPPS surveys represent the newest available survey data (NEFSC & SEFSC 2010, 2011, 2012, 2013, 2014, 2015, 2016). The data are more recent than those data used to create the cetacean habitat-based density models discussed below. Therefore, AMAPPs data was used to consider whether any deviations from predicted seasonal habitat use has occurred in recent years. Further, the abundance estimates used by National Oceanic and Atmospheric Administration ("NOAA") Fisheries for many of the marine mammals in the US Atlantic EEZ are based on the 2011 AMAPPS surveys (Hayes, Josephson, Maze-Foley, & Rosel 2017; Palka 2012). At least one survey in each survey year included the MA/RI WEA. Surveys were conducted from aerial and vessel-based platforms and in all four seasons of the year. AMAPPS surveys are ongoing.

Vineyard Wind, 2016 and 2017 Geophysical and Geotechnical ("G&G") Survey

Vineyard Wind conducted preliminary G&G surveys within the boundaries of the Lease Area in the fall of 2016 (Vineyard Wind, 2016) and late summer and fall of 2017 (Vineyard Wind, 2017). Activities occurred onboard the Research Vessel ("RV") *Shearwater*, the RV *Ocean Researcher*, and the RV *Synergy* over 54 survey days (excluding weather events) during the 2016 surveys. In 2017, activities occurred onboard the RV *Henry Hudson* and RV *Shearwater* over 47 surveys days (excluding weather events). Protected species observers ("PSOs") monitored the areas surrounding the survey boats for marine mammals and sea turtles using visual observation and PAM. The following marine mammal species were visually observed during the surveys:

- Gray Seal (Halichoerus grypus grypus)
- Unknown seal
- Unidentified dolphin or porpoise
- Short-Beaked Common Dolphin (Delphinus delphis)
- Unknown large whale

Short-Beaked Common Dolphins and unidentified dolphins were also detected acoustically. See Sections 6.7.1.2 and 6.7.1.3 for further details of visual observations and acoustic detections of marine mammals during the Vineyard Wind G&G surveys.

Marine Mammal Stock Assessment Reports (SARs)

Every year, NOAA Fisheries releases Stock Assessment Reports ("SARs") for marine mammals that occur in the US Atlantic EEZ as required under the 1994 amendments to the Marine Mammal Protection Act ("MMPA") (16 U.S.C. § 1361 et seq.). NOAA Fisheries works with regional offices to develop the technical reports by revising older SARs as new data become available (Hayes et al., 2017). Not all species' SARs are updated each year; the MMPA requires that NOAA Fisheries revise strategic stocks annually and non-strategic stock at least every three years. These reports must contain specified information such as broadly described geographic range, serious injury and mortality estimates, abundance estimates, stock status, and observed fisheries bycatch. In addition, when possible, the reports determine a minimum population estimate, maximum best productivity rate, population trend, and an estimate of the potential biological removal (i.e., maximum number of animals that may be removed from a marine mammal stock without reducing numbers below the optimum sustainable population) for each species. The number of SARs changes over time as stocks, and their definitions, shift.

Duke University Habitat-Based Cetacean Density Models

Duke University Habitat-Based Cetacean Density Models (Roberts et al., 2016) combine data from 15 aerial and shipboard surveys covering 895,000 km of trackline in the western Atlantic over 22 years from 1992 to 2014. Using data across multiple years allows for analysis of rare and cryptic species, for which there would be insufficient data for analysis in any given survey, and smooths interannual variation for a general prediction over time. This modeling assumes relatively similar population sizes and habitat preferences over time. Monthly density predictions were made in cases in which data were sufficient. If data were not sufficient to assess density by month, an average annual estimate was made. The Roberts et al., (2016) models do not include the AMAPPS data (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016) as discussed above.

In addition, this discussion relies on sources cited in the Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Massachusetts – Revised Environmental Assessment (BOEM, 2014) and the Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf in Massachusetts, Rhode Island, New York and New Jersey Wind Energy Area Endangered Species Act Section 7 Consultation Biological Opinion (NOAA, 2013).

The term "marine mammal" is a purely descriptive term referring to mammals that carry out all or a substantial part of their foraging in marine or, in some cases, freshwater environments. Marine mammals as a group are comprised of various species from three orders (Cetacea, Carnivora, and Sirenia). Cetaceans are divided into two major suborders: Mysticeti (baleen whales) and Odontoceti (toothed whales). Toothed whales are generally smaller and have teeth that are used to capture prey. Baleen whales use baleen to filter their prey from the water. In addition to contrasting feeding methods, there are differences in the life history and social organization of these two groups (Tyack, 1986). Pinnipeds (Order Carnivora) are divided into three families: Phocidae (earless seals), Otariidae (sea lions and fur seals), and Odobenidae (walruses). Of the pinnipeds, only Earless Seals occur in and around the Offshore Project Area. The four living Sirenian species are classified into two families: Trichechidae (includes three species of manatees); and Dugongidae (only includes the Dugong).

More than 120 species of marine mammals occur worldwide (Rice, 1998), 42 of which have been documented within the US Atlantic EEZ (CeTAP, 1982; Hayes et al., 2017; Roberts et al., 2016; USFWS, 2014). Of these 42, the following 16 species are not expected to occur within the Offshore Project Area based on lack of sightings and known habitat preferences and distributions of the species (Hayes et al., 2017; Kenny & Vigness-Raposa, 2010; Kraus et al., 2016; Roberts et al., 2016; USFWS, 2014):

- West Indian Manatee (Trichechus manatus latirostris)
- Bryde's Whale (Balaenoptera edeni)
- Beluga Whale (Delphinapterus leucas)
- Northern Bottlenose Whale (Hyperoodon ampullatus)
- Killer Whale (Orcinus orca)
- Pygmy Killer Whale (Feresa attenuate)
- False Killer Whale (Pseudorca crassidens)
- Melon-headed Whale (Peponocephala electra)
- White-beaked Dolphin (Lagenorhynchus albirostris)
- Pantropical Spotted Dolphin (Stenella attenuate)
- Fraser's Dolphin (*Lagenodelphis hosei*)
- Rough-toothed Dolphin (*Steno bredanensis*)

- Clymene Dolphin (*Stenella clymene*)
- Spinner Dolphin (*Stenella longirostris*)
- Hooded Seal (*Cystophora cristata*)
- Ringed Seal (*Pusa hipsida*)

Twenty-six species occur at least occasionally within the WDA, OECC, and adjacent waters (BOEM, 2014; Hayes et al., 2017; Kenney & Vigness-Raposa, 2010; Kraus et al., 2016; Roberts et al., 2016), and are listed in Table 6.7-1. These species are discussed in Sections 6.7.1.2 and 6.7.1.3. The species noted as rare in Table 6.7-1 are unlikely to be exposed to Project activities, and are not discussed in detail. Probability of exposure to stressors from the Project is related to occurrence. Therefore, probability of exposure is low if the species has rarely been observed in the MA/RI WEA and surrounding waters, or if the primary year-round distribution of the species is elsewhere and no individuals were visually observed during the Northeast Large Whale Pelagic Survey. The species noted as rare in Table 6.7-1 are briefly addressed in the following paragraph.

The Blue Whale, listed under the Endangered Species Act ("ESA") (16 U.S.C §.1531 et seq.) (35 Fed. Reg. 8491 [June 2, 1970]), is endangered and rare in nearshore waters of Massachusetts; Hayes et al., (2017) reports that this species is considered an occasional visitor in the US Atlantic EEZ and typically occurs north of the EEZ. Blue Whales were detected acoustically during PAM but were never visually observed in the RI/MA WEA between 2011-2015 (Kraus et al., 2016). The acoustic detection radius for Blue Whales exceeded 140 km (75.5 nautical miles ["nm"]) making it difficult to specify the location of vocalizing blue whales. Blue Whales were only detected on 3.9% of days analyzed (40/1,020 days) and there was not a discernable seasonal trend (Kraus et al., 2016). Exposure probability for this species is low, and there is no anticipated loss or disturbance of individual Blue Whales. Based on sighting and distribution data, other species that are rare enough that exposure probability is low include Dwarf and Pygmy Sperm Whales (*Kogia sima and K. breviceps*), Cuvier's Beaked Whale (*Ziphius cavirostris*), Mesoplodont Beaked Whales (*Mesoplodon* spp.), Atlantic Spotted Dolphin (*Stenella frontalis*), Striped Dolphin (*Stenella coeruleoalba*), and the Western North Atlantic Northern Migratory Coastal stock of Common Bottlenose Dolphin (Hayes et al., 2017; Kraus et al., 2016; Roberts et al., 2016; Kenny & Vigness-Raposa, 2010). These species, along with Blue Whales, will not be considered further because exposure probability is low.

Species that occur in and near the Offshore Project Area, but are relatively uncommon, include Sperm Whale (*Physeter macrocephalus*), Risso's Dolphin (*Grampus griseus*), Short-finned Pilot Whale (*Globicephalus macrorhynchus*), and Harp Seal (*Pagophilus groenlandicus*). Sighting and distribution data suggest that Risso's Dolphins and Sperm

Whales typically occur in deeper waters along the continental slope and oceanic waters (Hayes et al., 2017; Roberts et al., 2016), though both species were observed during aerial surveys of MA/RI WEA from 2011-2015 (Kraus et al., 2016). Between 2011 and 2015, Kraus et al., (2016) made two sightings of individual Risso's Dolphins in spring, one sighting of one Sperm Whale in fall, and three sightings totaling eight Sperm Whales in summer. Short-finned Pilot Whales (*G. macrorhynchus*) tend to occur south of the Offshore Project Area, and are typically observed on the continental slope and in oceanic waters in the northern part of their range (Hayes et al., 2017; Roberts et al., 2016). Pilot Whales were observed during Kraus et al., (2016)'s aerial surveys of MA/RI WEAs; however, due to the difficulty in distinguishing between Long-finned and Short-finned Pilot Whales, the specific species of Pilot Whale was not clarified. However, the distribution records of Pilot Whales suggest these were likely Long-Finned Pilot Whales since these are more common (*G.melas*; Hayes et al., 2017). Harp Seals typically range north of the Offshore Project Area, though they strand annually in Massachusetts and Rhode Island (Hayes et al., 2017). Uncommon species may experience small levels of individual exposure probability and so are considered further (see Table 6.7-1).

Species that are likely to occur in the Offshore Project Area, and are considered common, include the North Atlantic Right Whale ("NARW"; *Eubalaena glacialis*), Humpback Whale (*Megaptera novaeangliae*), Fin Whale (*Balaenoptera physalus physalus*), Sei Whale (*Balaenoptera borealis*), Minke Whale (*Balaenoptera acutorostrata acutorostrata*), Long-Finned Pilot Whale, Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*), Short-Beaked Common Dolphin, Bottlenose Dolphin (Western North Atlantic Offshore Stock), Harbor Porpoise (*Phocoena phocoena*), Harbor Seal (*Phoca vitulina concolor*), and Gray Seal (BOEM, 2014; Hayes et al., 2017; Kenney & Vigness-Raposa, 2010; Kraus et al., 2016; Roberts et al., 2016). Because of their common use of the WDA, OECC, and surrounding areas, these species are likely to be exposed to stressors, such as noise, increased vessel traffic, and structures in the water that may result in short-term, localized disturbance of individuals and/or long-term, localized modification of habitat. Thus, these species are considered further (see Table 6.7-1).

6.7.1.2 Threatened and Endangered Marine Mammals

All marine mammals are protected by the MMPA. Four large whale species that occur in the Offshore Project Area are listed as endangered and, therefore, are afforded additional protection under the ESA. These species are the NARW, Fin Whale, Sei Whale, and Sperm Whale (35 Fed. Reg. 8491 [June 2, 1970]).

The following section provides information on the biology, habitat use, abundance, distribution, and the existing threats to these ESA-listed marine mammals that are both in Massachusetts offshore waters and have the likelihood of occurring, at least seasonally, in the Offshore Project Area. Marine mammal hearing is discussed in Section 6.7.2.1.1.

North Atlantic Right Whale. NARWs are among the rarest of all marine mammal species in the Atlantic Ocean. They average approximately 15 meters ("m") (50 feet ["ft"]) in length (NOAA, 2016k). They have stocky, black bodies with no dorsal fin, and bumpy, coarse patches of skin on their heads called callosities. NARW feed mostly on zooplankton and copepods belonging to the *Calanus* and *Pseudocalanus* genera (Hayes et al., 2017). NARWs are slow-moving grazers that feed on dense concentrations of prey at or below the water's surface, as well as at depth (NOAA, 2016k). Research suggests that NARWs must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo & Marx, 1990). These dense zooplankton patches are a primary characteristic of the spring, summer, and fall NARW habitats (Kenney, Hyman, Owen, Scott, & Winn, 1986; Kenney, Winn, & Macaulay, 1995).

These baleen whales are considered to be two separate stocks: the Eastern and Western Atlantic stocks. NARWs in US waters belong to the Western Atlantic stock. The Western Atlantic stock ranges primarily from calving grounds in coastal waters of the southeastern US to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Hayes et al., 2017).

Table 6.7-1 Marine Mammals that Potentially Occur in the WDA and OECC: Abundance, Status, Distribution, and Occurrence

Species	Scientific Name	Stock	Best Population Estimate in SAR[a]	Population Estimate Roberts et al., (2016)[b]	Strategic Status under MMPA[c]	Endangered Species Act Status	Occurrence within Offshore Project Area[d]
North Atlantic Right Whale	*Eubalaena glacialis*	Western North Atlantic	440[e]	535 Winter, 416 Spring, 379 Summer, 334 Fall	Strategic	Endangered	Common
Humpback Whale	*Megaptera novaeangliae*	Gulf of Maine	823[e]	205 Winter, 1,637 Summer	None	None	Common
Fin Whale	*Balaenoptera physalus physalus*	Western North Atlantic	1,618	4,633	Strategic	Endangered	Common
Sei Whale	*Balaenoptera borealis*	Nova Scotia	357	98 Winter, 627 Spring, 717 Summer, 37 Fall	Strategic	Endangered	Common (but less common than other common baleen whales)
Minke Whale	*Balaenoptera acutorostrata acutorostrata*	Canadian east coast	2,591	2,112 Summer, 740 Winter	None	None	Common
Blue Whale	*Balaenoptera musculus musculus*	Western North Atlantic	Unknown	11	Strategic	Endangered	Rare
Sperm Whale	*Physeter macrocephalus*	North Atlantic	2,288	5,353	Strategic	Endangered	Uncommon
Dwarf and Pygmy Sperm Whale	*Kogia sima* and *K. breviceps*	Western North Atlantic	2,598	3,785	None	None	Rare
Cuvier's Beaked Whale	*Ziphius cavirostris*	Western North Atlantic	6,532	14,491[f]	None	None	Rare
Mesoplodont Beaked Whales (Blainville's, Gervais', True's, Sowerby's)	*Mesoplodon* spp.	Western North Atlantic	7,092	14,491[f]	None	None	Rare
Risso's Dolphin	*Grampus griesus*	Western North Atlantic	18,250	7,732	None	None	Uncommon
Pilot Whale, Long-Finned	*Globicephalus melas*	Western North Atlantic	5,636	18,977[g]	Strategic	None	Uncommon
Pilot Whale, Short-Finned	*Globicephalus macrorhynchus*	Western North Atlantic	21,515	18,977[g]	Strategic	None	Rare
Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*	Western North Atlantic	48,819	37,180	None	None	Common
Short-Beaked Common Dolphin	*Delphinus delphis*	Western North Atlantic	70,184	86,098	None	None	Common
Atlantic Spotted Dolphin	*Stenella frontalis*	Western North Atlantic	44,715	55,436	None	None	Rare
Striped Dolphin	*Stenella coeruleoalba*	Western North Atlantic	54,807	75,657	None	None	Rare
Common Bottlenose Dolphin*	*Tursiops truncatus*	Western North Atlantic, offshore	77,532	97,476h	None	None	Common
Common Bottlenose Dolphin*	*Tursiops truncatus*	Western North Atlantic, northern migratory coastal	11,548	97,476h	Strategic	None	Rare

Table 6.7-1 Marine Mammals that Potentially Occur in the WDA and OECC: Abundance, Status, Distribution, and Occurrence (Continued)

Species	Scientific Name	Stock	Best Population Estimate in SAR[a]	Population Estimate Roberts et al., (2016)[b]	Strategic Status under MMPA[c]	Endangered Species Act Status	Occurrence within Offshore Project Area[d]
Harbor Porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	79,883	17,651 Winter, 45,089 Summer	None	None	Common
Harbor Seal	*Phoca vitulina concolor*	Western North Atlantic	75,834	Not Estimated	None	None	Common
Gray Seal	*Halichoerus grypus*	Western North Atlantic	Unknown[i]	Not Estimated	None	None	Common
Harp Seal	*Pagophilus groenlandicus*	Western North Atlantic	Unknown[i]	Not Estimated	None	None	Uncommon

*Bottlenose dolphins are listed twice because there are two stocks that potentially occur within the Offshore Project Area.

Notes:

[a] Best population estimates provided in the SARs (Hayes et al., 2017) generally consider only the portion of the population found in US Atlantic EEZ waters and may not include the entire US range depending on available survey data. Most cetacean population estimates are based on 2011 AMAPPS surveys (Hayes et al., 2017; NEFSC & SEFSC, 2011; Palka, 2012), with the exceptions of the following: Humpback Whales are based on surveys in the Gulf of Maine and Bay of Fundy in 2008; North Atlantic Right Whales are based on maximum number of photo-identified individuals (in 2012); Northern Migratory Stock of Bottlenose Dolphins is based on aerial surveys in 2010 and 2011 from Florida to New Jersey; Short-Beaked Common Dolphins are based on Canadian Trans-North Atlantic Sighting Survey in 2007 and include areas outside the EEZ. The Harbor Seal population estimate is based on 2012 surveys along the Maine coast. SARs often provide information on abundance estimates from larger or different parts of stock ranges when such estimates are available, but these estimates are not provided in this table.

[b] Roberts et al., (2016) uses habitat-based density modeling of 22 years of sighting data to predict densities of cetaceans in the US Atlantic EEZ. These models are often used for evaluating marine mammal harassment estimates for Incidental Harassment Authorizations and represent integrated population abundance estimates across multiple years of surveys. Roberts et al., (2016) does not include the NEFSC & SEFSC (2011) surveys used in Palka (2012) to estimate abundance for most species in the SARs (Hayes et al. 2017).

[c] The MMPA defines a "strategic" stock as a marine mammal stock (a) for which the level of direct human-caused mortality exceeds the potential biological removal level; (b) which, based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; or (c) which is listed as a threatened species or endangered species under the ESA, or (d) is designated as depleted.

[d] Occurrence in the Offshore Project Area was mainly derived from sightings and information in Hayes et al., (2017), Kenney & Vigness-Raposa (2010), Kraus et al., (2016), and Roberts et al., (2016).

[e] The minimum population estimate is reported as the best population estimate in the SAR.

[f] Roberts et al., (2016) grouped the following species in their analysis: Blainsville's Beaked Whale (*Mesoplodon densirostris*), Cuvier's Beaked Whale, Gervais' Beaked Whale (*M. europaeus*), Sowerby's Beaked Whale (*M. bidens*) and True's Beaked Whale (*M. mirus*).

[g] Roberts et al., (2016) grouped Long-Finned and Short-Finned Pilot Whales in their analysis.

[h] Roberts et al., (2016) did not differentiate the stocks of Bottlenose Dolphins, similar to how NOAA Fisheries estimates in stock assessments.

[i] Hayes et al., (2017) report the population sizes of these seal species as "unknown" because surveys have not been conducted within the US due to the northerly location of rookeries; however, they also report that estimates based on surveys at pupping areas north of the US have resulted in population estimates of 505,000 Gray Seals in 2014, and 7.1 million Harp Seals in 2012.

The size of the Western Atlantic stock is considered extremely low relative to its Optimum Sustainable Population ("OSP") in the US Atlantic EEZ (Hayes et al., 2017). The Western Atlantic NARW is classified as a strategic stock under the MMPA and is listed as endangered under the ESA. Historically, the population suffered severely from commercial overharvesting and has more recently been threatened by incidental fishery entanglement and vessel collisions (Pace, Corkeron, & Kraus, 2017; Knowlton & Kraus, 2001; Kraus et al., 2005). The minimum rate of annual human-caused mortality and serious injury to NARWs averaged 5.66 per year for the period of 2010 through 2014 (Hayes et al., 2017).

Hayes et al., (2017) reports a minimum of 440 individuals in this stock based on photo-identification recapture data from 2012. A recent estimate of 529 photographed individuals was reported in the NARW annual report card, but the best estimate of living whales was reported to be 451 (Pettis, Pace, Schick, & Hamilton, 2017) based on Pace et al., (2017), which reports a 99.99% probability of NARW population decline from 2010 to 2015. This estimate does not consider that NARWs have been experiencing an unusual mortality event since June 2017, with 16 documented deaths as of October 31, 2017 (NOAA, 2017d). This unusual mortality event appears to be driven by entanglement and trauma associated with fisheries interactions mainly in Canada. In addition to 16 deaths, five live NARWs entangled in fishing gear were recorded (Daoust, Couture, Wimmer, & Bourque, 2017; NOAA, 2017d). Cause of death findings for the unusual mortality event are based on six necropsies of the dead NARWs found in Canada in the Gulf of St. Lawrence (Daoust et al., 2017).

The NARW is a migratory species that travels from high-latitude feeding waters to low-latitude calving and breeding grounds, though this species has been observed feeding in winter in the mid-Atlantic region and was recorded off the coast of New Jersey in all months of the year (Whitt, Dudzinski, & Laliberte, 2013). These whales undertake a seasonal migration from their northeast feeding grounds (generally spring, summer, and fall habitats) south along the US East Coast to their calving grounds in the waters of the southeastern US (Kenney & Vigness-Raposa, 2010).

NARWs are usually observed in groups of less than 12 individuals, and most often as single individuals or pairs. Larger groups may be observed in feeding or breeding areas (Jefferson, Webber, & Pitman, 2008). Surveys have demonstrated the existence of seven areas where Western Atlantic NARWs congregate seasonally: the coastal waters of the southeastern US; the Great South Channel; Jordan Basin; Georges Basin along the northeastern edge of Georges Bank; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Roseway Basin on the Scotian Shelf (Hayes et al., 2017). NOAA Fisheries has designated two critical habitat areas for the NARW under the ESA: the Gulf of Maine/Georges Bank region, and the southeast calving grounds from North Carolina to Florida (81 Fed. Reg. 4837 [2016]). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the NARW (Brown et al., 2009).

NEFSC observed NARWs three times in the WDA during two AMAPPS surveys in 2014 (NEFSC & SEFSC, 2011, 2012, 2013, 2014, 2015, 2016). Two observations of NARWs in the WDA were in the winter during an aerial survey; one observation was in the spring during a shipboard survey (NEFSC & SEFSC, 2014).

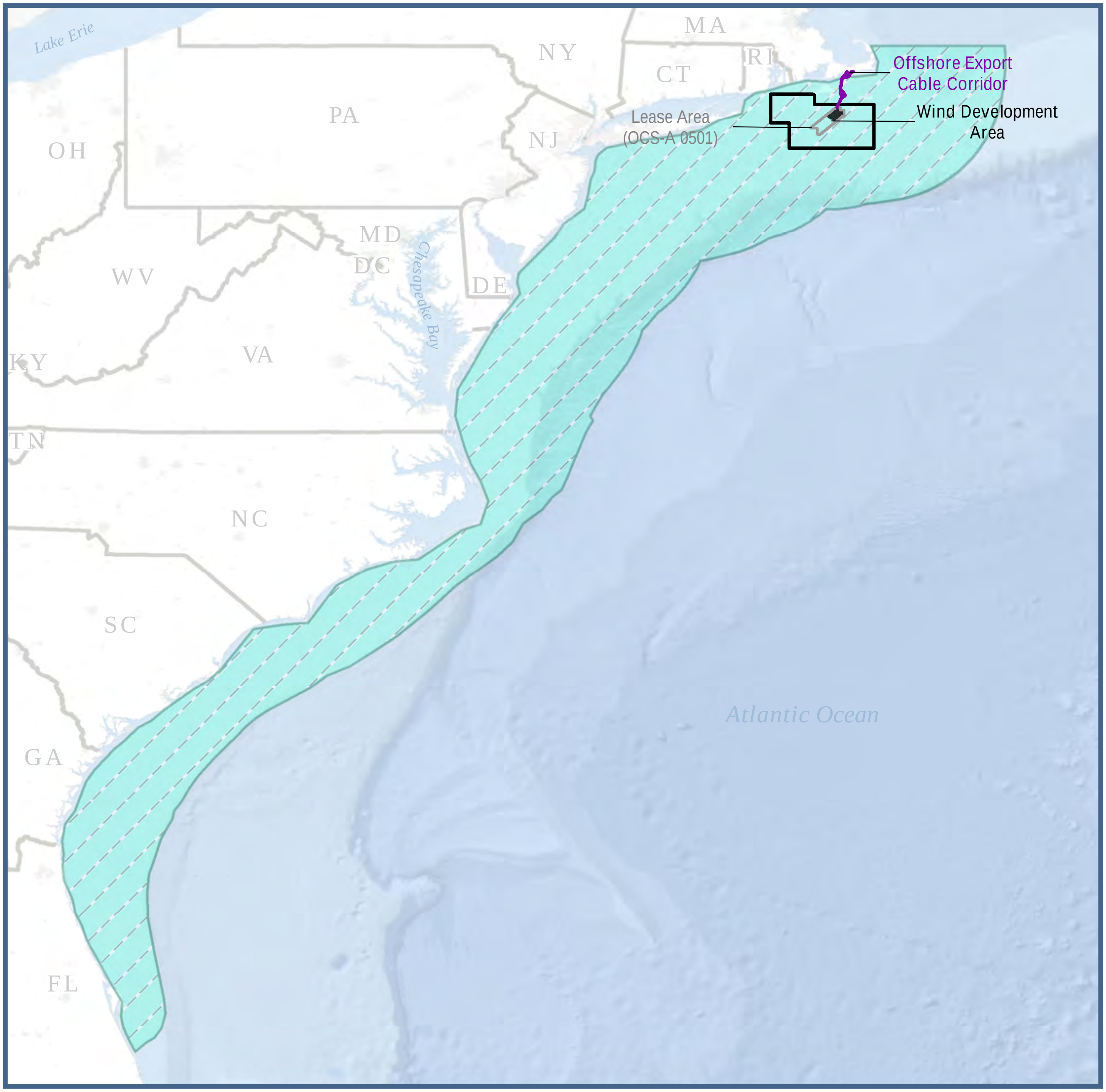
Kraus et al., (2016) observed NARWs in the MA/RI WEAs in winter and spring and observed 11 instances of courtship behavior. The greatest sightings per unit effort ("SPUE") in the MA/RI WEAs by Kraus et al., (2016) was in March, with a concentration of spring sightings in the WDA and winter sightings in the OECC. Seventy-seven unique individual NARWs were observed in the MA/RI WEAs over the duration of the Northeast Large Whale Pelagic Survey (October 2011-June 2015) (Kraus et al., 2016). Monthly SPUE for NARWs by Kraus et al., (2016) are shown in Figure 6.7-1. No calves were observed. Kraus et al., (2016) acoustically detected NARWs with PAM within the MA WEA on 43% of project days (443/1,020 days) and during all months of the year. Acoustic detections do not differentiate between individuals, so detections on multiple days could be the same or different individuals. The NARWs exhibited notable seasonal variability in acoustic presence, with maximum occurrence in the winter and spring (January through March), and minimum occurrence in summer (July, August, and September). Mean detection range for NARWs using PAM ranged from 15-24 km (49.2-78.7 ft), with a mean radius of 21 km (13 mi) (95% Confidence Interval of three kilometers [1.8 mi]) for the PAM system within the WDA. However, not all NARWs recorded by PAM in the MA WEAs were likely to be within a distance of the Project that would result in any disturbance of individuals by construction and operation. Keeping in mind that such estimates were based on a number of assumptions and are not species-specific, the maximum distance from pile driving to behavioral harassment for low frequency cetaceans such as NARWs was estimated at 7,116 m (23,346 ft) with no sound reduction technology (unweighted; 160 dB; 10.3 m monopiles; see Appendix III-M Table A-10). Vineyard Wind will use sound reduction technology, including Hydro-sound Dampers [HSD], bubble curtains, or similar technology, to achieve a target of approximately 12 dB of noise reduction, resulting in an estimated maximum behavioral harassment distance of 2,907 m (9,537 ft) (unweighted; 160 dB; 10.3 m monopiles; see Appendix III-M Table A-37). This results in a much smaller radius of disturbance than the mean detection range of the PAM system. Additionally, animals are less likely to respond to sound levels distant from a source, even when those levels elicit response at closer ranges; both proximity and received levels are important factors in behavioral response (Dunlop et al., 2017).

This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the Project (Vineyard Wind, 2016, 2017). Roberts et al., (2016) predict that the highest density of NARW in the MA WEA and adjacent waters occurs in April, and Kraus et al., (2016) reported greatest levels of SPUE of NARWs in the WDA in March (Figure 6.7-1). A NARW Biologically Important Area ("BIA") for migration occurs within the Lease Area from March to April and from November to December

(LaBrecque, Curtice, Harrison, Van Parijs, & Halpin, 2015). To determine BIAs, experts were asked to evaluate the best available information and to summarize and map areas important to cetacean species' reproduction, feeding, and migration. The purpose of identifying these areas was to help resource managers with planning and analysis. The NARW BIA for migration includes the MA/RI WEA and beyond to the continental slope, extending northward to offshore of Provincetown, MA and southward to halfway down the Florida coast. The edge seaward of the BIA shifts inshore of the continental slope off North Carolina and remains closer to shore to its southward extent. The shoreward edge remains in nearshore waters along the length of the BIA (see Figure 6.7-2) (LaBrecque et al., 2015).

Fin Whale. Fin Whales are the second-largest species of baleen whale, with a maximum length of about 22.8 m (75 ft) in the Northern Hemisphere (NOAA, 2016e). These whales have a sleek, streamlined body with a V-shaped head that makes them fast swimmers. This species has a distinctive coloration pattern: the dorsal and lateral sides of the body are black or dark brownish-gray and the ventral surface is white. Fin Whales feed on krill (Euphausiacea), small schooling fish (e.g., Herring [*Clupea harengus*], Capelin [*Mallotus villosus*], and Sand Lance [*Ammodytidae spp.*]), and squid (*Teuthida spp.*) by lunging into schools of prey with their mouths open (Kenney & Vigness-Raposa, 2010). They occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally (NOAA, 2016e). Fin Whales are the most commonly observed large whales in continental shelf waters from the mid-Atlantic coast of the US to Nova Scotia (Sergeant, 1977; Sutcliffe & Brodie, 1977; CeTAP, 1982; Hain, Ratnaswamy, Kenney, & Winn, 1992).

Fin Whales off the eastern US, Nova Scotia, and the southeastern coast of Newfoundland are believed to constitute a single stock under the present International Whaling Commission scheme (Donovan, 1991), which has been called the Western North Atlantic stock. The best abundance estimate available for the Western North Atlantic Fin Whale stock in US waters is estimated at 1,618 individuals (Hayes et al., 2017). The status of this stock relative to OSP in the US Atlantic EEZ is unknown, but the North Atlantic population is listed as a strategic stock under the MMPA and is listed as endangered under the ESA. Waring, Josephson, Maze-Foley, & Rosel (2013) reported the abundance of Fin Whales estimated in Palka (2012) from 2011 NEFSC & SEFSC (2011) surveys; Lawson & Gosselin (2011) corrected estimates from Canadian surveys in 2007; and a survey by the National Marine Fisheries Service ("NMFS") in 2006 (unpublished data reported in Waring et al., 2013) that covers additional areas of the stocks range. The sum of these abundance estimates, which consider a larger portion of the Fin Whale breeding population range than Hayes et al., (2017), is 7,409. Newer estimates are being evaluated based on NEFSC & SEFSC (2016) surveys and concurrent surveys in Canadian waters. Like most other whale species along the US Atlantic EEZ, ship strikes and fisheries entanglements are perennial causes of serious injury and mortality. For the period 2010 through 2014, the minimum annual rate of human-caused mortality and serious injury to Fin Whales was 3.8 per year (Hayes et al., 2017).



Service Layer Credits: Esri, DeLorme, GEBCO,
NOAA NGDC, and other contributors
LaBrecque et al. 2015; ESRI 2017, BOEMRE 2017;
E&E 2017

Map Coordinate System: GCS NAD83 (2011)

LEGEND

- State Boundary
- County Boundary
- ☐ Lease Area
- ■ Wind Development Area
- ☐ Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area
- Offshore Export Cable Corridor
- ▨ North Atlantic Right Whale Biologically Important Area for migration

N
W E
S

0 25 50 100 Nautical Miles

0 50 100 Kilometers

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Figure 6.7-2

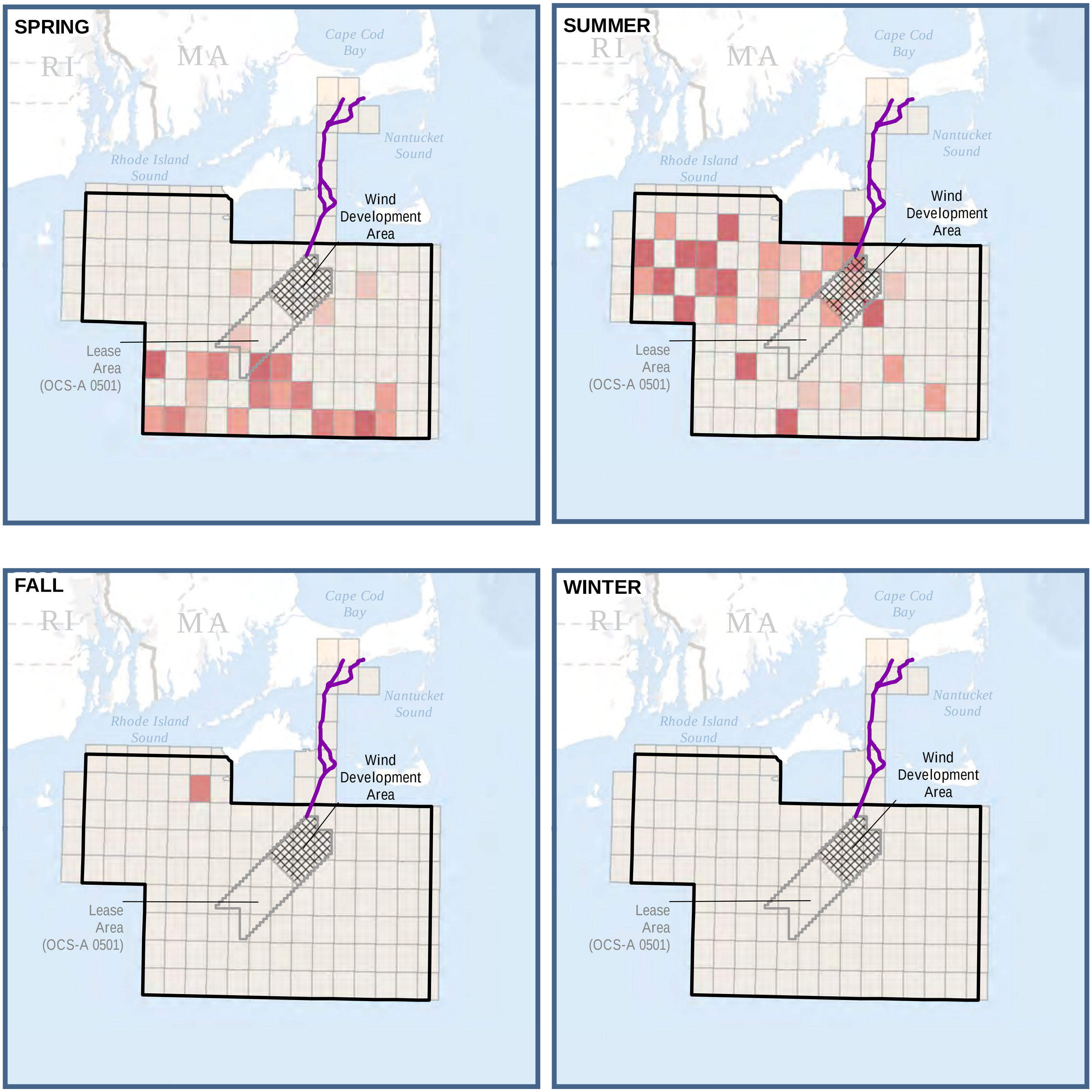
North Atlantic Right Whale Biologically Important Area for Migration
March to April and November to December

The Fin Whale's range in the western North Atlantic extends from the Gulf of Mexico and Caribbean Sea, to the southeastern coast of Newfoundland (Hayes et al., 2017). Fin Whales are common in waters of the US Atlantic EEZ, principally from Cape Hatteras northward. While Fin Whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas are largely unknown (Hain et al., 1992; Hayes et al., 2017). It is likely that Fin Whales occurring in the US Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire Fin Whale populations make distinct annual migrations like some other Mysticetes has questionable support (Hayes et al., 2017). Based on an analysis of neonate stranding (newborn whale beaching) data, Hain et al., (1992) suggest that calving takes place during October to January in latitudes of the US mid-Atlantic region.

Fin Whales are the dominant large cetacean species during all seasons from Cape Hatteras to Nova Scotia, having the largest standing stock, the largest food requirements, and, therefore, the largest influence on ecosystem processes of any baleen whale species (Hain et al., 1992; Kenney, Scott, Thompson, & Winn, 1997). There are currently no critical habitat areas established for the Fin Whale under the ESA.

NEFSC observed Fin Whales six times in the WDA during three AMAPPS surveys (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). One observation was in the summer of 2013 during a shipboard survey; three observations were in the summer of 2016 during a shipboard survey; and two observations were during fall of 2016 during an aerial survey (NEFSC & SEFSC, 2013, 2014, 2016).

Kraus et al., (2016) suggest that, compared to other baleen whale species, Fin Whales have a high multi-seasonal relative abundance in the MA/RI WEA and surrounding areas. Fin Whales were observed in the MA WEA in spring and summer. This species was observed primarily in the offshore (southern) regions of the BOEM MA and MA/RI WEA during spring, and found closer to shore (northern areas) during the summer months (see Figure 6.7-3) (Kraus et al., 2016). Calves were observed three times and feeding was observed nine times during the Kraus et al., (2016) study. Although Fin Whales were largely absent from visual surveys in the MA/RI WEA in the fall and winter months (Kraus et al., 2016), acoustic data indicated that this species was present in the MA/RI WEs during all months of the year. Fin Whales were acoustically detected in the MA WEA on 87% of project days (889/1,020 days). Acoustic detections do not differentiate individuals, so detections on multiple days could be the same or different individuals. Acoustic detection data indicated a lack of seasonal trends in Fin Whale abundance with slightly less detections from April to July (Kraus et al., 2016). As the detection range for Fin Whale vocalizations is in excess of 200 km (108 nm), detected signals may have originated from areas far outside of the MA/RI WEA; however, though the arrival patterns of many Fin Whale vocalizations indicated that



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016., ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*

LEGEND

- State Boundary
- County Boundary
- Lease Area
- ▨ Wind Development Area
- Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area
- Offshore Export Cable Corridor

Fin Whale

Sightings per Unit Effort (SPUE*)

- 0
- <0 - 10
- 10 - 20
- 20 - 30
- 30 - 225

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Figure 6.7-3

Fin Whale Seasonal Aerial Survey Sightings per Unit Effort from Kraus et al. (2016) October 2011 to June 2015 received signals likely originated from within the Kraus et al., (2016) study area. This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the Project (Vineyard Wind, 2016, 2017). The Lease Area is flanked by two BIAs for feeding for Fin Whales. The area to the northeast is considered a BIA year-round, while the area off the tip of Long Island to the southwest is a BIA from March to October (LaBrecque et al., 2015).

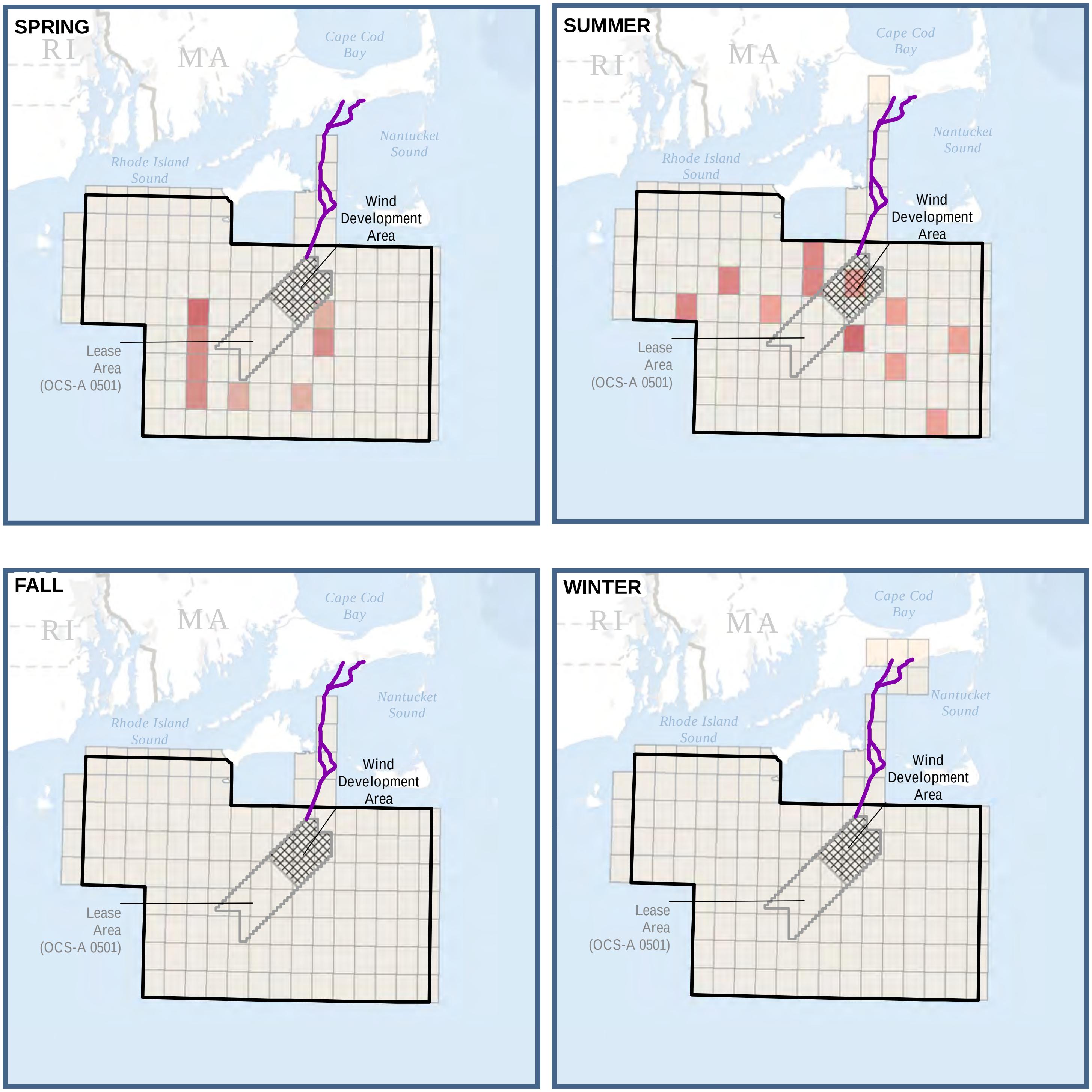
Sei Whale. Sei Whales are a baleen whale that can reach lengths of about 12-18 m (40 -60 ft) (NOAA, 2015c). This species has a long, sleek body that is dark bluish-gray to black in color and pale underneath (NOAA, 2015c). Their diet is comprised primarily of plankton, schooling fish, and cephalopods. Sei Whales generally travel in small groups (two to five individuals), but larger groups are observed on feeding grounds (NOAA, 2015c).

The stock that occurs in the US Atlantic EEZ is the Nova Scotia stock, which ranges along the continental shelf waters of the northeastern United States to Newfoundland (Hayes et al., 2017). The best abundance estimate for this stock in the US Atlantic EEZ is 357 individuals. This estimate is considered an underestimate because the full known range of the stock was not surveyed, the estimate did not include availability-bias correction for submerged animals, and there was uncertainty regarding population structure (Hayes et al., 2017). Sei Whales are listed as endangered under the ESA and the Nova Scotia stock is considered strategic under the MMPA. Between 2010 and 2014, the average annual minimum human-caused mortality and serious injury was 0.8 Sei Whales per year (Hayes et al., 2017).

Sighting data suggest Sei Whale distribution is largely centered in the waters of New England and eastern Canada (Hayes et al., 2017; Roberts et al., 2016). There appears to be a strong seasonal component to Sei Whale distribution. Sei Whales are relatively widespread and most abundant in New England waters from spring to fall (April to July). During winter, the species is predicted to be largely absent (Roberts et al., 2016). There are no critical habitat areas designated for the Sei Whale under the ESA.

NEFSC observed Sei Whales two times in the WDA during one AMAPPS survey (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). The two observations were made in the summer of 2016 during a shipboard survey (NEFSC & SEFSC, 2016).

Kraus et al., (2016) observed Sei Whales in the MA/RI WEAs and surrounding areas only between the months of March and June. The number of Sei Whale observations was less than half that of other baleen whale species in the two seasons in which Sei Whales were observed (spring and summer). This species demonstrated a distinct seasonal habitat use pattern that was consistent throughout the study (see Figure 6.7-4). Calves were observed three times and feeding was observed four times during the Kraus et al., (2016) study. Because of uncertainty associated with identifying Sei Whale vocalizations, this species was



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016., ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*

N W E S

0 5 10 20 Nautical Miles

0 10 20 Kilometers

LEGEND

- State Boundary
- County Boundary
- ▭ Lease Area
- ▩ Wind Development Area
- ▭ Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area
- Offshore Export Cable Corridor

Sei Whale

Sightings per Unit Effort (SPUE*)

- ■ <0
- ■ >0 - 5
- ■ 5 - 10
- ■ 10 - 20
- ■ 20 - 42

Vineyard Wind Project

VINEYARD WIND

Figure 6.7-4

Sei Whale Seasonal Aerial Survey Sightings per Unit Effort from Kraus et al. (2016) October 2011 to June 2015 not included in Kraus et al., (2016) PAM analyses. Sei Whales were not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the Project (Vineyard Wind, 2016, 2017); however, the survey was conducted during October and November when Sei Whale occurrence is not anticipated due to the seasonal nature of their occurrence in this region. A BIA for feeding for Sei Whales occurs west of the Lease Area from May to November (LaBrecque et al., 2015). Sei Whales are expected to be present but much less common than Fin, Minke, Humpback, and NARWs based on Kraus et al., (2016) sighting rates.

Sperm Whale. The Sperm Whale is the largest of all toothed whales; males can reach 16 m (52 ft) in length and weigh over 40,823 kilograms ("kg"); (45 US tons), and females can attain lengths of up to 11 m (36 ft) and weigh over 13,607 kg (15 tons) (Perrin, Wursig, & Thewissen, 2002). Sperm Whales have extremely large heads, which account for 25-35% of the total length of the animal. This species tends to be uniformly dark gray in color, though lighter spots may be present on the ventral surface. Sperm Whales frequently dive to depths of 400 m (1,300 ft) in search of their prey, which includes large squid, fishes, octopus, sharks, and skates (Perrin et al., 2002). This species can remain submerged for over an hour and reach depths as great as 1,000 m (3,280 ft). Sperm Whales have a worldwide distribution in deep water and range from the equator to the edges of the polar ice packs (Whitehead, 2002). Sperm Whales form stable social groups and exhibit a geographic social structure; females and juveniles form mixed groups and primarily reside in tropical and subtropical waters, whereas males are more solitary and wide-ranging and occur at higher latitudes (Whitehead, 2002, 2003).

The International Whaling Commission recognizes only one stock of Sperm Whales for the North Atlantic, and Reeves & Whitehead (1997) and Dufault, Whitehead, & Dillon (1999) suggest that Sperm Whale populations lack clear geographic structure. Current threats to the Sperm Whale population include ship strikes, exposure to anthropogenic noise and toxic pollutants, and entanglement in fishing gear (though entanglement risk for sperm whales is relatively low compared to other, more coastal whale species) (NOAA, 2017e; Waring, Josephson, Maze-Foley, & Rosel, 2015). Though there is currently no reliable estimate of total Sperm Whale abundance in the entire western North Atlantic, the most recent population estimate for the US Atlantic EEZ is 2,288 (Waring et al., 2015). This estimate was generated from the sum of surveys conducted in 2011, and is likely an underestimate of total abundance, as these surveys were not corrected for Sperm Whale dive-time. Maximum monthly abundance in the US Atlantic EEZ was estimated to be 7,200 in density models based on 22 years of survey data (Roberts et al., 2016). Sperm Whales are listed as endangered under the ESA and the North Atlantic stock is considered strategic under the MMPA. Total annual estimated average human-caused mortality to this stock during the period from 2008 to 2012 was 0.8 Sperm Whales (Waring et al., 2015).

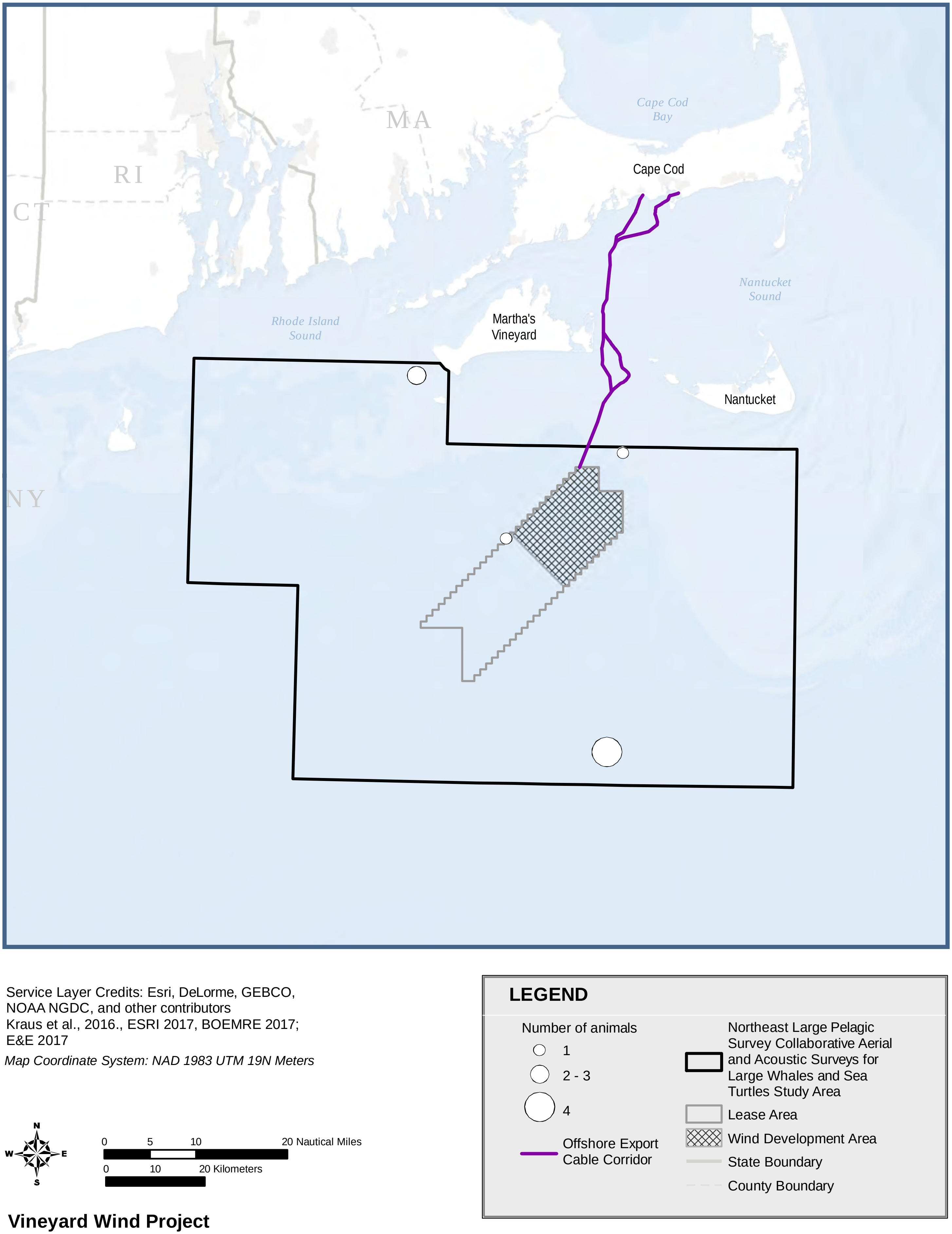
Sperm Whales mainly reside in deep-water habitats on the Outer Continental Shelf, along the shelf edge, and in mid-ocean regions (NOAA, 2010). However, this species has been observed in relatively high numbers in the shallow continental shelf areas of southern New England (Scott & Sadove, 1997). Sperm Whale migratory patterns are not well-defined, and no obvious migration patterns have been observed in certain tropical and temperate areas. However, general trends suggest that most populations move poleward during summer months (Waring et al., 2015). In US Atlantic EEZ waters, Sperm Whales appear to exhibit seasonal movement patterns (CeTAP, 1982; Scott & Sadove, 1997). During the winter, Sperm Whales are concentrated to the east and north of Cape Hatteras. This distribution shifts northward in spring, when Sperm Whales are most abundant in the central portion of the mid-Atlantic bight to the southern region of Georges Bank. In summer, this distribution continues to move northward, including the area east and north of Georges Bank and the continental shelf to the south of New England. In fall months, Sperm Whales are most abundant on the continental shelf to the south of New England and remain abundant along the continental shelf edge in the mid-Atlantic bight. There are no critical habitat areas designated for the Sperm Whale under ESA.

No Sperm Whales were observed in the WDA or OECC during AMAPPS surveys from 2010-2016 (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Kraus et al., (2016) observed Sperm Whales four times in the MA/RI WEAs during the summer and fall from 2011 to 2015. Sperm Whales, traveling singly or in groups of three or four, were observed three times in August and September of 2012, and once in June of 2015. Effort-weighted average sighting rates could not be calculated. In the WDA, one Sperm Whale was observed on the northwestern border and in the OECC, and one was observed between the WDA and Nantucket Island (see Figure 6.7-5). The frequency of Sperm Whale clicks exceeded the maximum frequency of PAM equipment used in Kraus et al., (2016), so no acoustic data are available for this species from that study. This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the Project (Vineyard Wind, 2016, 2017). Sperm Whales are expected to be present but uncommon in the Offshore Project Area based on Kraus et al., (2016) sightings.

6.7.1.3 Non-ESA Listed Marine Mammals

The following section provides additional information on the biology, habitat use, abundance, distribution, and the existing threats to the non-endangered or threatened marine mammals that are both in Massachusetts offshore waters and have the likelihood of occurring, at least seasonally, in the Offshore Project Area. Marine mammal hearing is discussed in Section 6.7.2.1.1.

Minke Whale. Minke Whales are a baleen whale species, reaching 10 m (35 ft) in length (NOAA, 2014b). Minke Whales have a cosmopolitan distribution in temperate, tropical, and high latitude waters (Hayes et al., 2017). The Minke Whale is common and widely distributed within the US Atlantic EEZ and is the third most abundant great whale (any of



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016., ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

Vineyard Wind Project

VINEYARD WIND

Figure 6.7-5

Sperm Whale Aerial Survey Sightings from Kraus et al. (2016) October 2011 to June 2015 the larger marine mammals of the order Cetacea) in the EEZ (CeTAP, 1982). This species has a dark gray-to-black back and a white ventral surface (NOAA, 2014b). Its diet is comprised primarily of crustaceans, schooling fish, and copepods. Minke Whales generally travel in small groups (one to three individuals), but larger groups have been observed on feeding grounds (NOAA, 2014b).

In the North Atlantic, there are four recognized populations: Canadian East Coast, West Greenland, Central North Atlantic, and Northeastern North Atlantic (Donovan, 1991). Until better information becomes available, Minke Whales in the US Atlantic EEZ are considered part of the Canadian East Coast stock, which inhabits the area from the western half of the Davis Strait (45°W) to the Gulf of Mexico. It is also uncertain if there are separate sub-stocks within the Canadian East Coast stock. The best abundance estimate for the US Atlantic EEZ is 2,591 (Hayes et al., 2017). Lawson and Gosslin (2011) corrected estimate of abundance of this stock in Canadian waters was 20,741 in 2007. This is the estimate derived from the Canadian Trans-North Atlantic Sighting Survey ("TNASS") in July-August 2007. This survey covered more of the Minke Whale range than other surveys (Lawson & Gosselin 2009). If US estimates (2,591 Central Virginia to Lower Bay of Fundy and 3,312 South Gulf of Maine to Upper Bay of Fundy and Gulf of St. Lawrence) are added to the TNASS estimate, total abundance across that part of the Minke Whale range is estimated to be 26,644 (Waring et al., 2013). Minke Whales are not listed as threatened or endangered under the ESA and the Canadian East Coast stock is not considered strategic under the MMPA. During 2010 to 2014, the average annual minimum human-caused mortality and serious injury was 8.25 Minke Whales per year (Hayes et al., 2017).

Sighting data suggest that Minke Whale distribution is largely centered in the waters of New England and eastern Canada (Hayes et al., 2017). Risch et al., (2013) reported a decrease in Minke Whale calls north of 40°N in late fall with an increase in calls between 20° and 30°N in winter and north of 35°N during spring. Mating and calving most likely take place during the winter season in lower latitude wintering grounds (NOAA, 2014b).

NEFSC observed Minke Whales five times in the WDA during four AMAPPS surveys (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). One observation was in the fall of 2010 during an aerial survey; one observation was in the spring of 2014 during a shipboard survey; two observations were during the summer of 2016 during a shipboard survey; and one observation was in the fall of 2016 during an aerial survey (NEFSC & SEFSC, 2010, 2014, 2016).

Kraus et al., (2016) observed Minke Whales in the MA/RI WEA and surrounding areas primarily from May to June. This species demonstrated a distinct seasonal habitat usage pattern that was consistent throughout the study. Though Minke Whales were observed in spring and summer months in the MA WEA, they were only observed in the Lease Area in the spring. Minke Whales were not observed between October and February, but acoustic data indicate the presence of this species in the Offshore Project Area in winter months.

Calves were observed twice and feeding was also observed twice during the Kraus et al., (2016) study. Minke Whales were acoustically detected in the MA WEA on 28% of project days (291/1,020 days). Acoustic detections do not differentiate between individuals, so detections on multiple days could be the same or different individuals. Minke Whale acoustic presence data also exhibited a distinct seasonal pattern; acoustic presence was lowest in the months of December and January, steadily increased beginning in February, peaked in April, and exhibited a gradual decrease throughout the summer months (Kraus et al., 2016). Acoustic detection range for this species was small enough that over 99% of detections were limited to within the Kraus et al., (2016) study area. This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 surveys for the Project (Vineyard Wind, 2016, 2017). Minke Whales have a BIA for feeding west of the Lease Area from March to November (LaBrecque et al., 2015).

Humpback Whale. Humpback Whale females are larger than males and can reach lengths of up to 18 m (60 ft) (NOAA, 2016g). Humpback Whale body coloration is primarily dark gray, but individuals have a variable amount of white on their pectoral fins, belly, and flukes. These distinct coloration patterns are used by scientists to identify individuals. These baleen whales feed on small prey often found in large concentrations, including krill and fish such as Herring and Sand Lance (Kenney & Vigness-Raposa, 2010). Humpback Whales use unique behaviors, including bubble nets, bubble clouds, and flickering of their flukes and fins, to herd and capture prey (NOAA, 1991).

In the North Atlantic, six separate Humpback Whale sub-populations have been identified by their consistent maternally determined fidelity to different feeding areas (Clapham & Mayo, 1987). These populations are found in the Gulf of Maine, Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Hayes et al., 2017). The large majority of Humpback Whales that inhabit the waters in the US Atlantic EEZ belong to the Gulf of Maine stock. The most recent ocean-basin-wide estimate of the North Atlantic Humpback Whale population is 11,570 (Palsbøll et al., 1997). The most recent minimum population estimate for the Gulf of Maine stock is 823 individuals (Hayes et al., 2017).

The entire Humpback species was previously listed as endangered under the ESA. However, in September 2016, NMFS identified 14 DPSs of Humpback Whale and revised the ESA listing for this species. Four DPSs were listed as endangered, one as threatened, and listing was deemed not warranted for the remaining nine DPSs. All Humpback Whales in the US Atlantic EEZ belong to the West Indies DPS, which is not listed under the ESA (81 Fed. Reg. 62,269 [2016]). For the period of 2010 through 2014, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine Humpback Whale stock averaged 9.05 animals per year (Hayes et al., 2017).

Humpback Whales in the Gulf of Maine stock typically feed in the waters between the Gulf of Maine and Newfoundland during spring, summer, and fall, but have been observed feeding in other areas, such as off the coast of New York (Sieswerrda, Spagnoli, & Rosenthal n.d.). Some Humpback Whales from most feeding areas, including the Gulf of Maine, 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 because significant numbers of animals are located in mid- and high-latitude regions at this time (Swingle, Barco, Pitchford, McLellan, & Pabst, 1993).

NEFSC observed Humpback Whales nine times in the WDA during three AMAPPS surveys (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Six observations were in the summer of 2013 during a shipboard survey; one observation was in the spring of 2014 during a shipboard survey; and two observations were during fall of 2016 during an aerial survey (NEFSC & SEFSC, 2013, 2014, 2016).

Kraus et al., (2016) observed Humpback Whales in the MA/RI WEA and surrounding areas during all seasons. Humpback Whales were observed most often during spring and summer months, with a peak from April to June. Calves were observed 10 times and feeding was observed 10 times during the Kraus et al., (2016) study. Kraus et al., (2016) also observed one instance of courtship behavior. Although Humpback Whales were only rarely seen during fall and winter surveys, acoustic data indicates that this species may be present within the MA WEA year-round, the with highest rates of acoustic detections in winter and spring (Kraus et al., 2016). Humpback Whales were acoustically detected in the MA WEA on 56% of project days (566/1,020 days). Acoustic detections do not differentiate between individuals, so detections on multiple days could be the same or different individuals. Mean detection range for Humpback Whales using PAM ranged from 30-36 km (18.6-22.3 mi), with a mean radius of 36 km (22.3 mi) (95% Confidence Interval of five kilometers [3.1 mi]) for the PAM system within the WDA. However, not all Humpback Whales recorded by PAM in the MA WEA were likely to be within a distance of the Project that would result in any disturbance of individuals by construction and operation. Keeping in mind that such estimates are based on a number of assumptions and are not species-specific, the maximum distance from pile driving to behavioral harassment for low frequency cetaceans such as humpback whales has been estimated at 7,116 m (23,346 ft) with no sound reduction technology (unweighted; 160dB; 10.3 m monopiles; see Appendix III-M Table A-10). Vineyard Wind will use sound reduction technology to achieve a target of approximately 12 dB of noise reduction, resulting in an estimated maximum behavioral harassment distance of 2,907 m (9,537 ft) (unweighted; 160dB; 10.3 m monopiles; see Appendix III-M Table A-37). This results in a much smaller radius of disturbance than the mean detection range of the PAM system.

Kraus et al., (2016) estimated that 63% of acoustic detections of Humpback Whales represented whales within their study area. This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 surveys for the Project (Vineyard Wind, 2016, 2017). Humpback Whales in the Western North Atlantic have been experiencing an unusual mortality event since January 2016 that appears to be related to larger than usual numbers of vessel collisions (NOAA, 2017a). A total of 57 mortalities have been documented through October 31, 2017, as part of this event (NOAA, 2017a). Humpback Whales have a BIA for feeding west of the Lease Area from March to December (LaBrecque et al., 2015).

Pilot Whales. Two species of Pilot Whale occur within the Western North Atlantic: the Long-Finned Pilot Whale and the Short-Finned Pilot Whale. These species are difficult to differentiate at sea and cannot be reliably distinguished during most surveys (Hayes et al., 2017; Rone & Pace, 2012), so some of the descriptions below refer to both species unless otherwise stated. Pilot Whales have bulbous heads, are dark gray, brown, or black in color, and can reach approximately 7.3 m (25 ft) in length (NOAA, 2016i, 2016m). These whales form large, relatively stable aggregations that appear to be maternally determined (ACS, 2016). Pilot Whales feed primarily on squid, although they also eat small to medium-sized fish and octopus when available (NOAA, 2016i, 2016m).

Within the US Atlantic EEZ, both species are categorized into Western North Atlantic stocks. The best available population estimate in the US Atlantic EEZ for Short-Finned Pilot Whales is 21,515 and for Long-Finned Pilot Whales is 5,636 (Hayes et al., 2017). These estimates are from summer 2011 aerial and shipboard surveys covering waters from central Florida to the lower Bay of Fundy (Hayes et al., 2017). Total annual estimated average fishery-related mortality or serious injury during 2010-2014 was 38 Long-Finned Pilot Whales, and 192 Short-Finned Pilot Whales per year (Hayes et al., 2017). Neither Pilot Whale species is listed as threatened or endangered under the ESA. Both stocks are considered strategic under the MMPA (Hayes et al., 2017).

In US Atlantic waters, Pilot Whales are distributed principally along the continental shelf edge off the northeastern US coast in winter and early spring (CeTAP, 1982; Payne & Heinemann, 1993; Abend & Smith, 1999; Hamazaki, 2002). In late spring, Pilot Whales move onto Georges Bank, into the Gulf of Maine, and into more northern waters, where they remain through late fall (CeTAP, 1982; Payne & Heinemann, 1993). Short-Finned Pilot Whales are present within warm temperate to tropical waters and Long-Finned Pilot Whales occur in temperate and subpolar waters. Long-Finned and Short-Finned Pilot Whales overlap spatially along the mid-Atlantic shelf break between New Jersey and the southern flank of Georges Bank (Payne & Heinemann, 1993; Hayes et al., 2017). Long-Finned Pilot Whales have occasionally been observed stranded as far south as South Carolina, and Short-Finned Pilot Whale have stranded as far north as Massachusetts (Hayes et al., 2017). The latitudinal ranges of the two species therefore remain uncertain. However, south of Cape Hatteras, most Pilot Whale sightings are expected to be Short-Finned Pilot Whales, while north of approximately 42°N, most Pilot Whale sightings are expected to be Long-Finned Pilot Whales (Hayes et al., 2017). Based on the distributions described in Hayes et al., (2017), Pilot Whale sightings in the Offshore Project Area would most likely be Long-Finned Pilot Whales.

No Pilot Whales were observed in the WDA or OECC during AMAPPS surveys from 2010-2016 (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Kraus et al., (2016) observed Pilot Whales infrequently in the MA/RI WEA and surrounding areas. Effort-weighted average sighting rates for Pilot Whales could not be calculated. No Pilot Whales were observed during the fall or winter, and these species were only observed 11 times in the spring and three times in the summer. Two of these sightings included calves. It is possible that the Northeast Large Whale Pelagic Survey may have underestimated the abundance of Pilot Whales, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al., 2016). This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the Project (Vineyard Wind, 2016, 2017).

Risso's Dolphin. Risso's Dolphins are located worldwide in both tropical and temperate waters (Jefferson et al., 2008, 2014). The Risso's Dolphin attains a body length of approximately 2.6-4 m (8.5-13 ft) (NOAA, 2015b). This dolphin has a narrow tailstock and whitish or gray body. The Risso's Dolphin forms groups ranging from 10 to 30 individuals (NOAA, 2015b). Risso's Dolphins feed primarily on squid, but also fish such as anchovies (*Engraulidae*), krill, and other cephalopods (NOAA, 2015b).

Risso's Dolphins in the US Atlantic EEZ are part of the western North Atlantic Stock. The best available abundance estimate for Risso's Dolphins in the Western North Atlantic stock is 18,250, estimated from data collected during 2011 surveys (Hayes et al., 2017). Total annual estimated average fishery related mortality or serious injury to this stock during 2010 to 2014 was 53.6 per year (Hayes et al., 2017).

The Western North Atlantic stock of Risso's Dolphins inhabits waters from Florida to eastern Newfoundland (Leatherwood, Caldwell, & Winn, 1976; Baird & Stacey, 1991). During spring, summer, and fall, Risso's Dolphins are distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank (CETAP, 1982; Payne, Selzer, & Knowlton, 1984). During the winter, the distribution extends outward into oceanic waters (Payne et al., 1984). The stock may contain multiple demographically independent populations that should themselves be stocks, because the current stock spans multiple eco-regions (Longhurst, 1998; Spalding et al., 2007).

NEFSC observed Risso's Dolphins two times in the WDA during one AMAPPS survey (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). The two observations were made in the summer of 2013 during a shipboard survey (NEFSC & SEFSC, 2013).

Kraus et al., (2016) results suggest that Risso's Dolphins occur infrequently in the BOEM MA and MA/RI WEAs and surrounding areas. Effort-weighted average sighting rates for Risso's Dolphins could not be calculated. No Risso's Dolphins were observed during summer, fall, or winter, and this species was only observed twice in the spring. It is possible that the Northeast Large Whale Pelagic Survey may have underestimated the abundance of Risso's Dolphins, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species. This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 G&G survey for the Project, but 12 visual observations and 10 acoustic detections of marine mammals during the G&G survey were classified as "unidentified" dolphin or porpoise (Vineyard Wind, 2016).

Atlantic White-Sided Dolphin. Atlantic White-Sided Dolphins are located in cold temperate and subpolar waters of the North Atlantic (Cipriano, 2002). The Atlantic White-Sided Dolphin is robust and attains a body length of approximately 2.8 m (9 ft) (Jefferson et al., 2008). It is characterized by a strongly "keeled" tail stock and distinctive, white-sided color pattern (BOEM, 2014). Atlantic White-Sided Dolphins form groups of varying sizes, ranging from a few individuals to over 500 (NOAA, 2016c). Atlantic White-Sided Dolphins feed mostly on small schooling fish, shrimp, and squid, and are often observed feeding in mixed-species groups with Pilot Whales and other dolphin species (Cipriano, 2002; Jefferson et al., 2008).

Atlantic White-Sided Dolphins in the US Atlantic EEZ are part of the Western North Atlantic stock. The best available abundance estimate for White-Sided Dolphins in the Western North Atlantic stock is 48,819, estimated form data collected during a 2011 survey (Hayes et al., 2017). Total annual estimated average fishery related mortality or serious injury to this stock during 2010 to 2014 was 77 per year (Hayes et al., 2017).

The Western North Atlantic stock of White-Sided Dolphin inhabits waters from central West Greenland to North Carolina (about 35°N), primarily in continental shelf waters to the 100 m (328 ft) depth contour (Doksaeter, Olsen, Nottestad, & Ferno, 2008). Sighting data indicate seasonal shifts in distribution (Northridge, Tasker, Webb, Camphuysen, & Leopold, 1997). During January to May, low numbers of White-Sided Dolphins are located from Georges Bank to Jeffreys Ledge (off New Hampshire). During this time period, even lower numbers of White-Sided Dolphins are present south of Georges Bank, as documented by a few strandings collected on beaches from Virginia to South Carolina. From June through September, large numbers of White-Sided Dolphins occur from Georges Bank to the lower Bay of Fundy. From October to December, White-Sided Dolphins occur at intermediate densities from southern Georges Bank to the southern Gulf of Maine (Payne & Heinemann, 1990).

No Atlantic White-Sided Dolphins were observed in the WDA or OECC during AMAPPS surveys from 2010-2016 (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Kraus et al., (2016) suggested that Atlantic White-Sided Dolphins occur infrequently in the MA/RI WEA and surrounding areas. Effort-weighted average sighting rates for White-Sided Dolphins could not be calculated. No White-Sided Dolphins were observed during the winter months, and this species was only observed twice in the fall and three times in the spring and summer. It is possible that the Northeast Large Whale Pelagic Survey may have underestimated the abundance of White-Sided Dolphins, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species. This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 G&G survey for the Project, but 12 visual observations and 10 acoustic detections of marine mammals during the 2016 G&G survey and one visual observation in the 2017 G&G survey were classified as "unidentified" dolphin or porpoise (Vineyard Wind, 2016, 2017).

Short-Beaked Common Dolphin. The Short-Beaked Common Dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al., 2008). Short-Beaked Common Dolphins can reach 2.7 m (9 ft) in length and have a distinct color pattern with a white ventral patch, yellow or tan flank, and dark gray dorsal "cape" (NOAA, 2016l). This species feeds on squid and small fish, including species that school in proximity to surface waters as well as mesopelagic species found near the surface at night (International Union for the Conservation of Nature, 2010; NatureServe, 2010). They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NOAA, 1993). These dolphins can gather in schools of hundreds or thousands, although groups generally consist of 30 or fewer individuals (NOAA, 1993).

Short-Beaked Common Dolphins in the US Atlantic EEZ belong to the Western North Atlantic stock, generally occurring from Cape Hatteras, North Carolina to the Scotian Shelf (Hayes et al., 2017). The best population estimate in the US Atlantic EEZ for the Western North Atlantic Short-Beaked Common Dolphin is 70,184 (Hayes et al., 2017). Total annual estimated average fishery-related mortality or serious injury to this stock during 2010-2014 was 409 per year (Hayes et al., 2017).

Short-Beaked Common Dolphins are a highly seasonal, migratory species. In the US Atlantic EEZ this species is distributed along the continental shelf between the 100-2,000 m (328-6,561.6 ft) isobaths and is associated with Gulf Stream features (CeTAP, 1982; Selzer & Payne, 1988; Hamazaki, 2002; Hayes et al., 2017). Common Dolphins occur from Cape Hatteras northeast to Georges Bank (35˚ to 42˚N) during mid-January to May and move as far north as the Scotian Shelf from mid-summer to fall (Selzer & Payne, 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs when water temperatures exceed 11°C (51.8°F) (Sergeant, Mansfield, & Beck, 1970; Gowans & Whitehead, 1995). Breeding usually takes place between the months of June and September and females have an estimated calving interval of two to three years (Hayes et al., 2017).

NEFSC observed Short-Beaked Common Dolphins 10 times in the WDA during seven AMAPPS surveys (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). One observation was in the fall of 2010 during an aerial survey; two observations were in the fall of 2012 during an aerial survey; three observations were during the summer of 2014 during a shipboard survey; one was during the summer of 2014 during a shipboard survey; one observation was during the summer of 2016 during a shipboard survey; one observation was in the summer of 2016 during an aerial survey; and one was in the fall of 2016 during an aerial survey (NEFSC & SEFSC, 2010, 2012, 2013, 2014, 2016).

Kraus et al., (2016) suggested that Short-Beaked Common Dolphins occur year-round in the MA/RI WEA and surrounding areas. Short-Beaked Common Dolphins were the most frequently observed small cetacean species within the Kraus et al., (2016) study area. Short-Beaked Common Dolphins were observed in the MA/RI WEA in all seasons and observed in the Lease Area in spring, summer, and fall. Short-Beaked Common Dolphins were most frequently observed during the summer months; observations of this species peaked between June and August. Two sightings of Short-Beaked Common Dolphins in the Kraus et al., (2016) study included calves, two sightings involved feeding behavior, and three sightings involved mating behavior. Sighting data may indicate that Short-Beaked Common Dolphin distribution tended to be farther offshore during the winter months, than during spring, summer, and fall. It is possible that the Northeast Large Whale Pelagic Survey may have underestimated the abundance of Short-Beaked Common Dolphins, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al., 2016). Short-Beaked Common Dolphins were the most frequently observed or detected animal during the 2016 survey in the Lease Area and one was also visually observed during the 2017 G&G survey (Vineyard Wind, 2016, 2017). During 2016 G&G survey, Short-Beaked Common Dolphins were visually observed 123 times and acoustically detected 50 times. Also, 12 visual observations and 10 acoustic detections of marine mammals during the 2016 G&G survey and one visual observation during the 2017 G&G survey were classified as "unidentified" dolphin or porpoise (Vineyard Wind, 2016, 2017).

Bottlenose Dolphin. Bottlenose Dolphins are one of the most well-known and widely distributed species of marine mammals. These dolphins reach two to four meters (6-12.5 ft) in length, and are light gray to black in color (NOAA, 2016d). Bottlenose Dolphins are commonly found in groups of two to 15 individuals, though aggregations in the hundreds are occasionally observed (NOAA, 2016d). They are considered generalist feeders and consume a wide variety of organisms, including fish, squid, and shrimp and other crustaceans (Jefferson et al., 2008).

Bottlenose Dolphins along the New England Coast belong to the Western North Atlantic Offshore stock, which ranges along the US Atlantic EEZ and into Canada (Hayes et al., 2017). The best available population estimate for this stock of Bottlenose Dolphins is 77,532 (Hayes et al., 2017). This estimate is from summer 2011 surveys covering waters from central Florida to the lower Bay of Fundy (Hayes et al., 2017). The estimated mean annual fishery-related mortality or serious injury to this stock during 2010 to 2014 was 39.4 Bottlenose Dolphins per year (Hayes et al., 2017).

The Bottlenose Dolphin is a cosmopolitan species that occurs in temperate and tropical waters worldwide. Two distinct morphotypes of Bottlenose Dolphin, coastal and offshore, occur along the eastern coast of the US (Curry & Smith, 1997; Hersh & Duffield, 1990; Mead & Potter, 1995; Rosel, Hansen, & Hohn, 2009). The offshore morphotype inhabits outer continental slope and shelf edge regions from Georges Bank to the Florida Keys, and the coastal morphotype is continuously distributed along the Atlantic Coast from south of New York to the Florida Peninsula (Hayes et al., 2017). Offshore Bottlenose Dolphin sightings occur from Cape Hatteras to the eastern end of Georges Bank (Kenney, 1990).

NEFSC observed Bottlenose Dolphins four times in the WDA during three AMAPPS surveys (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Two observations were in the fall of 2012 during an aerial survey; one observation was in the summer of 2013 during a shipboard survey; and one observation was during the summer of 2014 during a shipboard survey (NEFSC & SEFSC 2012, 2013, 2014).

Kraus et al., (2016) observed Bottlenose Dolphins during all seasons within the MA/RI WEA. Bottlenose Dolphins were the second most commonly observed small cetacean species and exhibited little seasonal variability in abundance. Bottlenose Dolphins were observed in the MA WEA in all seasons, and observed in the Lease Area in fall and winter. One sighting of Bottlenose Dolphins in the Kraus et al., (2016) study included calves, and one sighting involved mating behavior. It is possible that the Northeast Large Whale Pelagic Survey may have underestimated the abundance of Bottlenose Dolphins, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al., 2016). Bottlenose Dolphins were not observed visually or detected acoustically during the 2016 or 2017 surveys in the Lease Area, but 12 visual observations and 10 acoustic detections of marine mammals during the 2016 G&G survey and 1 visual observation during the 2017 G&G survey were classified as "unidentified" dolphin or porpoise (Vineyard Wind, 2016, 2017).

Harbor Porpoise. The Harbor Porpoise is the only porpoise species found in the Atlantic. It is a small, stocky cetacean with a blunt, short-beaked head, dark gray back, and white underside (NOAA, 2014a). It reaches a maximum length of 1.8 m (6 ft) and feeds on a wide variety of small fish and cephalopods (Kenney & Vigness-Raposa, 2010; Reeves & Reed, 2003). Most Harbor Porpoise groups are small, usually between five and six individuals, although they aggregate into large groups for feeding or migration (Jefferson et al., 2008).

There are four distinct populations of Harbor Porpoise in the Western Atlantic: Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland, and Greenland (Hayes et al., 2017). Harbor Porpoises observed in the US Atlantic EEZ are considered part of the Gulf of Maine/Bay of Fundy stock. The best current abundance estimate of the Gulf of Maine/Bay of Fundy Harbor Porpoise stock is 79,883 individuals, based upon data collected during a 2011 line-transect sighting survey (Hayes et al., 2017). The total annual estimated average human-caused mortality is 437 per year (Hayes et al., 2017). The Gulf of Maine/Bay of Fundy stock was considered strategic until 2014 because annual human-caused mortality rates exceeded the potential biological removal. In 2001, the Harbor Porpoise was removed from the candidate species list for the ESA because a review of the biological status of the stock indicated that a classification of threatened was not warranted (66 Fed. Reg. 40,176 [2011]).

The Harbor Porpoise is usually found in shallow waters of the continental shelf, although they occasionally travel over deeper offshore waters. They are commonly found in bays, estuaries, harbors, and fjords less than 200 m (650 ft) deep (NOAA, 2014a). Hayes et al., (2017) report that Harbor Porpoises are generally concentrated along the continental shelf within the northern Gulf of Maine and southern Bay of Fundy region during summer months (July through September). During fall (October through December) and spring (April through June), they are more widely dispersed from New Jersey to Maine. During winter (January through March), they range from New Brunswick, Canada, to North Carolina (Hayes et al., 2017).

NEFSC observed Harbor Porpoises four times in the WDA during two AMAPPS surveys (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Three observations were in the spring of 2012 during an aerial survey; and one observation was in the spring of 2014 during a shipboard survey (NEFSC & SEFSC, 2012, 2014).

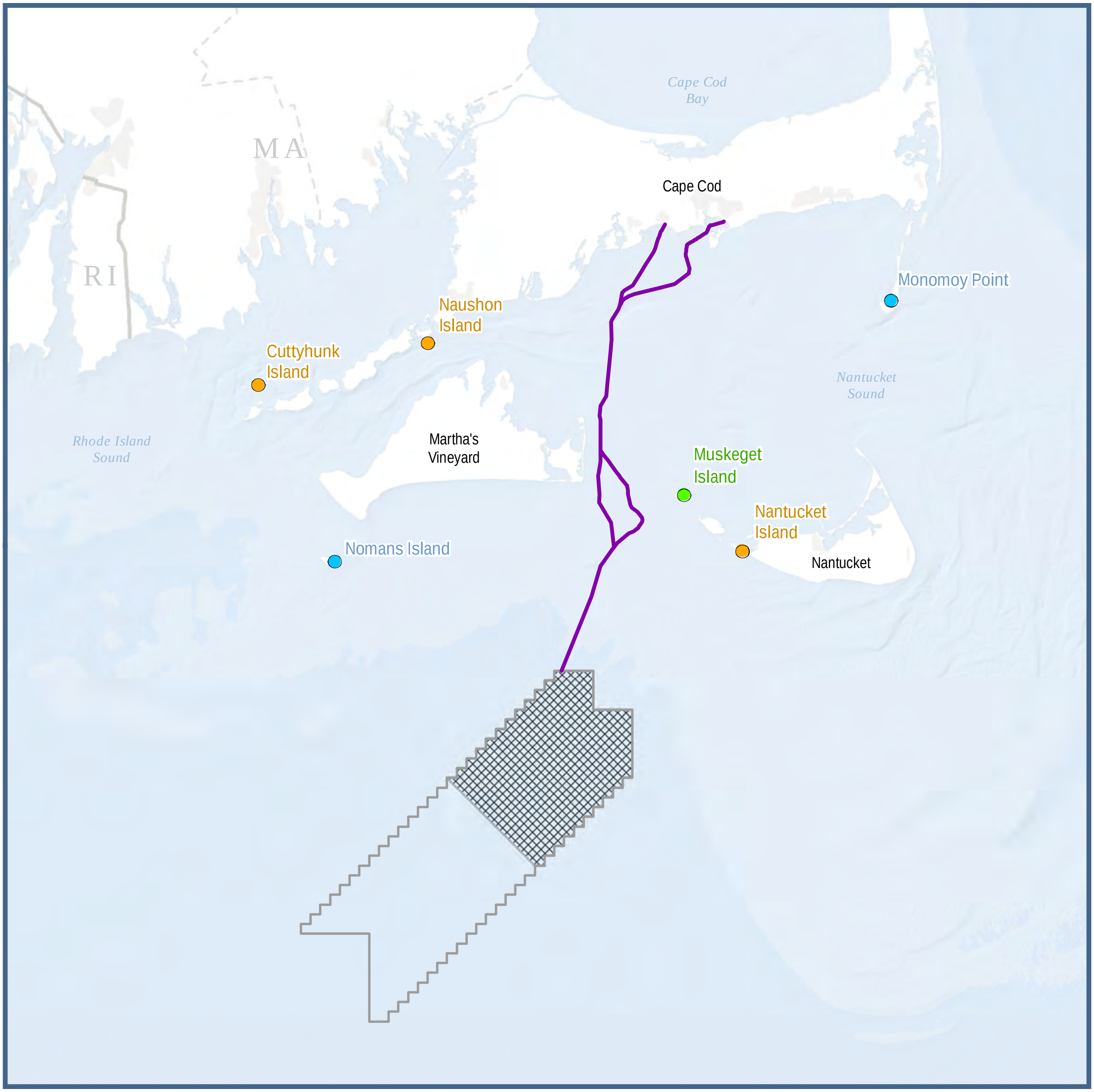
Kraus et al., (2016) indicate that Harbor Porpoises occur within the MA/RI WEA in fall, winter, and spring. Harbor Porpoises were observed in groups ranging in size from three to 15 individuals, and were primarily observed in the Kraus et al., (2016) study area from November through May, with very few sightings during June through September. It is possible that the Northeast Large Whale Pelagic Survey may have underestimated the abundance of Bottlenose Dolphins, as this survey was designed to target large cetaceans and the majority of small cetaceans were not identified to species (Kraus et al., 2016). This species was not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the Project, but 12 visual observations and 10 acoustic detections of marine mammals during the 2016 G&G survey and one visual observation during the 2017 G&G survey were classified as "unidentified" dolphin or porpoise (Vineyard Wind, 2016).

Harbor Seal. The Harbor Seal is found throughout coastal waters of the Atlantic Ocean and adjoining seas above 30°N and is the most abundant pinniped in the US Atlantic EEZ (Hayes et al., 2017). This species is approximately two meters (6 ft) in length and has a blue-gray back with light and dark speckling (NOAA, 2016f). Harbor Seals complete both shallow and deep dives during hunting, depending on the availability of prey (Tollit, Greenstreet, & Thompson, 1997). This species consumes a variety of prey, including fish, shellfish, and crustaceans (Bigg, 1981; Burns, 2002; Jefferson et al., 2008; Reeves, Stewart, & Leatherwood, 1992). Harbor Seals commonly occur in coastal waters and on coastal islands, ledges, and sandbars (Jefferson et al., 2008).

Although the stock structure of the Western North Atlantic population is unknown, it is thought that Harbor Seals found along the eastern US and Canadian coasts represent one population that is termed the Western North Atlantic stock (Tempte, Bigg, & Wiig, 1991; Anderson & Olsen, 2010). The best estimate of abundance for Harbor Seals in the Western North Atlantic stock is 75,834 (Hayes et al., 2017). This estimate was derived from a coast-wide survey along the Maine Coast during May/June 2012. For the period of 2010-2014 the total human caused mortality and serious injury to Harbor Seals was estimated to be 389 per year (Hayes et al., 2017).

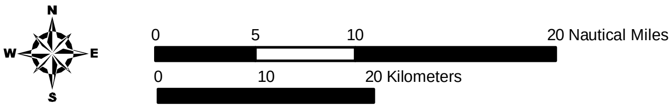
Harbor Seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona, Rough, & Richardson, 1993) and occur seasonally along the southern New England to New Jersey coasts from September through late May (Barlas, 1999; Schneider & Payne, 1983; Schroeder, 2000). A general southward movement from the Bay of Fundy to southern New England waters occurs in fall and early winter (Barlas, 1999; Jacobs & Terhune, 2000; Rosenfeld, George, & Terhune, 1988; Whitman & Payne, 1990). A northward movement from southern New England to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June along the Maine Coast (Kenney, 1994; Richardson, 1976; Whitman & Payne, 1990; Wilson, 1978).

No Harbor Seals were observed in the WDA or OECC during AMAPPS surveys from 2010-2016 (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Kraus et al., (2016) observed Harbor Seals in the MA/RI WEA and surrounding areas, but this survey was designed to target large cetaceans so locations and numbers of seal observations were not included in the study report (Kraus et al., 2016). Harbor Seals have five major haul-out sites in and near the MA/RI WEA: Monomoy Island, the northwestern side of Nantucket Island, Nomans Land, the north side of Gosnold Island, and the southeastern side of Naushon Island (see Figure 6.7-6) (Payne & Selzer, 1989). Payne and Selzer (1989) conducted aerial surveys and found that for haul-out sites in Massachusetts and New Hampshire, Monomoy Island had approximately twice as many seals as any of the 13 other sites in the study (maximum count of 1,672 in March of 1986). Harbor Seals were not observed visually, or detected acoustically, in the Lease Area during the 2016 or 2017 G&G surveys for the



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Hayes et al. 2017; Payne and Selzer 1989; BOEMRE 2017; ESRI 2017; E&E 2017.

Map Coordinate System: NAD 1983 UTM 19N Meters



LEGEND

— State Boundary	Seal Haul Out/Pupping Location
- - County Boundary	● Gray Seals
— Offshore Export Cable Corridor	● Harbor Seals
☐ Lease Area	● Gray Seals/Harbor Seals
▨ Wind Development Area	

Vineyard Wind Project

VINEYARD WIND

Figure 6.7-6

Major Haul-Outs of Harbor Seals and Pupping Locations of Gray Seals near WDA and OECC

Project, even though this survey overlapped with months seals would be expected to be present (October and November) (Vineyard Wind, 2016, 2017). Two seals visually observed during the 2017 G&G survey were classified as "unknown" (Vineyard Wind, 2017).

Gray Seal. Gray Seals are the second most common pinniped in the US Atlantic EEZ (Jefferson et al., 2008). This species inhabits temperate and sub-arctic waters and lives on remote, exposed islands, shoals, and unstable sandbars (Jefferson et al., 2008). Gray Seals are large, reaching two to three meters (7.5-10 ft) in length, and have a silver-gray coat with scattered dark spots (NOAA, 2016h). These seals are generally gregarious and live in loose colonies while breeding (Jefferson et al., 2008). Though they spend most of their time in coastal waters, Gray Seals can dive to depths of 300 m (984 ft), and frequently forage on the Outer Continental Shelf (Jefferson et al., 2008; Lessage & Hammill, 2001). These opportunistic feeders primarily consume fish, crustaceans, squid, and octopus (Bonner, 1971; Reeves et al., 1992; Jefferson et al., 2008).

Gray Seals form three populations in the Atlantic: Eastern Canada, Northwestern Europe, and the Baltic Sea (Katona et al., 1993). The Western North Atlantic stock is equivalent to the eastern Canada population. Available data are insufficient to estimate the size of the entire Eastern Canada Gray Seal population, but estimates are available for portions of the stock for certain time periods (Hayes et al., 2017). Gray Seal pup production for the three Canadian herds (Gulf of St Lawrence, Nova Scotia Eastern Shore, and Sable Island) totaled 93,000 animals. The total population size for these areas is estimated at 505,000 (Department of Fisheries and Oceans, 2011). For the period 2010 to 2014, the total estimated human caused mortality and serious injury to Gray Seals was 4,937 per year (Hayes et al., 2017).

The eastern Canada population ranges from New Jersey to Labrador and is centered at Sable Island, Nova Scotia (Davies, 1957; Mansfield, 1966; Katona et al., 1993; Lessage & Hammill, 2001). There are three breeding concentrations in eastern Canada: Sable Island, the Gulf of St. Lawrence, and along the east coast of Nova Scotia (Laviguer & Hammill, 1993). In US waters, Gray Seals currently pup at four established colonies from late December to mid-February: Muskeget and Monomoy Islands in Massachusetts, and Green and Seal Islands in Maine (Center for Coastal Studies, 2016; Hayes et al., 2017). Pupping was also observed in the early 1980s on small islands in Nantucket-Vineyard Sound and more recently at Nomans Land (see Figure 6.7-6) (Hayes et al., 2017). Following the breeding season, Gray Seals may spend several weeks ashore in the late spring and early summer while undergoing a yearly molt. Gray Seals are expected to occur year-round in at least the OECC, with seasonal occurrence in the WDA from September to May (Hayes et al., 2017).

No Gray Seals were observed in the WDA or OECC during AMAPPS surveys from 2010-2016 (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Kraus et al., (2016) observed Gray Seals in the MA/RI WEA and surrounding areas, but this survey was designed to target large cetaceans so locations and numbers of seal observations were not included in the study report (Kraus et al., 2016). Gray Seals were observed on two occasions during the 2016 survey and two additional occasions in the 2017 survey in the Lease Area (Vineyard Wind, 2016, 2017).

Harp Seal. The Harp Seal is found throughout the North Atlantic and Arctic Oceans (Lavigne & Kovacs, 1988; Ronald & Healey, 1981). This species is approximately 1.7 m (5-6 ft) in length and has light gray fur with a black face and a horseshoe-shaped black saddle on its back (NOAA, 2015a). Harp Seals complete both shallower dives relative to other pinnipeds (Schreer & Kovacs, 1997). This species consumes a variety of species of finfish and invertebrates, mainly Capelin, cod (Gadidae), and krill (NOAA, 2015a).

The world's Harp Seal population is divided into three separate stocks, with the Front/Gulf stock equivalent to western North Atlantic stock (Lavigne & Kovacs, 1988; Bonner, 1990). The best estimate of abundance for Harp Seals in the Western North Atlantic stock is 7.1 million (Waring et al. 2014). This estimate was derived from a population model that was applied to 1952-2012 population estimates (Waring et al., 2014). For the period of 2007-2011, the total human caused mortality and serious injury to Harp Seals was estimated to be 306,082 (Waring et al., 2014).

Harp Seals are year-round inhabitants of the coastal waters off eastern Canada and occur seasonally in the northeastern US. Harp Seals begin their seasonal shift south toward US waters following summer feeding in the more northern Canadian waters (Sergeant, 1965; Lavigne and Kovacs, 1988). The most southerly point of observation for this species has been New Jersey, from January through May (Harris, Lelli, & Jakush, 2002). Sightings of Harp Seals this far south have been increasing since the early 1990s. The number of sightings and strandings from January to May have also increased off the east coast of the US (NOAA, 2015a).

No Harp Seals were observed during AMAPPS surveys from 2010-2016 (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, 2016). Kraus et al., (2016) did not observe Harp Seals in the BOEM MA and MA/RI WEAs and surrounding areas (Kraus et al., 2016). Harp Seals were not observed visually, or detected acoustically, in the Lease Area during the 2016 G&G survey for the Project (Vineyard Wind, 2016).

6.7.2 *Potential Project Impacts*

Construction and installation, operations and maintenance, and decommissioning activities associated with the Offshore Project Area have the potential to impact marine mammals through noise, changes in vessel traffic, marine debris, reductions in prey availability, habitat disturbance and modification, entanglement, electromagnetic fields ("EMF"), and sediment mobilization (see Table 6.7-2).

This section provides an initial assessment of the potential risks to populations (stocks) of marine mammals from Project activities. Criteria used for this risk assessment are shown in Table 6.7-3. This assessment will be supplemented with additional information and acoustical data that will better inform the potential risks from the Project and mitigation measures that may be employed. A draft version of the supplemental report can be found in Appendix III-M.

In this initial assessment, the potential risks posed by Project activities and their associated stressors are categorized as none, low, moderate, or high based on the probability of marine mammal exposure and the vulnerability of the marine mammal species to project stressors (Table 6.7-3). Occurrence of marine mammal taxa and their relationships to the established criteria were evaluated using existing literature on marine mammal distribution and habitat use in the MA and MA/RI WEA, impacts of marine construction, wind farm construction and operations in Europe, construction and operation of the Block Island offshore wind farm, and studies that provide a general understanding of hearing, vessel collision risk, noise response, and other factors that influence the potential impacts of offshore wind construction, operation, and decommissioning activities on marine mammals.

Based on this assessment, some of the impact-producing factors are not expected to pose any risk to populations of marine mammals. Therefore, further in-depth analysis was not conducted. These include impacts from marine debris, reductions in prey availability, habitat disturbance and modification, entanglement, EMF, and sediment mobilization. Each of these is briefly described below. See Table 6.7-3 for criteria for determining an impact risk level of "none." The remainder of this section focuses on impacts to marine mammals associated with noise and vessel traffic during construction and installation (see Section 6.7.2.1), operations and maintenance (see Section 6.7.2.2), and decommissioning (see Section 6.7.2.3). Avoidance, minimization and mitigation measures are provided for each of these stages of the Offshore Project.

In addition, this risk assessment considers the definitions of harassment established by NOAA under the MMPA for the purposes of evaluating noise impacts. The MMPA defines any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild as Level A Harassment. Level B Harassment is defined as any act that has the potential to disturb marine mammals or their stock in the wild by causing a disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. The Project has the potential to "harass" marine mammals, as discussed in Sections 6.7.2.1. Mitigation and best management practice ("BMP") measures, including those outlined in Table 31 of Appendix III-M, are expected to minimize impacts of noise on marine mammals and avoid vessel collision entirely.

Importantly, positive impacts to marine mammals are expected to occur from the Offshore Project Area, and these positive impacts are briefly described in the Project Summary (Section 2.0).

Table 6.7-2 Potential Impact-producing Factors for Marine Mammals

Potential Impact-producing Factor	Stressor	Wind Development Area	Export Cable Corridor	Construction and Installation	Operations and Maintenance	Decommissioning
Noise	Pile driving, construction and support vessels, wind turbines, removal of turbines	X	X	X	X	X
Vessel traffic	Construction and support vessels	X	X	X	X	X
Marine debris	Discarded material	X	X	X	X	X
Reduction in prey Abundance	Jet plow, pile driving, discharges/ withdrawals	X	X	X	X	X
Habitat disturbance and modification	Wind turbine generators, cable corridor, electrical service platform	X	X	X	X	X
Entanglement	Anchor lines, tow lines, wind turbines, fishing gear, marine debris, undersea cables	X	X	X	X	X
Electromagnetic fields (EMF)	Cable system	X	X		X	
Suspended sediments	Jet plow, pile driving, dredging	X	X	X	X	X

Table 6.7-3 Definitions of Risk, Exposure, and Vulnerability for Marine Mammals

Risk Level	Exposure	Individual Vulnerability
None	No or limited observations of the species in or near the WDA and Offshore ECC and noise exposure zones (low expected occurrence) AND/OR Species tends to occur mainly in other habitat (such as deeper water or at lower or higher latitudes) AND/OR No indication the Lease Area has regional importance	Literature and/or research suggest the affected species and timing of the stressor are not likely to overlap AND/OR Literature suggests limited sensitivity to the stressor AND/OR Little or no evidence of impacts from the stressor in the literature
Low	Few observations of the species in or near the WDA and Offshore ECC and noise exposure zones (occasional occurrence) AND/OR Seasonal pattern of occurrence in or near the WDA and Offshore ECC and noise exposure zones	Literature and/or research suggest the affected species and timing of the stressor may overlap AND/OR Literature suggests some low sensitivity to the stressor AND/OR Literature suggests impacts are typically short-term (end within days or weeks of exposure) AND Literature describes mitigation/BMPs that reduce risk

Table 6.7-3 Definitions of Risk, Exposure, and Vulnerability for Marine Mammals (Continued)

Risk Level	Exposure	Individual Vulnerability
Moderate	Moderate year-round use of the WDA and Offshore ECC and noise exposure zones AND/OR Evidence of preference for near-shore habitats and shallow waters in the literature	Literature and/or research suggest the affected species and timing of the stressor are likely to overlap. AND/OR Literature and/or research suggest a moderate susceptibility to the stressor exists in the region and/or from similar activities elsewhere. AND Literature does not describe mitigation/BMPs that reduce risk
High	Significant year-round use of the WDA and Offshore ECC and noise exposure zones	Literature and/or research suggest the affected species and timing of the stressor will overlap. AND Literature suggests significant use of WDA and Offshore ECC and noise exposure zones for feeding, breeding, or migration AND Literature does not describe mitigation/BMPs that reduce risk

Impact-producing factors not expected to pose a risk to marine mammal populations

Reductions in prey availability: As demonstrated in Sections 6.5 and 6.6, potential impacts on benthic and finfish resources from substrate (habitat) disturbance, noise, and increased turbidity will be localized and short-term; therefore, risk of declining prey availability is not anticipated. Increased substrate and reef effects are likely to increase prey availability for some species in operating wind farms (Bergström et al., 2014; Russell et al., 2014). Bergstrom et al., (2014) assessed windfarms in the North Sea and Baltic Sea and found that disturbance associated with noise during construction was lower for fish than for marine mammals, suggesting that fish would not be temporarily displaced further than marine mammals during pile driving events, allowing prey to remain available to marine mammals. Bergström et al., (2013) found increased densities of some fish species close to operating wind turbines, but no large-scale effects on fish diversity or abundance (With respect to turbidity, sediment modeling tends to be conservative and sampling conducted for the Block Island offshore wind farm did not show measurable impacts compared to modeling results (Elliott, Smith, Gallien, & Khan, 2017). Therefore, it is not expected that project activities will reduce prey availability to marine mammals.

Habitat Modification: The presence of the wind turbine generator ("WTG") foundations, offshore cables, and electrical service platform ("ESP") foundations are not expected to modify marine mammal habitat. Marine mammals can continue to use the area after the turbines are installed, as demonstrated by the continued use of areas where other structures have been built in marine environments. For example, Delefosse, Rahbek, Roesen, & Clausen (2017) evaluated sightings of marine mammals around oil and gas installations in the North Sea. They studied an area with 25 fixed installations. Observations of Harbor Porpoises, Minke Whales, Killer Whales, White-Beaked Dolphins, Pilot Whales, Harbor Seals, and Gray Seals reflected the general expectation for marine mammal abundance and diversity in the area.

There have been some mixed results in wind farm studies in Europe. For example, a study of a wind farm in the Baltic Sea documented 89% fewer Harbor Porpoises inside the wind farm during construction and 71% fewer 10 years later compared to baseline levels (Teilmann & Carstensen, 2012). However, a similar study found a significant increase of 160% in the presence of Harbor Porpoise within an operating wind farm in the Dutch North Sea (Scheidat et al., 2011). Indeed, offshore wind energy projects may benefit fish by acting as artificial reefs, and consequently benefit marine mammals by increasing prey abundance and diversity during long-term operation (see Section 8.1 in Appendix III-M).

For the Offshore Project Area, WTGs will be placed a minimum of 1,400 m (0.8 nm) apart and a maximum of 1,850 m (1 nm) apart. These large distances between wind turbine will minimize the extent of habitat modification that could potentially impact marine mammals. Because of large distances between turbines, barriers to activities, including migration, are not anticipated from modification of the water column habitat.

Entanglement: Project activities are not expected to pose an entanglement risk to marine mammals. First, marine anchored vessels will not be routinely used within the WDA. Anchors may be used for offshore export cable installation (see Section 4.2.3.3.2 of Volume I). Steel anchor cables used on construction barges are typically five to seven centimeters ("cm") (2-3 inches ["in"]) in diameter. Typically, these cables are under tension while deployed, eliminating the potential for entanglement. Similarly, tow lines for cable installation are expected to be under constant tension and should not present an entanglement risk for marine mammals. Second, as reported in Inger et al., (2009), wind turbines are unlikely to be a significant risk for entanglement of marine mammals given the large, static nature of the structures. Lost fishing gear and other marine debris could possibly catch on wind turbines and present a secondary entanglement hazard to marine mammals; however, WTG and ESP foundations have large monopile diameters (7.5-10 m [25-34 ft]) or jacket diameters (1.5-3.0 m [5-10 ft]) without the protrusions on which lost fishing gear or other marine debris would become snagged. As such, it is unlikely that entanglement of debris would be followed by a close enough approach by marine mammals to secondarily become entangled in such debris. Finally, all undersea cables have large diameters and will be buried in the seabed at target depths of 1.5-2.5 m (5-8 ft). Where sufficient burial depths cannot be achieved, the cables would be covered with concrete mattresses or similar protective measures that would preclude any risk of entanglement.

Marine Debris: The Clean Water Act (33 U.S.C §§ 1251 et seq., 1972) and other applicable federal regulations will be followed regarding any substances that could be released into the ocean during construction, operation, and decommissioning of the Offshore Project Area. Any items that could become marine debris will not be discarded in the water and will be appropriately discarded ashore. Thus, activities occurring in the Offshore Project Area are not expected to produce marine debris and therefore would not pose a risk to marine mammals.

EMF: The Offshore Project Area's offshore cable system will generate EMF. However, the intensity of any generated EMF will be minimized by cable burial into the seafloor at target depths of 1.5-2.5 m (5-8 ft). EMF are a natural occurrence that certain marine mammals are capable of detecting (Bauer, Fuller, Pery, Dunn, & Zoeger, 1985; Czech-Damal, Dehnhardt, Manger, & Hanke, 2012; Kirschvink, Dizon, & Westphal, 1986; Kirschvink, 1990; Walker, Diebel, & Kirschvink, 2003; Walker, Kirschvink, Ahmed, & Dizon, 1992).

In general, there is a lack of research into the potential impacts of EMF on marine mammals (Slater, Schultz, Jones, & Fischer, 2011). Behavioral disturbances, such as temporary changes in swim direction or longer detours during migrations, are possible, as studies have demonstrated statistical increases in strandings near naturally occurring, slightly weakened, magnetic fields (Kirschvink, 1990). However, studies that examined the reaction of Harbor

Porpoises to operating subsea cable EMF did not detect an impact to behavior (Gill, Bloyne-Philips, Neal, & Kimber, 2005; Slater et al., 2011; Walker, 2001). In addition, it has been suggested that species that feed near the benthos are at greater risk than those that feed in the water column (Normandeau et al., 2011), and none of the common species of marine mammals in the Offshore Project Area are benthic foragers. Several reviews of existing studies have determined that, due to the lack of documented evidence of marine mammal interactions with subsea cables, cetaceans would likely not be affected by subsea cable EMF, as the area of influence would be too small to alter their behavior (Copping et al., 2016; Gill, Gloyne-Phillips, Kimber, & Sigray, 2014; Normandeau et al., 2011). Therefore, EMF associated with the offshore cable system is not expected to pose a risk to marine mammals.

Sediments: Turbidity caused by disturbance of sediment would be limited to an area near the construction or maintenance activity and be short-term. In addition, field verification of sediment plume modeling for cable installation during Block Island offshore wind farm indicated that the actual sediment plume was less than the modeled plume, without any evidence of a sediment plume in the water column resulting from use of the jet plow (Elliott et al., 2017). Sediment plumes are dependent on sediment type and mobilization of sediments and would be expected to vary from region to region. Sediments in the WDA and offshore portion of the OECC in greater than 30 m (98.4 ft) water depths are predominately fine sand with some silt, fining in the offshore direction. Heading north through Muskeget, median grain size increases, with sand and gravel dominant, along with coarser deposits (cobbles, boulders) locally. Continuing north into the main body of Nantucket Sound, sand still dominates the seabed, with coarser deposits concentrated around shoals and in high current areas and finer grained sediments occupying deeper water and/or more quiescent flow areas. These sandy sediments would be expected to settle quickly. Marine mammals are also expected to avoid areas very close to pile driving, dredging, or offshore export cable installation, thereby avoiding areas where most temporarily suspended sediments may occur before settling back to the bottom. Therefore, based on the limited mobilization of sediment into the water column, project activities are not expected to pose a risk to marine mammals.

The potential risk-producing factors that are not expected to pose a risk to marine mammal populations (reduction in prey availability, habitat disturbance and modification, marine debris, EMF, entanglement, and sediments) (see Table 6.7-2) are not addressed further in this analysis.

6.7.2.1 Construction and Installation

6.7.2.1.1 Noise from Construction and Installation

All marine mammals use sound for various components of their daily activity, such as foraging, navigating, and avoiding predators. Marine mammals also use sound to learn about their surrounding environment by gathering information from other marine mammals, prey species, phenomena such as wind, waves, and rain, or from seismic activity (Richardson, Greene, Malme, & Thomson, 1995).

Marine Mammal Hearing and NOAA Thresholds for Injury and Behavioral Harassment

High-frequency cetaceans generally possess a higher upper-frequency hearing limit and better sensitivity at high frequencies compared to the mid-frequency cetacean species (Finneran, 2016; Southall et al., 2007). Most baleen whales (low-frequency cetaceans) are most sensitive to sounds under one kiloHertz ("kHz") (Richardson et al., 1995; Southall et al., 2007). However, despite the generalization reviews (e.g., Finneran, 2016) and the NOAA (2016k) acoustic guidance, 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 Hertz ("Hz") to 15 Hz, while the Minke Whale can hear sounds at frequencies as low as 60 Hz and produce clicks as high as 20 kHz (Beamish & Mitchell, 1973; Richardson et al., 1995). Humpback Whales are also noted as producing vocalizations greater than one kHz, including sounds up to 1.8 kHz or even possibly 8.2 kHz (Beamish, 1979; Payne & Payne, 1985; Thompson, Cummings, & Ha, 1986). Parks, Ketten, O'Malley, & Arruda (2007) used morphometric analysis of NARW ear anatomy to estimate a hearing range of 10 Hz to 22 kHz for this species. For noises such as pile driving, mid-frequency cetaceans are less sensitive than high- and low-frequency cetaceans; therefore, it takes louder sources or a closer approach to noise sources to potentially cause hearing injury for mid-frequency cetaceans (Finneran, 2016). The generalized hearing ranges of low-, mid-, and high-frequency cetaceans and seals as established by NOAA (2016k) are shown in Table 6.7-4.

In 2016, NOAA issued new guidance for determining potential impacts of noise on marine mammals and established new injury thresholds for Level A Harassment under the MMPA (NOAA, 2016k). This guidance was reviewed per Executive Order 13795 and reissued in 2018. Thus, this guidance may change prior to the implementation of the Offshore Project Area.

Under the new guidance, NOAA Fisheries based the criteria on the potential for a sound source to result in permanent threshold shift ("PTS"). PTS occurs when exposure to noise results in a permanent loss of hearing in a portion of the frequency spectrum, which can have direct negative consequences for marine mammals. PTS can result from repeated exposures to reversible threshold shifts (temporary threshold shifts ["TTS"]), or acute exposure to an intense sound that causes immediate damage to the ear. PTS thresholds are used to determine if Level A Harassment (injury) may occur.

In addition to focusing on PTS, the criteria differentiate between five functional hearing groups and the varied susceptibility of those groups to noise from different portions of the frequency spectra (see Table 6.7-4). Consequently, different thresholds apply to each functional hearing group (see Table 6.7-5).

Table 6.7-4 Marine Mammal Hearing Groups (see Appendix III-M Section 4.3.1)

Hearing Group	Generalized Hearing Range[1]
Low-frequency Cetaceans (Baleen Whales)	7 Hz to 35 kHz
Mid-frequency Cetaceans (Dolphins, Toothed Whales, Beaked Whales, Bottlenose Whales)	150 Hz to 160 kHz
High-frequency Cetaceans (Porpoises, Dwarf and Pygmy Sperm Whales, River Dolphins, Cephalorhynchids, *Lagenorhynchus cruciger*, & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds[2] (underwater) (Earless Seals)	50 Hz to 86 kHz

Source: NOAA, 2016k

Note:

[1] Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on a ~65 decibel (dB) threshold from normalized composite audiogram, with the exception for lower limits for low-frequency cetaceans (Southall et al., 2007) and earless seals (approximation).

[2] Because sea lions and fur seals do not occur in US Atlantic EEZ, that hearing group is not included here.

Also, NOAA Fisheries based the new criteria on different metrics than in the past. The criteria use dual metric acoustic thresholds for impulsive sounds, peak sound pressure ("Lpk") and cumulative sound exposure level ("SELcum"). For non-impulsive sources, such as vibratory pile driving, the criteria specify a single SELcum for each hearing group. All sound exposure levels for Lpk and SELcum are in decibels ("dB"), with Lpk referenced to 1 microPascal ("μPa") and SELcum referenced to 1 μPa^2 in 1 second ("$\mu Pa^2 s$").

Table 6.7-5 NOAA Injury Criteria for Marine Mammals

Hearing Group	Threshold Type[1]	Permanent Threshold Shift Onset Acoustic Thresholds (Received Level)	
		Impulsive	Non-impulsive
Low-Frequency Cetaceans	Lpk	219 dB	199 dB
	SELcum	183 dB	
Mid-Frequency Cetaceans	Lpk	230 dB	198 dB
	SELcum	185 dB	
High-Frequency Cetaceans	Lpk	202 dB	173 dB
	SELcum	155 dB	
Phocid Pinnipeds	Lpk	218 dB	201 dB
(Underwater)	SELcum	185 dB	

Source: NOAA, 2016k
Note: Because sea lions and fur seals do not occur in US Atlantic EEZ, that hearing group is not included here.
[1] Lpk = Peak Sound Pressure Level, SELcum = Cumulative Sound Exposure Level.

For underwater Level B (behavioral) Harassment, NOAA Fisheries defines the threshold as received level of 160 dB root mean square ("RMS") re 1 μPa for impulsive sound and 120 dB RMS re 1 μPa for continuous sound for all marine mammals. Although actual perception of underwater sound is dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels, the NOAA-established Level B Harassment criteria do not consider species-specific hearing capabilities and are, therefore, very conservative and was not updated in the new guidance, described above (NOAA, 2016k). For airborne Level B Harassment, which can occur for pinnipeds on land, the thresholds are 100 dB RMS re 20 μPa for all pinnipeds except Harbor Seals, which have a threshold of 90 dB RMS re 20 μPa. For further discussion of acoustic thresholds for marine mammals, see Appendix III-M.

General Impacts of Noise

As noted above, marine mammals can experience TTS or PTS as a result of noise. Marine mammals' behavioral responses to noise range from no response, to mild aversion, to panic and flight (Southall et al., 2007). Short- and long-distance displacement have been observed for seals and cetaceans in response to noise. For example, studies have shown that Harbor Porpoises (Brandt, Diederichs, Betke, & Nehls, 2011; Dähne et al., 2013) and Harbor and Gray Seals (Edrén et al., 2010) may temporarily leave an area in response to pile driving noise. Displacement could cause animals to move into less suitable habitat or into areas with a higher risk from vessel collision or other anthropogenic impacts. Masking, or interference of noise with a marine mammal's ability to send and receive acoustic signals, is another potential impact. The susceptibility of a marine mammal to masking depends on the frequencies at which the marine mammal sends and receives signals and the frequencies, loudness, and other attributes of ambient noise (David, 2006). Low-frequency cetaceans such as baleen whales may be vulnerable to masking by low-frequency noise (Richardson et al., 1995), such as vessel traffic noise (Redfern et al., 2017).

Pile driving is the loudest activity expected to occur during construction of the Project. It is estimated that each monopile will typically take less than approximately three hours to install (significantly less for pin piles) and that up to two foundations could be driven per day. Assuming the maximum design scenario (100 foundations for WTGs), there could be 100 days of pile driving activity (if only one pile were driven per day), not including weather delays; however, if larger WTGs are utilized there would be fewer WTG locations and therefore less pile driving.

There will be many days where no pile driving occurs, creating periods without noise from project construction throughout the construction period. Some habituation and/or adaptation to pile driving noise may occur. For example, Sperm Whales in the Gulf of Mexico, where seismic surveys have been conducted for decades, were found to maintain their behavior state when subjected to seismic sound sources, suggesting habituation to this relatively loud sound source (Miller et al., 2009), and similar results were found in the Arctic, including no changes in normal Sperm Whale vocal patterns during feeding dives in areas with seismic survey noise (Madsen, Møhl, Nielsen, & Wahlberg, 2002). Some cetaceans may be able to modulate their hearing to reduce the sound of loud noise (akin to putting on ear protection for humans) and physiologically reduce impacts of masking in noisy environments (Nachtigall & Supin, 2008; Nachtigall, Supin, Pacini, & Kastelein, 2017). Marine mammals in the Offshore Project Area are regularly subjected to commercial shipping noise and would potentially be habituated to vessel noise as a result of this exposure (BOEM, 2014).

Noise from Pile Driving

The Project will be the first commercial-scale wind project constructed in the US. Past construction projects in the region either involved more limited pile driving or relied on other methods of pile installation. However, the noise generated by construction-related pile driving in the Offshore Project Area would be consistent with that described for other planned wind farms (TetraTech, 2012). A description of the proposed pile driving techniques for the Project is described and used for acoustic modeling in Appendix III-M (see Sections 2.2 and Appendix A for details). Noise generated by the impact hammer would include regular, pulsed sounds of short duration (an impulsive noise source). These pulsed sounds are typically high-energy with fast rise times and sharp peaks, which can cause both behavioral changes and injury, depending on proximity to the sound source and a variety of environmental and biological conditions (Dahl, de Jong, & Popper 2015;

Nedwell et al., 2007). There is typically a decrease in sound pressure and an increase in pulse duration the greater the distance from the noise source (Bailey et al., 2010). Measurements have also indicated that the noise is broadband close to the source (two kilometers [1.2 mi]) with peak energy around 110 Hz to two kHz but with energy up to 10 kHz (Bailey et al., 2010). Noise generated by vibratory hammers would be continuous, but have lower energy without any sharp peaks and, therefore, would likely only result in behavioral impacts. For either the impact or vibratory hammer, the pile driving would last a few hours, stopping for moving equipment and other breaks.

Illingworth & Rodkin (2007) measured an unattenuated sound pressure within 10 m (33 ft) at a peak of 220 dB re 1 μPa for a 2.4 m (96 in) steel pile driven by an impact hammer. Studies of underwater pile driving indicate that most acoustic energy is below one to two kHz, with broadband sound near the source (40 Hz to >40 kHz), but only low frequencies (<400 Hz) at long ranges (Illingworth & Rodkin, 2007; Erbe, 2009). Brandt et al., (2011) found that for a pile driven in a Danish wind farm in the North Sea, the peak at 720 m (0.4 nm) from the source was 196 dB re 1 μPa. This is lower than the received levels estimated for PTS (i.e., Level A Harassment) for cetaceans and seals, which ranges from 202-230 dB Lpk re1 μPa (see Table 6.7-5). The spectral maximum was between 80 and 200 Hz, which is audible to low-frequency cetaceans (Brandt et al. 2011). These studies suggest that, although the majority of the energy in pile driving is at low frequencies, a low-frequency cetacean would need to be relatively close to the source to potentially experience PTS. Behavioral impacts may occur at farther ranges, and behavioral response may differ among individuals and relative to behavioral state and other factors (Ellison, Southall, Clark, and Frankel, 2012; Southall, Dowacek, Miller, & Tyack, 2016). To address this range of behavioral dose responses, Wood, Southall, & Tollit (2012) developed a probabilistic step function for which 10%, 50%, and 90% of individuals exposed to different dose levels of sound are expected to exhibit behavioral responses dependent on received sound levels. This approach is discussed and applied to analyses in BOEM's Programmatic Environmental Impact Statement for G&G surveys in the Gulf of Mexico (BOEM, 2017).

The risk to marine mammals from pile driving noise must also be considered in the context of existing ambient noise. Other anthropogenic noise sources can mask pile driving noise, to a certain extent. For example, during construction of a Belgian wind farm, the combined effect of the bathymetry and the noise generated by shipping was predicted to be of greater relevance to Harbor Porpoises, as the noise emitted from a single pile driving strike did not add to the soundscape for at least half of the time (EU Commission, 2016). Kraus et al., (2016) recorded ambient noise in the frequency range of 70.8-224 Hz in the MA/RI WEA from 2011 to 2015. Sound levels ranged from 96 dB re 1 μPa to 103 dB during 50% of recording time. Sound pressure levels were 95 dB re 1 μPa or less 40% of the time and greater than 104 dB re 1 μPa 10% of the time.

Noise from pile driving can cause temporary, localized displacement of marine mammals. For example, during construction of wind farms, Harbor Seals have demonstrated displacement during pile driving of up to 25 km (13.5 nm) from the center of the wind farm (Russell et al., 2016). Harbor Porpoises have also demonstrated displacement of up to 20 km (10.8 nm) from pile driving for wind farms (Dahne et al., 2013), as well as documented sensitivity to TTS from simulated pile driving sounds (Kastelein, Gransier, Marijt, & Hoek, 2015; Kastelein, Helder-Hoek, Covi, & Gransier, 2016). Zone of harassment risk to marine mammals is likely to occur from a maximum of approximately 0.5 km (0.27 nm) for potential injury to several kilometers for potential behavioral responses based on modeled and measured noise from pile driving relative to NOAA Fisheries' thresholds for injury and behavioral harassment (Chen, Guan, & Chou, 2016; Nedwell et al., 2007; TetraTech, 2012). However, field studies have indicated that distances over which injury might occur could be smaller (Bailey et al., 2010).

Species of particular concern for pile driving noise impacts include NARW, other baleen whales, Harbor Porpoises, and seals. Baleen whales and seals, as low-frequency specialists, have the potential to be particularly sensitive to the low frequencies of pile driving noise and will likely detect noise at longer distances than mid- and high-frequency cetaceans (Finneran, 2016; Kastelein, Gransier, & Jennings, 2013), though detection does not necessarily result in harassment as defined under MMPA. Generally, although low-frequency cetaceans and seals may hear pile driving noise at greater distances than high- and mid-frequency cetaceans, they are likely less sensitive to acute exposure to noise than high-frequency cetaceans because the peak energy of noise must be higher for low-frequency cetaceans to experience PTS (see Table 6.7-5; Finneran, 2016). Risk from pile driving noise to mid-frequency cetaceans is low as these species are not very sensitive to low- and high-frequency noise (Finneran, 2016); it would be expected to take more sound energy, and thus closer proximity to pile driving, to expose mid-frequency cetaceans to noise levels likely to impact behavior or cause injury.

NARWs are of particular concern because they are listed as endangered under the ESA, the population declined from 2010 to 2015 (Pace et al., 2017), the species is currently experiencing an unusual mortality event (NOAA, 2017d), and the NARW range is limited to US and Canadian east coasts, without distribution across the North Atlantic like other baleen whale species. Further, Kraus et al., (2016) identified 77 individual NARW in the MA/RI WEA and observed courtship behavior on multiple occasions. LaBrecque et al., (2015) identified the Offshore Project Area as part of a BIA for NARW migration; however, this migration BIA extends well beyond the Offshore Project Area, suggesting suitable areas for migration are extensive (see Figure 6.7-2). Mitigation will reduce risk to NARWs, and the Offshore Project is not expected to result in reductions in individual or population fitness. NARWs have been documented to modify the amplitude of their calls during periods of increased ambient noise, suggesting some flexibility in adapting to temporarily noisy environments (Parks, Johnson, Nowacek, & Tyack, 2011). NARWs may experience some chronic stress associated with relatively constant anthropogenic noise already existing in their environment (Rolland et al., 2012).

Harbor Porpoises may have sensitivity to behavioral disruptions of foraging due to energetic needs and associated foraging requirements. Although the daily feeding rate of non-lactating adult Harbor Porpoises is only about 3.5% of body weight per day, this rate can increase by as much as 80% for lactating females in summer months, resulting in about five additional hours of foraging per day at that time (Yasui & Gaskin, 2012). Tagging data suggest that Harbor Porpoises may have high metabolic demands and disruption to foraging for some individuals may be important to energy budgets and fitness (Wisniewska et al., 2016), though Hoekendijk et al., (2018) cautions that the feeding behaviors recorded by Wisniewska et al., (2016) are not representative of normal behaviors, could not be sustained over long periods to time, and may suggest resilience of Harbor Porpoises to adjust their feeding behaviors to account for disruptions in their environment. Wisniewska et al., (2018) provide some additional details and analysis regarding their original study. Interruption to feeding may occur during pile driving. Risk from pile driving noise is expected to be low for Harbor Porpoises as they are predicted to occur in the largest densities outside the MA/RI WEA (Roberts et al., 2016), suggesting better foraging habitat occurs outside the Offshore Project Area. Harbor Porpoises in proximity to pile driving may have a higher risk of injury than mid-frequency cetaceans that have less sensitivity to the frequencies of noise generated by pile driving; however, there is some evidence to suggest that several cetacean taxa may be able to modulate their hearing relative to noise, both to dampen loud noise and to improve their perception of returning echolocation sounds in noisy environments (Nachtigall & Supin, 2008; Nachtigall et al., 2017). There is also evidence to suggest that Harbor Porpoises can habituate and/or adapt to noise in their environment (Cox, Read, Solow, & Tregenza, 2001).

Distribution can also play a role in marine mammal exposure to pile driving noise. Gray Seals are present year-round in the Offshore Project Area. Gray Seals spend periods of time on land at haul-outs and breeding sites where they will not be subject to noise from the Offshore Project Area. Likewise, Harbor Seals are not subject to exposure to underwater noise while on land. Risk to Gray Seals and Harbor Seals is low as both species mainly occur farther north than the Offshore Project Area (Hayes et al., 2017), thereby limiting the number of individuals available for exposure to pile driving relative to their populations.

The risk of behavioral disturbances are difficult to quantify, but sufficient disturbances may result in temporary displacement and/or some decline in foraging activity in the Offshore Project Area. Species ranges for Gray Seals, Harbor Seals, and Harbor Porpoises described above extend well beyond the Offshore Project Area, and predictions of the density of cetaceans (Roberts et al., 2016) suggest that densities of baleen whales are low in the Offshore Project Area, with preferred foraging habitats outside the Offshore Project Area (LaBrecque et al., 2015).

With respect to airborne sound that could potentially impact seals hauled-out near pile driving activities, Van Renterghem, Botteldooren, & Dekoninck (2014) evaluated airborne sound propagation over the Belgian North Sea during wind farm pile driving activities. Though airborne sound is expected to propagate differently depending on variables such as type of equipment, wind speed, sea state, etc., this study is informative for considering how far sound that meets behavioral disturbance criteria may travel from offshore pile driving locations. Van Renterghem et al., (2014) found that, at distances over 10 km (5.4 nm), noise impact was expected to be very low. The closest major seal haul-out site to the WDA where pile driving would take place is on the northwestern side of Nantucket Island. This haul-out is 23 km (12.4 nm) from the WDA. Given this distance, risk from airborne noise from pile driving would be low and would not reach NOAA thresholds for Level B disturbance of seals at major haul-out sites. Thus, airborne noise will not be considered further.

Concerns of acoustic impacts of pile driving on prey availability have been raised by McCauley et al. (2017) who argued that seismic survey air gun operations negatively impact zooplankton. However, the study design of McCauley et al. (2017) had weaknesses. There was considerable variability in plankton in the control (decreased abundance by 91% in the control) and differences in tide height between the two days studied, suggesting natural fluctuations in plankton may have caused the study results. Richardson et al. (2017) evaluated the impact on ocean ecosystem dynamics and zooplankton and found that even if effects such as those in conclusions by McCauley et al. (2017) did exist, extensive movements of water masses and rapid reproductive cycle of these organisms would result in no effects to population dynamics.

Noise from Vessel Traffic

Ship engines and vessel hulls emit broadband, continuous sound, generally ranging from 150 to 180 dB re 1 μPa/m, at low frequencies below 1,000 Hz, which overlaps with the hearing frequency range for all marine mammals (NSF & USGS, 2011). Researchers have reported a change in the distribution and behavior of marine mammals in areas experiencing increased vessel traffic, particularly associated with whale watching, likely due to increases in ambient noise from concentrated vessel activity (Erbe, 2002; Jelinski, Krueger, & Duffus, 2002; Nowacek, 2004). Kraus et al., (2016) recorded ambient noise in the BOEM MA/RI WEAs from November 2011 to March 2015. Kraus et al., (2016) reported that sound levels in the 70.8 to 224 Hz frequency band for all PAM sites varied between 96 dB and 103 dB re 1 μPa during 50% of the recording time.

Vessel traffic associated with the Offshore Project Area would potentially originate from Rhode Island and/or Massachusetts (see Section 2.0). However, depending on the pace and timing of the Project's construction efforts, Vineyard Wind may stage certain activities from other North Atlantic ports. Potential acoustic impacts would consist of vessel noise produced during transit to and from multiple ports as well as the vessel noise produced during construction at the WDA. DP thrusters would likely be used; however, these thrusters are commonly used by the shipping traffic in the area and would be consistent with existing ambient vessel noise. Because marine mammals rely on sound for communication, navigation, and predator/prey detection, increased vessel traffic in the Offshore Project Area may potentially impact these species (Clark et al., 2009; Southall, 2005; Kraus et al., 2013). Possible effects from vessel noise are variable and would depend on the species of marine mammal, the marine mammal's location and activity, the novelty of the noise, vessel behavior, and habitat. As noise from vessel traffic associated with construction is likely to be similar to background vessel traffic noise additional vessel noise risk to marine mammals would be low relative to pile driving noise.

Vessel traffic throughout the MA/RI WEA is relatively high (see Appendix III-M Section 8.2); marine mammals in the area are presumably habituated to vessel noise (BOEM, 2014). Although received levels of noise may, at times, be above the continuous sound threshold for Level B Harassment (120 dB), NARWs are known to continue to feed in Cape Cod Bay despite disturbance from passing vessels (Brown & Marx, 2000). In addition, construction vessels would be stationary on site for significant periods of time and the large vessels would travel to and from the site at low speeds, which would produce lower noise levels than vessel transit at higher speeds. Cable installation is described in detail in Section 4.2.3 of Volume I. Potential noise risk is predicted to be low, and noise generated from vessels installing the offshore export cables is comparable to potential vessel noise from vessels traveling to and within the WDA (see above).

Noise from Cable Installation

Cable installation is described in detail in Section 4.2.3 of Volume I; noise impacts within the OECC due to cable installation are comparable to vessel noise impacts expected in the WDA for construction and installation. Risk is low that cable installation noise will have an effect on marine mammal behavior.

Noise from Survey Operations

High frequency (>200 kHz) and low frequency acoustic surveys (<200 kHz) could be conducted during construction activities to map and document temporary physical conditions for informing the installation process. Examples could include checking cable burial, mapping trench depth after dredging prior to laying cable within, or imaging the areal extent of scour protection around the base of WTGs. These surveys would include the appropriate PSO monitoring and mitigation procedures. Refer to Section 1.7 of Volume I and Section 6.7.2.1.3 below for a summary of these BMPs. Accordingly, the risk to marine mammals from noise from survey operations would be low.

6.7.2.1.2 Vessel Traffic

Vessel collisions with cetaceans (whales, dolphins, and porpoises) that result in serious injury or death can occur. Vessel collisions are more of a threat to baleen whales than any other marine species (Wiley, Asmutis, Pitchford, & Gannon, 1995). Research indicates that most vessel collisions with whales resulting in serious injury or death occur when a ship is traveling over speeds of 7.2 meters per second (14 knots) (Laist, Knowlton, Mead, Collet, & Podesta, 2001). Thus, the highest risk for vessel strike would most likely occur during transit to and from the WDA, if vessels travel at increased speeds. However, construction vessels are large and travel at relatively low speeds. Laist et al., (2001) reviewed 407 stranding deaths of seven large whale species from 1975 to 1996 along the US East Coast (Maine to Florida). The review indicated that 67% of Sei Whale, 33% of Fin Whale, 33% of NARW, 8% of Humpback Whale, 5% of Minke Whale, and zero Sperm and Bryde's Whale stranding deaths included signs of vessel collision (Laist et al., 2001). In 2016 and through October 31, 2017, there were 57 Humpback Whale strandings on the US Atlantic coast; of the 20 cases examined, 10 had injuries consistent with vessel collision (NOAA, 2017e). As such, vessel collision risk for individuals would be highest for Sei Whales, Fin Whales, NARWs, and Humpback Whales; however, guidance to avoid such collisions has been produced by NOAA NMFS (2008) and will be followed to reduce risk.

Several studies have reported a shift in the distribution and behavior of marine mammals in high traffic areas (Erbe, 2002; Jelinski et al., 2002; Nowacek et al., 2004). Therefore, increased vessel activity associated with construction could result in marine mammals avoiding the area, which would reduce the risk of collision with oncoming vessels, but the potential for vessel collision may increase if whales are displaced into higher shipping traffic areas (such as commercial shipping corridors) by pile driving noise. Given the distance (at least 40 km [22 nm]) to the nearest shipping lane and Project activities, risks resulting from marine species moving into the shipping lane are low and will be further evaluated in the context of mitigation and Project-specific BMPs. Also, existing marine vessels in the area adhere to vessel collision avoidance measures. Reductions in vessel speed have been shown to reduce the risk of collision-related mortality for NARWs (Conn & Silber, 2013) and is also inherently protective of other marine mammals. Risk of collision within the vessels in the OECC is expected to be similar to the risk experienced with construction activities in the WDA. However, since the OECC is closer to shore, vessel transit times would decrease, reducing the risk of vessel collision.

6.7.2.1.3 Avoidance, Minimization, and Mitigation Options

Working collaboratively with BOEM and NOAA, Vineyard Wind will develop mitigation that will effectively minimize and avoid the risk of impacts to marine mammals from construction, operation, and decommissioning. Vineyard Wind will continue to use acoustic modeling as a tool to inform approaches to mitigation and address sensitive variables relative to potential risks of Project-related noise on marine mammals. Modeling, as part of permitting and regulatory processes, will continue to be used to evaluate potential risks and specific mitigation and BMP options. A draft of the acoustic modeling report can be found in Appendix III-M.

Mitigation and BMPs must consider both practicability for a large-scale project and effectiveness at avoiding and minimizing impacts to marine mammals. Practicability includes safety, logistical ability, project integrity, environmental impacts, and the potential to increase the Project construction duration, which may have secondary impacts on other Project resources. Options will be modeled and weighed against biological value and effectiveness relative to practicability. NOAA and BOEM will be engaged in this iterative and adaptive process that will also incorporate lessons learned from Block Island offshore wind farm's five-turbine demonstration project.

Thus, it is premature to discuss all potential mitigation measures based solely on this qualitative assessment. However, at this stage, a number of potential measures and initiatives have been identified. Measures such as the establishment of exclusion and monitoring zones, pile driving soft-start procedures, vessel speed restrictions and avoidance measures, noise reduction technology, and the use of PSOs are expected to be part of the final mitigation plan (and are described below).

Importantly, upon financial close, Vineyard Wind will establish a $3 million fund to develop and demonstrate innovative methods and technologies to enhance protections for marine mammals during offshore wind development. Investments by the fund will be guided by a steering committee that will include representatives of environmental advocacy groups and others with expertise in the field of marine mammal protection. The fund may be directed toward such things as enhanced monitoring techniques and pile driving technologies.

Mitigation and BMP options to be considered include, but are not limited to, the following menu. A more detailed list of the acoustic and non-acoustic monitoring and mitigation measures currently proposed for the Project can be found in Table 31 of Appendix III-M and Section 3.4.2 of the COP Addendum.

Siting

The Massachusetts Request for Interest Area was determined by BOEM in collaboration with the Massachusetts Renewable Energy Task Force. Based on public input on the Request for Interest Area, BOEM selected a MA WEA. BOEM then modified the planning area and published a Call for Information and Nominations to identify areas where there was interest in commercial leases. After considering comments on the Call for Information and Nominations, BOEM further modified the WEA to exclude some areas of important habitat and fisheries value. BOEM conducted an Environmental Assessment of Commercial Wind Leasing and Site Assessment Activities (BOEM, 2014), which resulted in a Finding of No Significant Impact. Siting choices associated with these processes were the first step to minimize and avoid impacts to marine mammals and other resources and habitats.

Establishment of Monitoring and Exclusion Zones

As practicable, monitoring and exclusion zones could be established to minimize and avoid potential noise impacts on marine mammals during pile driving. An exclusion zone is a shutdown or power-down area surrounding construction activities that may be defined relative to Level A Harassment zones (as defined in NOAA, 2016) or based on other criteria as appropriate. The size of Level A Harassment zones may differ relative to different environmental conditions and different marine mammal hearing types (NOAA, 2016), and biologically appropriate and practicable zones may vary by species and situation. During pile driving, safety and Project integrity issues may affect practicability of shutdown or power-down timing and duration (see Section 3.4.2.6 of the COP Addendum).

In addition, a monitoring zone could be established during impact pile driving to monitor and record marine mammal occurrence and behavior. Monitoring zones are monitored for marine mammals, but marine mammal presence does not necessarily trigger shutdown or other actions. These monitoring zones are useful for observing potential approach by marine mammals to exclusion zones and can inform understanding of and adaptive management for potential behavioral disturbance.

Monitoring of exclusion and monitoring zones during pile driving will be conducted by NOAA Fisheries-approved PSOs and the final requirements and data sharing will be determined in collaboration with BOEM and NOAA Fisheries.

Establishment of Clearance Zones

As practicable, clearance zones could be established. Clearance zones are typically zones in which observations for marine mammals are made prior to starting pile driving. Commencement of pile driving may be delayed if marine mammals are observed in such a zone. As with exclusion and monitoring zones, biologically appropriate and practicable clearance zones may differ by species and circumstance. Specific requirements for clearance will be determined through collaboration with BOEM and NOAA Fisheries.

Pile Driving Ramp-up/Soft-start Procedures

As practicable, a ramp-up or soft-start could be used at the start of pile driving to provide additional protection to marine mammals located near the construction effort. A soft-start potentially allows marine mammals to become aware of noise at low levels and move away from the area prior to the commencement of full pile driving activities. Alternatively, other low noise sources could be used to alert animals. A soft-start utilizes an initial set of very low energy strikes from the impact hammer, followed by a waiting period. Additional strike sets gradually increase energy to what is needed to install the pile (usually less than hammer capability).

Equipment and Technology

Vineyard Wind will consider the best available equipment and technology for minimizing and avoiding impacts to marine mammals during construction and installation. Examples of potential technology include passive acoustic monitoring recorders, thermal cameras, and sound dampening devices. As described in Section 9 of Appendix III-M, Vineyard will use sound reduction technology, including Hydro-sound Dampers [HSD], bubble curtains, or similar technology, to reduce sound levels by a target of approximately 12 dB. Vineyard Wind will collaborate with BOEM and NOAA to integrate practicable technology choices in equipment, mitigation, and monitoring to meet the necessary standards for permitting and successful consultations.

Vessel Speed/Avoidance Procedures

Vineyard Wind will adhere to legally mandated speed, approach, and other requirements for NARW in the Offshore Project Area. As safe and practicable, NOAA's vessel strike guidance will also be implemented (NOAA NMFS, 2008). This guidance includes the following:

1. Vessel operators and crews shall maintain a vigilant watch for marine mammals to avoid striking sighted protected species.

2. When whales are sighted, maintain a distance of 91.4 m (100 yards) or greater between the whale and the vessel.

3. When small cetaceans are sighted, attempt to maintain a distance of 50 yards or greater between the animal and the vessel whenever possible.

4. When small cetaceans are sighted while a vessel is underway (e.g., bow-riding), attempt to remain parallel to the animal's course. Avoid excessive speed or abrupt changes in direction until the cetacean has left the area.

5. Reduce vessel speed to 18.5 km/hr (10 kt) or less when mother/calf pairs, groups, or large assemblages of cetaceans are observed near an underway vessel, when safety permits. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity; therefore, prudent precautionary measures should always be exercised. The vessel shall attempt to route around the animals, maintaining a minimum distance of 91.4 m (100 yards) whenever possible.
6. When an animal is sighted in the vessel's path or in proximity to a moving vessel, and when safety permits, reduce speed and shift the engine to neutral. Do not engage the engines until the animals are clear of the area.

Vessel strike avoidance measures specific to the Project are further described in Appendix III-M and Section 3.4.2 of the COP Addendum, which include Vineyard Wind's commitment to maintain a 500-meter (1,640-ft) setback distance between all transiting construction-related vessels and NARW. In addition, environmental training of construction personnel will stress individual responsibility for marine mammal awareness and reporting.

Reporting of Marine Mammal Impacts

Vineyard Wind will report impacts on marine mammals to jurisdictional/interested agencies, as required. These agencies include, but are not limited to, NOAA Fisheries and BOEM. Vineyard Wind will provide notification of commencement and completion of construction activities and provide all required documentation and reports for permitted activities to the jurisdictional agencies.

BMPs and mitigation will be integrated and applied to construction and installation to meet the required standards of applicable statutes, regulations, and policies in collaboration with implementing agencies. Mitigation and BMPs that may be individually practicable may not be practicable in concert. Thus, a suite of mitigation will be developed as part of permitting processes to ensure efficacy and practicability of the mitigation as an integrated whole.

6.7.2.2 Operations and Maintenance

6.7.2.2.1 Noise from Operations and Maintenance

There is a low risk that the Project's operations and maintenance activities, as discussed in Section 2.3, have a likelihood of causing acoustic impacts to marine mammal populations. A comparison of studies on ambient noise and turbine operational noise (e.g. Kraus et al. 2016; Tougaard et. al 2009) in Section 7.2 of Appendix III-M concluded that the operational noise is predicted to have minimal impact. Vineyard Wind has used the best available data to determine that noise levels generated by the Project's WTGs are expected to be low risk to marine mammals. See Section 6.7.2.1.1 for a general description of potential impacts of noise on marine mammals and NOAA guidance associated with injury and behavioral harassment of marine mammals. In addition, Vineyard Wind is developing a framework for a post-construction monitoring program for protected resources. Using a standardized protocol, the Project will document any observed impact to marine mammals and sea turtles during construction, operations and decommissioning. The standardized protocol will be developed with BOEM and NMFS.

Noise from Wind Turbine Operation

Noise from WTG operation is expected to be much lower and with different characteristics than noise generated during construction activities. Modeling indicates that operational noise from turbines might be audible to marine mammals up to several kilometers away (EU Commission, 2016); however, no evidence exists of any behavioral impacts on marine mammals from WTG operational noise. Injury to marine mammals would only occur if individuals remained in close proximity to WTGs over long periods of time (EU Commission, 2016). Tougaard, Henriksen, & Miller (2009) found that noise from three different wind turbine types in European waters was only measurable above ambient noise levels at frequencies below 500 Hz. Low-frequency cetaceans within a few kilometers of a wind farm may hear noise associated with operation at low levels depending on sound-propagation conditions and ambient noise levels (Madsen, Whalberg, Tougaard, Lucke, & Tyack, 2006). Studies of Harbor Porpoises in European offshore wind farm areas have found temporary displacement during pile driving, with resumption of activities in the area during operation (with operational noise) (e.g., Brandt et al., 2011), and Scheidat et al., (2011) reported increased use by Harbor Porpoise in an area of the North Sea after construction of a wind farm. Such results suggest the risk of operational noise generated by the Project to displace or negatively impact marine mammals is low.

Noise from Vessel Traffic

As described in Section 6.7.2.1.1, all cetaceans and seals use underwater sound for various components of daily survival, such as foraging, navigating, and predator avoidance. Consequently, increased vessel traffic in the Offshore Project Area may affect these species. However, ambient noise due to commercial shipping and other vessel traffic is expected to overwhelm any noise associated with ships conducting operations and maintenance activities during the Project. Therefore, the risk to marine mammals from Project-related vessel traffic noise would be low.

Noise from Survey Operations

High frequency (>200 kHz) and low frequency acoustic surveys (<200 kHz) could be conducted during post-construction activities to map and document changes in seafloor and subsurface conditions that could impact Project components. Examples could include checking cable burial depth for suitable overburden in mobile sediment areas or monitoring various types of scour around the WTGs and ESPs. These surveys would include the appropriate PSO monitoring and mitigation procedures. Refer to Section 1.7 of Volume I and Section 6.7.2.1.3 for a summary of these BMPs. Accordingly, the risk to marine mammals from noise from survey operations would be low.

6.7.2.2.2 Vessel Traffic

As discussed in Section 6.7.2.1.2, collisions between marine mammals and ships that result in serious injury or death can occur. Reductions in vessel speed have been shown to reduce the risk of collision-related mortality for NARW (Conn & Silber, 2013); and is also inherently protective of other marine mammals. Sei Whales are less common in the Offshore Project Area than Fin, Humpback, and NARWs. Through the incorporation of BMPs for vessels in the area, individual and population level collision risk from vessel traffic associated with the Project would be low for Sei Whales, Fin, Humpback, and NARWs.

6.7.2.2.3 Avoidance, Minimization, and Mitigation Options

During operations and maintenance activities, Vineyard Wind will use BMPs and mitigation to avoid vessel collisions as described in Section 6.7.2.1.3, Table 31 of Appendix III-M, and Section 3.4.2 of the COP Addendum.

6.7.2.3 Decommissioning

Decommissioning is expected to have similar levels of vessel traffic as construction and installation; however, pile driving is not part of the decommissioning process; therefore, noise is not expected to be a primary risk during decommissioning.

6.7.2.3.1 Noise from Decommissioning

The Project's decommissioning activities, as discussed in Section 2.4, are unlikely to cause acoustic impacts on marine mammals. See Section 6.7.2.1.1 for a general description of potential risks of noise on marine mammals and NOAA guidance associated with injury and behavioral harassment of marine mammals.

Noise from Removal of Wind Turbines

To decommission the Project, the wind turbines and towers will be removed and the steel foundation components (transition piece and pile) will be decommissioned. Sediments inside the piles will be suctioned out and temporarily stored on a barge to allow access for cutting. In accordance with BOEM's removal standards (30 C.F.R. 250.913), the pile and transition piece assembly will be cut below the seabed; the portion of the pile below the cut will remain in place. Depending upon the capacity of the available crane, the foundation assembly above the cut may be further cut into more manageable sections in order to facilitate handling. The cut piece(s) will then be hoisted out of the water and placed on a barge for transport to a suitable port area for recycling.

Cutting of the steel piles below the mudline would likely be completed using one or a combination of underwater acetylene cutting torches, mechanical cutting, or high pressure water jet. Noise produced by such equipment is not similar to pile driving and would not be expected to disturb marine mammals more than general vessel traffic noise (Molvaer & Gjestland, 1981; Pangerc, Robinson, Theobald, & Galley, 2016; Reine, Clarke, & Dickerson, 2012). The sediments previously removed from the inner space of the pile would be returned to the depression left when the pile is removed. A vacuum pump and diver or remotely operated vehicle-assisted hoses would likely be used in order to minimize sediment disturbance and turbidity. See Section 4.4 of Volume I for more details on decommissioning procedures.

Noise from Vessel Traffic

As described in Section 6.7.2.1.1, all cetaceans and seals use underwater sound for various components of daily survival, such as foraging, navigating, and predator avoidance. Consequently, increased vessel traffic in the Offshore Project Area may pose a risk for these species. However, ambient noise due to commercial shipping and other vessel traffic is expected to overwhelm any noise associated with ships conducting operations and maintenance activities during the Project. Anticipated risk from vessel noise associated with the Project would be low.

Noise from Offshore Export Cable Removal

The offshore export cables may be abandoned in place to minimize environmental impact; in this instance, there would be no impacts from its decommissioning. If removal of the cables is required, the cables would be removed from their embedded position in the seabed. Where necessary, the cable trench will be jet plowed to fluidize the sandy sediments covering the cables, and the cables will then be reeled up onto barges. Impacts from removing the cables would be short-term, localized to the Project Area, and similar to those experienced during cable installation (see Section 6.7.2.1.1).

Noise from Survey Operations

High frequency (>200 kHz) and low frequency acoustic surveys (<200 kHz) could be conducted during decommissioning activities to map and document the proper removal or onsite stabilization of Project components. Examples could include mapping scour protection materials over cables and around WTGs, checking cable burial depth, or monitoring seafloor conditions around Project components. These surveys would include the appropriate PSO monitoring and mitigation procedures. Refer to Section 1.7 of Volume I and Section 6.7.2.1.3 for a summary of these BMPs. Accordingly, the risk to marine mammals from noise from survey operations would be low.

6.7.2.3.2 Vessel Traffic

Vessel traffic rates during decommissioning are expected to be similar to traffic rates during the construction phase (see Section 6.7.2.1.2). Consequently, the risk from vessel collisions on marine mammals during decommissioning are anticipated to be similar to those during construction. The offshore export cables may be left in place to minimize environmental impact; in this instance, there would be no vessels, so there would be no risk of vessel collision from cable decommissioning. If removal of the cables is required, the cables would be removed from their embedded position in the seabed and reeled up onto barges. Collision risk from removing the cables would be short-term, localized to the Project Area, and similar to those experienced during cable installation, described in Section 6.8.2.1.2.

6.7.2.3.3 Avoidance, Minimization, and Mitigation Options

During decommissioning, Vineyard Wind will use BMPs and mitigation to avoid vessel collisions. BMP and mitigation options that can reduce the risk of vessel collision are described in Section 6.7.2.1.3.

6.7.2.4 Conclusions

There are 16 species likely to have some individuals exposed to stressors from the Offshore Project Area. Four of these species (Risso's Dolphin, Long-Finned Pilot Whale, Sperm Whale, and Harp Seal) are not common and, thus, have low exposure probability. Sperm Whales are listed as endangered under the ESA and may have vulnerability to noise via masking or displacement close to noise sources, but noise as loud as seismic surveys has been shown to have no effect on Sperm Whale behavior (Miller et al., 2009) or vocalizations (Madsen et al., 2002).

No population level impacts are anticipated, and all potential risks to marine mammal populations are localized in and near the Offshore Project Area, which comprises only a small portion of the ranges of these species. Although there is potential for vessel collision, mitigation and implementation of BMPs will make the risk of this occurring very low, and no loss of individuals is expected as a result of the Offshore Project.

Because of their common use of the WDA, the OECC, and surrounding areas, common species (see Table 6.7-1) are likely to have individuals exposed to noise and increased vessel traffic. Species vulnerability to these stressors varies, but it is unlikely that population level impacts will occur for ESA and non-ESA listed species. Mid-frequency cetaceans (Bottlenose Dolphins, Short-beaked Common Dolphins, and Atlantic White-sided Dolphins) have low sensitivity to pile driving and similar low-frequency dominated noise sources such as vessels (Finneran, 2016). The additional Project-related vessel traffic is not anticipated to significantly disrupt normal traffic patterns to which these species may already be habituated (see Section 8.2 of Appendix III-M). Thus, behavioral vulnerability of these species is low.

For Sei Whales, Fin Whales, and NARWs, which are listed as endangered under the ESA, there are no anticipated losses of individuals, but disturbance of individuals is anticipated. Behavioral responses for these species are likely limited to short-term disruption of behavior or displacement related to construction noise (i.e., pile driving). Similar responses would be anticipated for Humpback and Minke Whales. BIAs for feeding occur near but not within the Offshore Project Area for all of the large baleen whale species, and a NARW BIA for migration includes the Offshore Project Area and extends well beyond that area (see Figure 6.7-2) (LaBrecque et al., 2015). Thus, proximity of some important biological activities creates the potential for some exposure during these activities.

NARWs are endangered under the ESA and are declining (Pace et al., 2017); therefore, they are potentially more vulnerable to population level impacts than other marine mammals in the region. NARWs are also experiencing an unusual mortality event (NOAA, 2017d), and the Offshore Project Area is part of their migratory habitat (LaBrecque et al., 2015). NARWs can potentially adapt to noise by modifying their calls in noisy environments (Parks et al., 2011). NARWs may experience some chronic stress associated with relatively constant anthropogenic noise in their environment (Rolland et al., 2012). Additional noise may increase stress levels; however, unlike commercial vessel traffic noise, pile driving noise from the Offshore Project Area will be limited to a small fraction of the NARW range, allowing NARWs to avoid Project-generated noise. Pile driving noise will also only typically occur in less than approximately three-hour increments with hours or days in between, providing recovery time for cumulative sound exposure and returning noise to baseline levels for most of the construction period (only one to two piles could be driven per day). At least 77 individual NARWs were present in the MA/RI WEA from 2011 to 2015 (Kraus et al., 2016). This suggests that at least 15% of the NARW population may use the MA/RI WEA over a five-year period; however, this area is not considered a BIA for feeding (LaBrecque et al., 2015) and, despite several observations of courtship behavior by Kraus et al., (2016), calving and most breeding takes place south of the MA/RI WEA (Hayes et al., 2017). The migratory BIA includes a much larger area in the region than the MA/RI WEA (LaBrecque et al., 2015). Thus, displacement of individuals is unlikely to significantly affect important activities like foraging, migrating, and mating. In addition, mitigation, which will include MMPA permit requirements that result in negligible impacts and small numbers findings, will keep risk of population level impacts low.

Baleen whales migrate through the area that includes the WDA, and the WDA is part of a BIA for NARW migration; however, this BIA is extensive (see Figure 6.7-2). Therefore, some avoidance of noise in the WDA would not appreciably affect available habitat for migration. After construction is complete, turbines would have sufficient distance between them (approximately 1.9 km [1 nm]) so that NARWs and other species would not be impeded from using the habitat. Masking and displacement are potential results of pile driving noise, but the duration and intensity would be short-term and localized, and habituation will likely reduce behavioral response over time. Further, mitigation would reduce Project associated risk. Mitigation can be individualized for species such as NARWs. NARWs are vulnerable to vessel collisions (Laist et al., 2001), but mitigation, such as laws governing vessel speeds, PSOs watching for whales, and vessel collision guidance recommendations (NOAA NMFS, 2008), are expected to result in avoidance of vessel collision.

In addition to NARWs, Harbor Porpoise are high-frequency cetaceans, which make them susceptible to injury from high-frequency components of pile driving noise. Although high-frequency noise attenuates quickly in marine environments, high-frequency cetaceans, such as Harbor Porpoises, are sensitive to this noise (Finneran, 2016) and occur in areas of the WDA near pile driving locations. Feeding disruption of Harbor Porpoise could be an important response to noise, due to the energetic requirements of lactating females, in particular (Yasui & Gaskin, 2012). Given the use of this habitat for foraging, the installation of in-water structures may cause a decline in Harbor Porpoise foraging activity in the area. However, feeding can occur in nearby areas if Harbor Porpoises are temporarily displaced. Predictions of occurrence (Roberts et al., 2016) suggest nearby habitat is suitable and potentially preferred relative to the Offshore Project Area. Further, as with NARWs, mitigation measures will minimize risk to Harbor Porpoises.

As phocid seals, Harbor and Gray Seals are considered low-frequency specialists (Kastak & Schusterman, 1999; Kastelein, Wensveen, Hoek, & Terhune, 2009; Reichmuth, Holt, Mulsow, Sills, & Southall, 2013; Sills, Southall, & Reichmuth 2014; and Sills, Southall, & Reichmuth, 2015). Gray Seals are present year-round in the Offshore Project Area and spend periods of time on land at haul-outs and breeding sites where they would not be subject to stressors from the Offshore Project Area. Likewise, Harbor Seals are not subject to exposure to underwater noise while on land. Both Harbor Seals and Gray Seals primarily occur farther north than the Offshore Project Area (Hayes et al., 2017), limiting the numbers of individuals available for exposure to pile driving relative to their populations. Implications of behavioral disturbance are similar to those described above, and impacts can be minimized or offset through similar mitigation.

Baleen whales, Harbor Porpoises, and Harbor Seals all have a seasonal component to their occurrence in the WDA and Offshore EEC. Based on Kraus et al., (2016), AMAPPS surveys (NESFC & SESFC, 2010, 2011, 2012, 2013, 2014, 2015, 2016), and predictions by Roberts et al., (2016), NARWs are mainly present in the Offshore Project Area in the spring, with another smaller peak in the winter, and range elsewhere for their main feeding and breeding/calving activities as a species. Humpback, Fin, and Minke Whales are mainly present in the spring and summer. Sei Whales are also mainly present in the spring and summer but are less common than the other baleen whales. Harbor Porpoises and Harbor Seals tend to move out of the Offshore Project Area in the summer. There will be a risk of short-term, localized, behavioral disturbance to these species during some seasons. The implications of behavioral disturbance are hard to quantify, but sufficient disturbance may result in temporary displacement. Risk can be minimized or offset through mitigation consisting of vessel collision guidance and noise reduction through technology and real-time observation and mitigation actions.

In summary, the type of impact expected for common species in the Offshore Project Area is disturbance of individuals, mainly from pile driving noise. Exposure probability is low for uncommon species but probable for individuals of common species in seasons during which they are present. The duration of the impact is expected to be short-term, though it may extend through short periods during approximately a year of installation and construction activities, likely leading to some habituation and adaptation to the noise source. Impacts would be localized in the WDA and nearby waters, which make up only a small portion of the full ranges of the marine mammal species potentially affected. Risk is low to have population level consequences, and there is no anticipated loss of individuals of ESA-listed species. The two most vulnerable species are NARWs and Harbor Porpoises for the reasons described above. Both species are seasonal in the Offshore Project Area, allowing individuals to spend parts of the year away from noise. Further, both species are predicted to occur in higher densities outside of the WDA, suggesting suitable habitat is available for any displaced individuals. Mitigation and BMPs will be implemented to reduce risk to levels that meet regulatory requirements under ESA, MMPA, and other applicable laws. Further, benefits of the Project to marine mammals include the potential for increased prey availability after turbines are installed due to reef effects and fish aggregation, and decreased impacts to species from climate change as greenhouse gas production is reduced by use of offshore wind power (see Section 2.0 of Volume III for Project Benefits).

6.7.2.5 Mitigation/BMPs

It is anticipated that authorization for pile driving activities will be requested from NOAA (and later for decommissioning as necessary). A marine mammal experiencing NOAA's acoustic thresholds is not necessarily taken, by definition in the MMPA (e.g., behavior may not change when an animal enters a Level B Harassment radius calculated using NOAA thresholds), but, for practical reasons, thresholds are applied as levels that represent presumed take. NOAA recommends that a Level A take be requested for projects with noise exceeding Level A thresholds at distances of more than a few tens of meters from sound sources, and such projects must make its findings of negligible impacts and small numbers relative to the Level A take that NOAA Fisheries permits; however, Vineyard Wind will employ mitigation and BMPs with the goal of avoiding a Level A take, regardless of permitted take numbers. Mitigation and BMPs will be applied to reduce noise impacts. As such, risk to marine mammals from construction, installation, and decommissioning activities are ultimately expected to be low. Operations and maintenance activities are not expected to result in Level A or Level B Harassment of marine mammals.

Individual mitigation actions may be practicable, but a suite of individually practicable mitigation actions may become impracticable in concert. Thus, care must be taken in evaluating both the benefits to marine mammals and the practicability of final combined mitigation decisions to ensure that mitigation can be practically implemented to meet the goal of avoiding a Level A take. Mitigation can also be individualized to address concerns about particular species, such as NARWs.

6.8 Sea Turtles

The Lease Area is south of Cape Cod and located within the Massachusetts Wind Energy Area ("MA WEA"), which is approximately 22 kilometers ("km") (13.7 miles [mi]) south of Martha's Vineyard. The Vineyard Wind Lease Area, within the MA WEA, is just over 23 km (14 mi) from Martha's Vineyard and Nantucket. The Wind Development Area ("WDA"), a portion of the Vineyard Wind Lease Area, and/or Offshore Export Cable Corridor ("OECC") (see Figure 6.8-1[18]) overlaps with the range of several sea turtle species. The description of the affected environment below reviews the distribution and use patterns of sea turtles in the Offshore Project Area and surrounding region. Species that occur within the US Atlantic (East Coast) Exclusive Economic Zone are listed generally with evaluation of their likely occurrence in and near the Offshore Project Area. Species potentially affected by the Project are described in further detail.

Sea turtles are reptiles that use marine habitats throughout the tropical and temperate regions of the world's oceans, in addition to adjacent terrestrial habitats (i.e., sandy beaches) for nesting. Seven species of sea turtles occur worldwide (Pritchard, 1996).

Four species of sea turtles may occur in the Offshore Project Area: Loggerhead Sea Turtle (*Caretta Caretta*), Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Green Sea Turtle (*Chelonia mydas*), and Leatherback Sea Turtle (*Dermochelys coriacea*). The abundance, distribution, and sighting data for these species were primarily derived from the following sources, and data specific to the Offshore Project Area were used, where available.

Primary Data Sources

Northeast Large Pelagic Survey

The Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles were conducted for the Massachusetts Clean Energy Center and BOEM by the Large Pelagic Survey Collaborative (comprised of the New England Aquarium, Cornell University's Bioacoustics Research Program, the University of Rhode Island, and the Center for Coastal Studies) (Kraus et al., 2016). This study was designed to provide a comprehensive baseline characterization of the abundance, distribution, and

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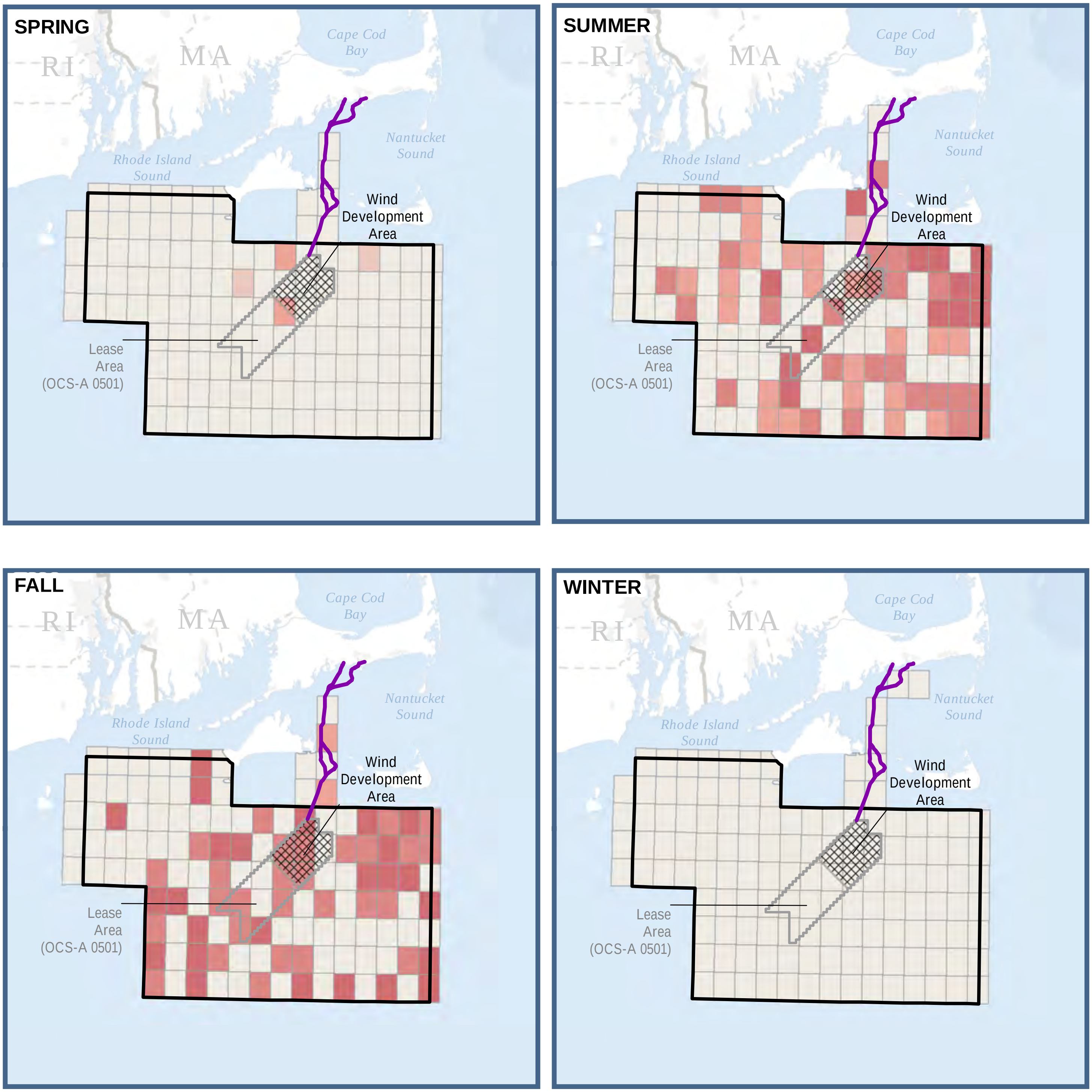
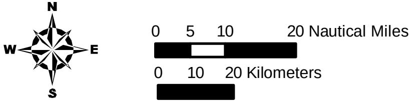
[18] All figures associated with this section depict the outline of the Offshore Export Cable Corridor.



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016., ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*



LEGEND

- State Boundary
- County Boundary
- Lease Area
- Wind Development Area
- Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area
- Offshore Export Cable Corridor

All Sea Turtles
Sightings per Unit Effort (SPUE*)
- 0
- <0 - 5
- 5 - 10
- 10 - 20
- 20 - 127.4

Vineyard Wind Project

VINEYARD WIND

Figure 6.8-1
All SeaTurtles Seasonal Aerial Survey Sightings per Unit Effort from Kraus et al. (2016) October 2011 to June 2015

temporal occurrence of marine life, with a focus on large endangered whales and sea turtles, in the Massachusetts and Rhode Island Wind Energy Areas ("MA/RI WEA") and surrounding waters. Information was collected using line-transect aerial surveys and passive acoustic monitoring from October 2011 to June 2015 in the MA WEA, and from December 2012 to June 2015 in the MA/RI WEA. Seventy-six aerial surveys were conducted, and Marine Autonomous Recording Units were deployed for 1,010 calendar days during the study period. For survey methodologies and details, please refer to Kraus et al., (2016).

Vineyard Wind, 2016 & 2017 Geotechnical and Geophysical (G&G) Surveys

Vineyard Wind conducted preliminary geotechnical and geophysical ("G&G") surveys within the boundaries of the Lease Area and potential OECCs to shore in the fall of 2016. Activities occurred onboard the Research Vessel ("RV") Shearwater and the RV Ocean Researcher over 54 survey days (excluding weather events). In 2017, Vineyard Wind conducted surveys in late summer and fall aboard the RV Henry Hudson and the RV Shearwater. Protected species observers ("PSOs") monitored the area surrounding the survey boats for marine mammals and sea turtles using visual observation and passive acoustic monitoring. All opportunistic sightings were recorded (Vineyard Wind, 2016).

The National Oceanic and Atmospheric Administration's ("NOAA") Fisheries Sea Turtle Stranding and Salvage Network ("STSSN")

NOAA established the Sea Turtle Stranding and Salvage Network ("STSSN") in response to the need to better understand threats faced by sea turtles in the marine environment, to provide aid to stranded sea turtles, and to salvage deceased sea turtles for scientific and educational purposes (SEFSC, 2017). In the northeast region, there is an active network of organizations that support and participate in the STSSN, and collected data are stored in the national STSSN database, which is maintained by NOAA's Southeast Fisheries Science Center ("SEFSC").

North Atlantic Right Whale Consortium ("NARWC") Database

Since the late 1970s, the NARWC has archived much of the existing aerial and shipboard survey data for marine mammals and sea turtles in southern New England waters. The NARWC database is managed and continually updated at the University of Rhode Island's Graduate School of Oceanography. Kenney & Vigness-Raposa (2010) have modeled the relative seasonal abundance of sea turtles from data gathered from 1974 to 2008.

Atlantic Marine Assessment Program for Protected Species ("AMAPPS") Sightings Data within the WDA

AMAPPS aggregates seasonality, spatial distribution, abundance, and density data for marine mammals, sea turtles, and seabirds from the collection efforts of the Northeast Fisheries Science Center ("NEFSC"), SEFSC, and the US Fish and Wildlife Service ("USFWS") Division of Migratory Birds for the years 2010 to 2016. The survey techniques for data collection include aerial and shipboard visual and acoustic practices. Each survey listed below contained at least one completed track line (i.e., aerial or ship line-transect) intersecting the WDA.

- NEFSC 17 August - 26 September 2010 Aerial Survey
- NEFSC 28 January - 15 March 2011 Aerial Survey
- NEFSC 1 - 31 August 2011 Aerial Survey
- NEFSC 28 March - 3 May 2012 Aerial Survey
- NEFSC 17 October - 16 November 2012 Aerial Survey
- NEFSC 1 July - 18 August 2013 Shipboard Survey
- NEFSC 17 February - 27 March 2014 Aerial Survey
- NEFSC 11 March - 1 May 2014 Shipboard Survey
- NEFSC 25 - 30 July 2014 Shipboard Survey
- NEFSC 5 December 2014 - 14 January 2015 Aerial Survey
- NEFSC 27 June - 25 August 2016 Shipboard Survey
- NEFSC 14 August - 28 September 2016 Aerial Survey
- NEFSC 15 October - 18 November 2016 Aerial Survey

Navy Operations Area (OPAREA) Density Estimates (NODEs)

OPAREA's NODEs for the Northeast OPAREA-Boston, Narragansett Bay, and Atlantic City-provide area-specific marine mammal and sea turtle density information estimates (Navy, 2007). These data were prepared for the US Navy Fleet Forces Command to meet its requirements established through the National Environmental Policy Act, Marine Mammal

Protection Act, and Endangered Species Act ("ESA") (16 U.S.C §.1531 et seq., 1973) compliance processes. Though these data have been superseded by more up-to-date abundance information for most species, this report provides general distribution information for sea turtles.

Northeast Ocean Data

In response to the U.S. National Ocean Policy call for regional ocean planning supported by a robust data management system, the Northeast Ocean Data Portal (NortheastOceanData.org) was created to bring together key data types. Data products are developed in association with the Northeast Regional Planning Body and the Northeast Regional Ocean Council. Currently, the portal contains information on loggerhead and leatherback sea turtle sightings in the Northeast for spring and summer.

OBIS-SEAMAP

The Ocean Biogeographic Information System Spatial Ecological Analysis of Megavetrebrate Populations (OBIS-SEAMAP; seamap.env.duke.edu) is an effort lead by Duke University aimed to augment our understanding of the distribution and ecology of marine mammals, sea turtles, seabirds, and rays & sharks. Data are collected from various providers world-wide and archived online in a spatially and temporally interactive format for distribution, abundance and modeling efforts.

6.8.1 Description of the Affected Environment

All sea turtles are protected by the ESA. However, only four species of sea turtles are likely to occur within the region of the WDA and/or OECC (see Table 6.8-1 and Figure 6.8-1). The official range of a fifth species, the Hawksbill Sea Turtle (*Eretmochelys imbricata*), extends into the Offshore Project Area; however, there are no recorded sightings of Hawksbill Sea Turtles in the area. Rather, the Hawksbill Sea Turtle is known in this region from an historical stranding record in Massachusetts in 1968 (Lazell, 1980; McAlpine, James, Lien, & Orchard, 2007) and an historical stranding record in New York in 1938 (Morreale, Meylan, Sadove, & Standora, 1992). Because the potential presence of this species is low, no impacts to the species are expected, and Hawksbill Sea Turtles will not be considered further in this analysis.

The presence of sea turtles in the Offshore Project Area is primarily limited to summer and fall months (see Figure 6.8-1) due to seasonal habitat use whereby sea turtles use warmer water habitats in the winter months (Milton & Lutz, 2003; Hawkes, Broderick, Coyne, Godfrey, & Godley, 2007; Dodge, Galaurdi, Miller, & Lutcavage, 2014, U.S. DON, 2017). No nesting sites are expected near landfall areas for the Project (NMFS & USFWS 1991, 1992a,b, 1993, 2008); evaluation of impacts to sea turtles will only be described and assessed based on their offshore distributions. Vineyard Wind consulted the STSSN database for strandings within this zone over the past 10 years (2007 to 2017) as a relative indication of each species' presence in the area (see Table 6.8-1), seasonal relative abundance patterns of sea turtles in the region (see Table 6.8-1) (Kenney & Vigness-Raposa, 2010), and sighting per unit effort ("SPUE") results from the Northeast Large Pelagic Survey (see Figure 6.8-1)(Kraus et al., 2016) to confirm the presence/absence of sea turtle species in the Offshore Project Area (see Figure 6.8-1). Sightings information from surveys reported in BOEM (2014) have also been integrated into the species-specific discussions below.

Threatened and Endangered Sea Turtles within the WDA and OECC

This section discusses the four sea turtle species known to occur within or near the Offshore Project Area, including a description of the species' biology, habitat use, abundance, and distribution, as well as the known threats to these populations.

Loggerhead Sea Turtle. Loggerheads are among the largest of the hard-shelled Chelonidae sea turtles, with carapace (i.e., shell) lengths ("CL") reaching 120 centimeters ("cm" (47 inches ["in"]) (TEWG, 2009). They have a reddish-brown carapace, with a dull brown integument (outer protective layer) dorsally and a light-to-medium yellow integument ventrally (Conant et al., 2009). When in the pelagic habitats, juvenile Loggerheads feed on invertebrates associated with *Sargassum* (a brown seaweed that can form large floating masses) as well as salps and jellyfish (Bjorndal, 1997). Once they reach a size of 40-60 cm (16 -24 in) CL, they recruit to coastal inshore and waters of the continental shelf throughout the US Atlantic to feed on a wide range of benthic and suspended animals including crabs, mollusks, jellyfish, and vegetation at or near the surface (NMFS, 2002).

Loggerhead Sea Turtles were listed as threatened in 1978 (43 Fed. Reg. 32,800 [1978]). In 2011, the National Marine Fisheries Services ("NMFS") and the USFWS issued a final rule concluding that, globally, the Loggerhead Sea Turtle is comprised of nine distinct population segments ("DPSs"), identifying four as threatened and five as endangered (76 Fed. Reg. 58,868 [2011]). Only the Northwest Atlantic DPS is likely to occur in the Offshore Project Area (see Table 6.8-1). Globally, Loggerheads occur throughout the temperate and tropical regions of all ocean basins (Dodd, 1988). The range of the Northwest Atlantic DPS is within the Atlantic Ocean, north of the equator, south of 60° N. and west of 40° W. Nesting for this DPS is concentrated along the Florida coast, with lower levels of nesting occurring into the Gulf of Mexico and up the Atlantic coast as far north as Virginia. Thus, there is no concern for nesting at the potential Landfall Sites.

Table 6.8-1 Sea Turtles in the Wind Development Area and Offshore Export Cable Corridor: Status and Occurrence

Species	Scientific Name	DPS/Stock	ESA Status	Average Strandings/Year (2007-2017)[1]	Combined Sighting, Stranding, and Bycatch Records for the Region (1974-2008; Kenney & Vigness-Raposa 2010)[3]	Relative Occurrence within the Offshore Project Area
Loggerhead	*Caretta caretta*	Northwest Atlantic DPS	Threatened	15.6	233	Common (summer and fall)
Kemp's Ridley	*Lepidochelys kempii*	N/A	Endangered	47.4[2]	14	Regular[1,4] (summer and fall)
Green	*Chelonia mydas*	North Atlantic DPS	Threatened	6.7	1	Rare
Hawksbill	*Eretmochelys imbricata*	Atlantic	Endangered	0	0	Hypothetical
Leatherback	*Dermochelys coriacea*	Atlantic	Endangered	13.5	142	Common (summer and fall)

Notes:

[1] From the STSSN (https://www.sefsc.noaa.gov/species/turtles/strandings.htm).

[2] Includes Kemp's Ridley Sea Turtles from large cold-stun events, likely inflating the number in relation to other species.

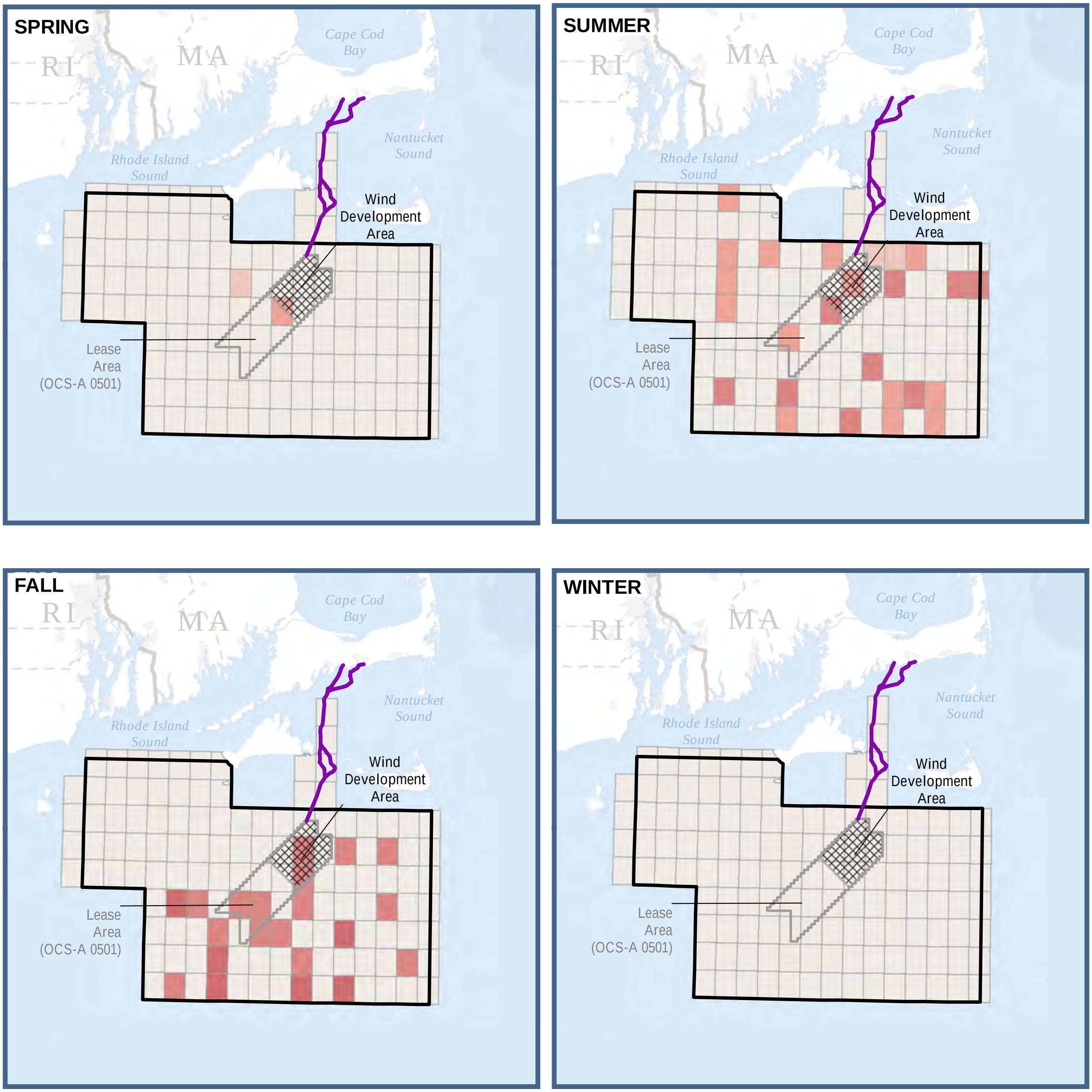
[3] Summarizes occurrence records from four data sources: (1) aerial and shipboard surveys conducted by various agencies and archived by the NARWC; (2) opportunistic sightings records with no associate survey, also archived by the NARWC; (3) strandings records from 1993-2005; and (4) fisheries bycatch records. Records for Loggerhead Sea Turtles from 1979-2002, Kemp's Ridley Sea Turtles from 1979-2002, Leatherback Sea Turtles from 1974-2008, Green Sea Turtles in 2005 only. Includes Kemp's Ridley Sea Turtles from large cold-stun events, likely inflating the number in relation to other species.

[4] While stranding records suggest Kemp's Ridleys may be common in the Project Area, the species is listed as regular due to the lack of survey-based sightings (Kenney & Vigness-Raposa, 2010).

The most common way to census sea turtle populations is to count nests on nesting beaches. In 2016, the Loggerhead nest count for Florida index beaches was 65,807 (FFWCC, 2017), which is the highest count since recording began in 1989. This value represents approximately 70% of all nesting that occurs in Florida. Females will lay three to four nests in a year, but will not nest every year; therefore, converting the nest count to a population count requires assumptions, and thus nest trends are typically used as a proxy for population trends. Overall, nesting trends for this DPS have been increasing since 2008.

Kraus et al., (2016) surveys of the MA/RI WEAs found that Loggerhead Sea Turtles occur throughout the region, with the most sightings occurring during the summer and fall months (over 92% of sightings occurred in August and September) (see Figure 6.8-2). Vineyard Wind also identified one Loggerhead Sea Turtle in the Lease Area during the 2016 G&G surveys (Vineyard Wind, 2016); four unknown species were sighted in 2017. Loggerheads tend to be absent during the winter months and are rare during the spring months, although sightings in spring were found within the Lease Area (Kraus et al., 2016). These findings of Loggerhead Sea Turtle spatial and temporal distributions are consistent with prior studies in the region; AMAPPS surveys have also spotted Loggerheads near the Project Area in the summer and fall months during surveys in 2010, 2012, 2013, and 2016 (NEFSC & SEFSC, 2010, 2012, 2013, & 2016). Data from the NARWC database report a majority of Loggerhead sightings in the region (99.6%) during the summer and fall months and are less likely to occur in nearshore waters (e.g., the OECC) (Kenney & Vigness-Raposa, 2010). However, nearshore areas should not be discounted, as juveniles present in more coastal areas or embayments may be too small to be detected during surveys (Kenney & Vigness-Raposa, 2010). STSSN data also indicate that Loggerhead Sea Turtles are relatively common within the region during the summer and fall. Additional studies consistent with Loggerhead Sea Turtle distributions reported here include the Cetacean and Turtle Assessment Program (CETAP, 1982) and Shoop & Kenney (1992) Loggerhead Sea Turtles spend approximately 3.8% of the time (or 2.3 minutes per hour) at the surface and are otherwise submerged, foraging, or resting (Thompson, 1988).

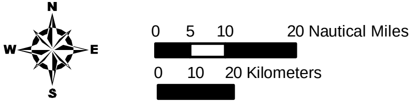
Historically, the primary threat to Loggerheads was the harvest of both eggs and turtles. Current threats include incidental capture in fishing gear (primarily longline and gill nets, trawls, traps, and dredges), and destruction and modification of nesting habitat from coastal construction, coastal erosion, and placement of erosion control structures (Conant et al., 2009).



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016., ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*



LEGEND

State Boundary
County Boundary
Lease Area
▨ Wind Development Area
Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles Study Area
Offshore Export Cable Corridor

Loggerhead Turtle Sightings per Unit Effort (SPUE*)
- 0
- <0 - 5
- 5 - 10
- 10 - 30
- 30 - 72

Vineyard Wind Project

VINEYARD WIND

Figure 6.8-2

Loggerhead Turtle Seasonal Aerial Survey Sightings per Unit Effort from Kraus et al. (2016) October 2011 to June 2015

Kemp's Ridley Sea Turtle. Kemp's Ridleys are the smallest of the Chelonidae Sea Turtles, with CLs reaching 65 cm (25.6 in). Their nearly circular-shaped carapace is almost as wide as it is long and is olive-gray in color. Integument coloration is olive-gray dorsally and light yellow ventrally. The plastron (bottom shell) is a light cream-white (NMFS, USFWS, & SEMARNAT, 2011). When in pelagic habitats, juvenile Kemp's Ridleys feed on small invertebrates associated with *Sargassum*, such as mollusks and crabs (Bjorndal, 1996). Once they recruit to nearshore habitats, their diet is primarily composed of crabs. Kemp's Ridleys spend approximately 11% of their time at the surface and are otherwise submerged, foraging, or resting (Renaud, 1995).

The Kemp's Ridley Sea Turtle was listed as endangered in 1970 (35 Fed. Reg. 18,319 [1970]). There is only one population of Kemp's Ridleys, and all nesting occurs in the western Gulf of Mexico. Nesting primarily occurs at Rancho Nuevo, Mexico, but nesting within the US (primarily on South Padre Island in Texas) has been increasing. Kemp's Ridley Sea Turtles and the closely related Olive Ridley Sea Turtles are the only turtles to exhibit a synchronized nesting behavior; large numbers of females gather offshore and then come ashore as a group to nest in an arribada (mass nesting behavior). Primarily due to harvest, the Kemp's Ridley population suffered severe declines over the latter half of the 20th century. Estimations from a 1947 video of an arribada suggest that approximately 45,760 females nested over a four-hour period (Bevan et al., 2016). By 1985, it was estimated that only 250 females nested during the entire year. Currently, the population appears to be recovering, with annual nest counts exceeding 20,000 in recent years (Bevan et al., 2016).

Kemp's Ridleys are distributed throughout the Gulf of Mexico and along the US Atlantic seaboard as far north as Nova Scotia; their range encompasses the Offshore Project Area. Although Kemp's Ridley's are expected to regularly occur within the Offshore Project Area, their abundance may be biased due to several factors: (1) most individuals are too small to be detected during surveys; (2) historically, shallow bays and estuaries utilized by Kemp's Ridleys in the region have been excluded from survey designs (including Kraus et al., 2016); and (3) Kemp's Ridleys may be overrepresented in stranding reports due to cold-stun events (i.e., a hypothermic reaction that occurs from prolonged exposure to cold water temperatures) (Kenney & Vigness-Raposa, 2010).

In the Kraus et al., (2016) surveys of the MA/RI WEAs, the only confirmed sightings of Kemp's Ridley Sea Turtles occurred within a four-week span in 2012 (one on August 23, four on September 12, and one on September 17, 2012). Modeling from the NARWC database show that Kemp's Ridley Sea Turtles are present in the MA/RI WEA, with over 85% of records in summer months; however, this species is sighted at much lower numbers than other species (Kenney & Vigness-Raposa, 2010). The AMAPPS surveys did not detect Kemp's Ridleys near the Project Area (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, & 2016). The STSSN records indicate that Kemp's Ridleys are the most common species to be found stranded within or near the Offshore Project Area (see Table 6.8-1); however, this does not necessarily indicate that they are the most common species, as noted above for their overrepresentation in stranding data. Cold stun events are relatively common in Cape Cod (Dodge, Prescott, Lewis, Murley, & Merigo, 2007), and 50 to 200 turtles are expected to be found cold-stunned each year and reported as strandings in the STSSN. Kemp's Ridleys are the most common cold-stunned stranding turtle species to be recovered (Dodge et al., 2007).

Historically, the primary threat to Kemp's Ridleys was the harvest of both eggs and turtles. Small levels of harvest still occur on nesting beaches in Mexico, but it has decreased dramatically from historical levels (NMFS, USFWS, & SEMARNAT, 2011). Current threats include vehicles on beaches and coastal development in terrestrial habitats, oils spills (e.g., the 2010 Deepwater Horizon spill), and bycatch in fisheries, especially the shrimp trawl fishery (NMFS, USFWS, & SEMARNAT, 2011).

Green Sea Turtle. Also in the family Chelonidae, Green Sea Turtles are similar in size to Loggerheads, reaching CLs of 100 cm (39 in) or greater at maturity (Seminoff et al., 2015). They are differentiated from Loggerheads by a heart-shaped carapace, small head, and single-clawed flippers. The carapace ranges from light to dark brown, can be olive-shaded, and contains radiating markings of darker color; the name "Green" refers to the color of their subdermal fat deposits and not to their external coloring. When in pelagic habitats, Green Sea Turtles are likely associated with *Sargassum* and feed on associated plants and animals. At 20-25 cm (8-10 in) CL, they recruit to nearshore habitats where they shift to a primarily herbivorous diet of seagrass and algae, occupying a unique feeding niche among sea turtles (Bjorndal, 1996).

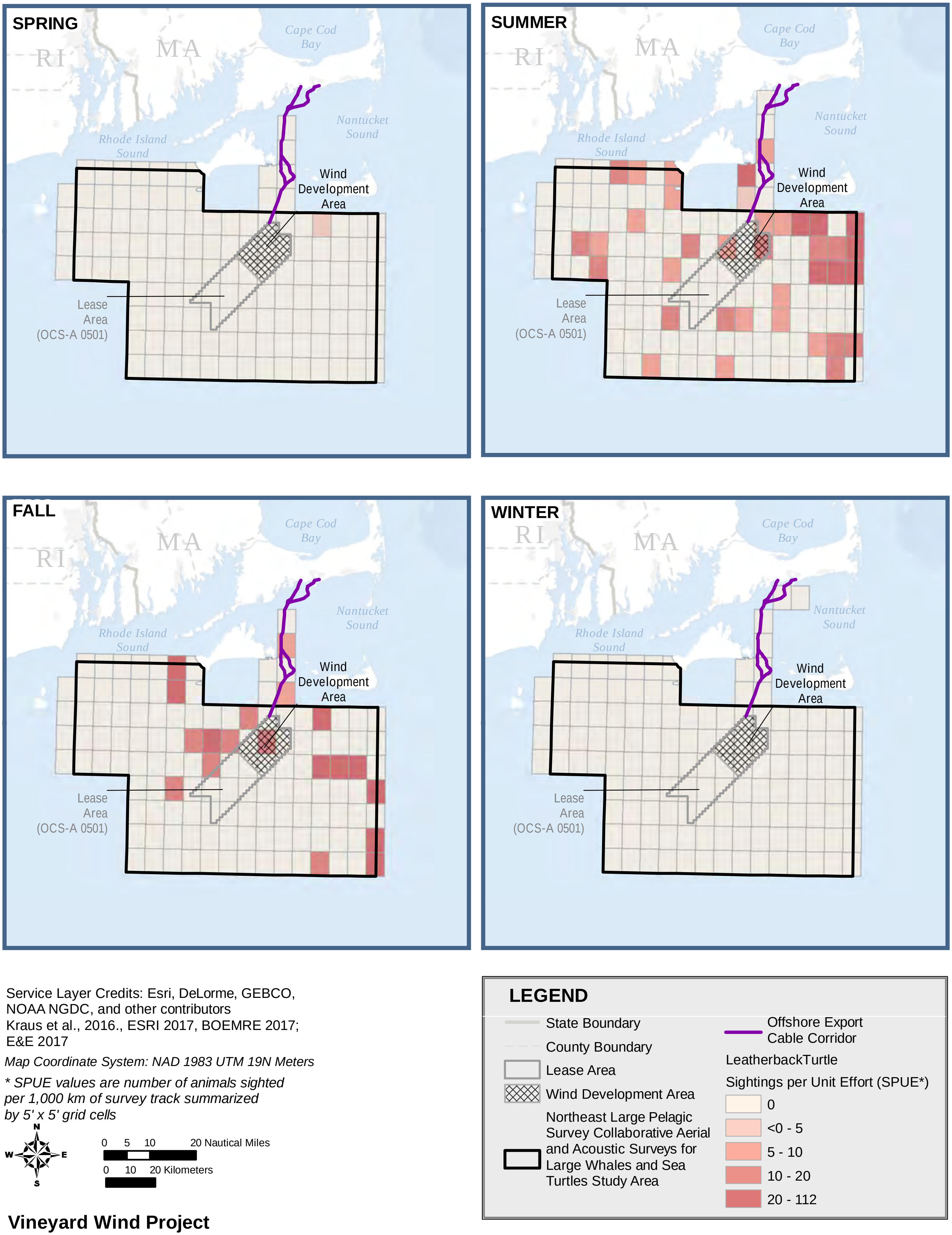
The Green Sea Turtle was listed as threatened in 1978 (43 Fed. Reg. 32,800 [1978]), except for breeding populations in Florida and the Pacific coast of Mexico, which were listed as endangered. In 2016, the NMFS and USFWS issued a final rule concluding that the Green Sea Turtle population is comprised of 11 DPSs and identified eight as threatened and three as endangered. Only the North Atlantic DPS is likely to occur in the Offshore Project Area (see Table 6.8-1). Globally, Green Sea Turtles typically occur along continental coasts and islands in tropical and subtropical waters between 30° N and 30° S. The range of the North Atlantic DPS is bounded east to west by the western coasts of Europe and Africa and the eastern coasts of the Americas. From north to south, the boundaries are 48° N and 14° N. Although nesting occurs throughout the US coastline south of North Carolina, Mexico, Central America, and areas of the Caribbean, the primary nesting beaches for the North Atlantic DPS are Costa Rica (Tortuguero; representing approximately 79% of the nesting for the DPS), Mexico (Campeche and Quintana Roo), US (Florida), and Cuba (Seminoff et al., 2015). Nesting trends are generally increasing for this DPS.

Given their preference for tropical and sub-tropical habitats, Green Sea Turtles are anticipated to be rare in the Offshore Project Area. Small, juvenile Green Sea Turtles do occur in the stranding records, and Kenney & Vigness-Raposa (2010) have reported one sighting in the region (March 25, 2005) south of Long Island, New York. Kraus et al., (2016) report no sightings of Green Sea Turtles in the MA/RI WEA during aerial surveys. The AMAPPS surveys did not detect Green Sea Turtles near the Project Area (NEFSC & SEFSC, 2010, 2011, 2012, 2013, 2014, 2015, & 2016). This may be in part due to their size; much like Kemp's Ridleys, many Green Sea Turtles are too small to be sighted during aerial surveys (Kenney & Vigness-Raposa, 2010). However, the STSSN does report strandings of Green Sea Turtles in the region and supports the research that Green Sea Turtles are known to be present in shallow waters around eastern Long Island, New York, and Cape Cod, and may transit through the offshore waters (Kenney & Vigness-Raposa, 2010). Green Sea Turtles spend approximately 5% time at the surface, with the remainder of the time spent submerged foraging or resting (Hays et al., 2000).

In many parts of the world, Green Sea Turtles are harvested, both for meat and for eggs, which remains a threat to the population (Seminoff et al., 2015). Terrestrial threats to nesting habitats are similar to those of other sea turtle species and include coastal development, erosion, erosion control, and recreation activities. Additional threats include bycatch in coastal artisanal and industrial fishing gear, including drift nets, set nets, pound nets, and trawls. Disease, especially tumor-forming fibropapilloma, and harmful algal blooms also pose a threat to the North Atlantic DPS (Seminoff et al., 2015).

Leatherback Sea Turtles. Leatherback Sea Turtles are the only remaining species of the family Dermochelyidae and are characterized by an extreme reduction of the bones of the carapace and plastron and a lack of scutes (i.e., bony plates) (Pritchard, 1997). They are the largest of the sea turtles, reaching over 180 cm (71 in) CL. They are black in coloration on their dorsal surfaces with varying patterns of white spotting; ventrally they are mottled pinkish-white and black (NMFS & USFWS, 1992). The carapace has seven longitudinal ridges that taper to a blunt point. Their diet primarily consists of jellyfish and salps.

The Leatherback Sea Turtle was listed as endangered in 1970 (35 Fed. Reg. 8,491 [1970]). Leatherbacks primarily use pelagic habitats, except when nesting. Leatherback Sea Turtles have thermoregulatory adaptations, including counter-current heat exchange systems, a high oil content, and large body size that allow them to have the widest geographical distribution of all sea turtles (Spotila, O'Connor, & Paladino, 1996). While primarily found in tropical and temperate waters, they occur as far north as British Columbia, Newfoundland, and the British Isles in the Northern Hemisphere. Primary nesting beaches for Atlantic Leatherbacks are Gabon, Africa, and French Guiana, though substantial nesting also occurs in the US, Puerto Rico, and US Virgin Islands. Nesting trends for these areas are generally stable or increasing (TEWG, 2007).



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Kraus et al., 2016., ESRI 2017, BOEMRE 2017; E&E 2017

Map Coordinate System: NAD 1983 UTM 19N Meters

** SPUE values are number of animals sighted per 1,000 km of survey track summarized by 5' x 5' grid cells*

Vineyard Wind Project

VINEYARD WIND

Figure 6.8-3

LeatherbackTurtle Seasonal Aerial Survey Sightings per Unit Effort from Kraus et al. (2016) October 2011 to June 2015

Modeled seasonal abundance patterns of Leatherback Sea Turtles suggest that Leatherbacks are present in the Offshore Project Area during the fall months and remain south of the Offshore Project Area during the summer months (Kenney & Vigness-Raposa, 2010). A recent survey of the MA/RI WEA differed from this conclusion and reported that Leatherbacks were widespread throughout the region during both summer and fall months (98.7% of sightings), with the highest abundances located within the OECC and to the east of the WDA (see Figure 6.8-3) (Kraus et al., 2016). Three Leatherback Sea Turtles (one live sighting and two deceased animals) were identified in October 2016 in the Lease Area during the 2016 G&G surveys conducted by Vineyard Wind (Vineyard Wind, 2016); and 14 Leatherbacks and four unknown species were identified during 2017 surveys conducted by Vineyard Wind. Only two Leatherback Sea Turtles were detected outside of the summer and winter months for MA/RI WEA surveys (both in the spring), and these sightings occurred south and southeast of the Offshore Project Area (Kraus et al., 2016). AMAPPS surveys sighted Leatherback Sea Turtles only during summer surveys (shipboard and aerial) in 2011 and 2016 (NEFSC & SEFSC, 2011, 2016). A lack of spring and winter survey sightings are consistent with previous modeling efforts that suggest Leatherback Sea Turtles are not expected to be present during these seasons (Kenney & Vigness-Raposa, 2010). Data from the STSSN also support the conclusion that Leatherback Sea Turtles are relatively common within the Offshore Project Area during the summer and fall months. Mean dive duration for Leatherback Sea Turtles is approximately 10 minutes with mean surface interval time of 5 minutes, suggesting they spend about a third of the time at the surface (Eckert, Eckert, Ponganis, & Kooyman, 1989).

Harvesting of eggs and meat continues to be a threat throughout parts of the Leatherback's nesting range. Terrestrial threats to nesting habitats are similar to those of other sea turtle species and include coastal development, erosion, erosion control, and recreational activities. Leatherbacks are also vulnerable to bycatch in fishing gear, such as longline, gillnets, trawls, traps, and dredges.

6.8.2 Potential Impacts of the Project

Construction and installation, operations and maintenance, and decommissioning activities associated with the Project have the potential to affect sea turtles through enhanced noise, changes in vessel traffic, marine debris, reductions in prey availability, habitat disturbance and modification, and entanglement (see Table 6.8-2). Criteria used for this risk assessment are shown in Table 6.8-3.

This section provides an initial assessment of the potential risks to populations of sea turtles from Project activities. This assessment will be supplemented with additional information and acoustical data that will better inform the potential risks from the Project and mitigation measures that may be employed. A draft version of the supplemental report can be found in Appendix III-M.

In this initial assessment, the potential risks posed by Project activities and their associated stressors are categorized as none, low, moderate, or high based on the probability of sea turtle exposure and the vulnerability of the sea turtle species to Project stressors (Table 6.8-3). Occurrence of sea turtle taxa and their relationships to the established criteria were evaluated using existing literature on sea turtle distribution and habitat use in the MA and MA/RI WEAs, impacts of marine construction, wind farm construction and operations in Europe, construction and operation of the Block Island offshore wind farm, and studies that provide a general understanding of hearing, vessel collision risk, noise response, and other factors that influence the potential impacts of offshore wind construction, operation, and decommissioning activities on sea turtles.

Based on this assessment, some of the impact-producing factors are not expected to pose any risk to populations of sea turtles. Therefore, further in-depth analysis was not conducted. These include impacts from marine debris, reductions in prey availability, entanglement, and sediment mobilization. Each of these is briefly described below. See Table 6.8-3 for criteria for determining an impact risk level of "none." The remainder of this section focuses on impacts to sea turtles associated with noise, vessel traffic, EMF, and habitat disturbance and modification during construction and installation (see Section 6.8.2.1), operations and maintenance (see Section 6.8.2.2), and decommissioning (see Section 6.8.2.3). Avoidance, minimization and mitigation measures are provided for each of these stages of the Offshore Project.

Importantly, positive impacts to sea turtles are expected to occur from the Offshore Project Area, and these positive impacts are briefly described in the Project Summary (Section 2.0).

Table 6.8-2 Potential Impact-producing Factors for Sea Turtles

Impact-producing Factor	Stressor	Wind Development Area	Offshore Export Cable Corridor	Construction and Installation	Operations and Maintenance	Decommiss-ioning
Noise	Pile driving, construction and support vessels, wind turbines, removal of turbines	X	X	X	X	X
Vessel traffic	Construction and support vessels	X	X	X	X	X
Marine debris	Discarded material	X	X	X	X	X
Reduction in prey Abundance	Jet plow, pile driving, discharges/ withdrawals	X	X	X	X	X
Habitat disturbance and modification	Wind turbine generators, cable corridor, electrical service platform	X	X	X	X	X
Entanglement	Anchor lines, tow lines, wind turbines, fishing gear, marine debris, undersea cables	X	X	X	X	X
Electromagnetic fields (EMF)	Cable system	X	X		X	
Suspended sediments	Jet plow, pile driving, dredging	X	X	X	X	X

Table 6.8-3 Definitions of Risk, Exposure, and Vulnerability for Sea Turtles

Risk Level	Exposure	Individual Vulnerability
None	No or limited observations of the species in or near the WDA and Offshore ECC and noise exposure zones (low expected occurrence) AND/OR Species tends to occur mainly in other habitat (such as deeper water or at lower or higher latitudes) AND/OR No indication the Lease Area has regional importance	Literature and/or research suggest the affected species and timing of the stressor are not likely to overlap AND/OR Literature suggests limited sensitivity to the stressor AND/OR Little or no evidence of impacts from the stressor in the literature
Low	Few observations of the species in or near the WDA and Offshore ECC and noise exposure zones (occasional occurrence) AND/OR Seasonal pattern of occurrence in or near the WDA and Offshore ECC and noise exposure zones	Literature and/or research suggest the affected species and timing of the stressor may overlap AND/OR Literature suggests some low sensitivity to the stressor AND/OR Literature suggests impacts are typically short-term (end within days or weeks of exposure) AND Literature describes mitigation/BMPs that reduce risk

Table 6.8-3 Definitions of Risk, Exposure, and Vulnerability for Sea Turtles (Continued)

Risk Level	Exposure	Individual Vulnerability
Moderate	Moderate year-round use of the WDA and Offshore ECC and noise exposure zones AND/OR Evidence of preference for near-shore habitats and shallow waters in the literature	Literature and/or research suggest the affected species and timing of the stressor are likely to overlap. AND/OR Literature and/or research suggest a moderate susceptibility to the stressor exists in the region and/or from similar activities elsewhere. AND Literature does not describe mitigation/BMPs that reduce risk
High	Significant year-round use of the WDA and Offshore ECC and noise exposure zones	Literature and/or research suggest the affected species and timing of the stressor will overlap. AND Literature suggests significant use of WDA and Offshore ECC and noise exposure zones for feeding, breeding, or migration AND Literature does not describe mitigation/BMPs that reduce risk

Impact-producing factors not expected to pose a risk to sea turtles

Reductions in prey availability: Risk of impacts to sea turtle prey availability, including crabs and whelks, from benthic disturbance during construction would be localized and short-term; therefore, risk of declining prey availability is not anticipated. During all phases of the Project, the loss of prey habitat would be localized, and the presence of the electrical service platform ("ESP") and wind turbine generator ("WTG") foundations and associated scour protection would result in a small loss of benthic habitat (less than one percent of the total WDA; see Section 6.5). During the operations and maintenance phase, the WTG foundations can be expected to create habitat and increase prey availability through the creation of artificial reef (Petersen & Malm, 2006; Friedlander, Ballesteros, Fay, & Sala, 2014; Sammarco et al., 2014), which would result in a long-term positive impact on sea turtles.

Entanglement: As with marine mammals, the direct risk of entanglement from construction and operation is extremely low. First, marine anchored vessels will not be routinely used within the WDA. Anchors may be used for offshore export cable installation (see Section 4.2.3.3.2 of Volume I). Steel anchor cables used on construction barges are typically five to seven centimeters (2-3 in) in diameter. Typically, these cables are under tension while deployed, eliminating the potential for entanglement. Similarly, tow lines for cable installation are expected to be under constant tension and should not present an entanglement risk for sea turtles. Lost fishing gear and other marine debris could possibly catch on wind turbines and present a secondary entanglement hazard to sea turtles; however, WTG and ESP foundations have large monopile diameters (7.5-10.3 m [25-34 ft]) or jacket diameters (1.5-3.0 m [5-10 ft]) without the protrusions on which lost fishing gear or other marine debris would become snagged. As such, it is unlikely that entanglement of debris would be followed by a close enough approach by sea turtles to secondarily become entangled in such debris.

Marine Debris: The Clean Water Act (33 U.S.C §§ 1251 et seq., 1972) and other applicable federal regulations will be followed regarding any substances that could be released into the ocean during construction, operation, and decommissioning of the Offshore Project Area. Any items that could become marine debris will not be discarded in the water and will be appropriately discarded ashore. Thus, activities occurring in the Offshore Project Area are not expected to produce marine debris and therefore would not pose a risk to sea turtles.

Sediments: Turbidity caused by disturbance of sediment would be limited to an area near the construction or maintenance activity and be short-term. In addition, field verification of sediment plume modeling for cable installation during Block Island offshore wind farm indicated that the actual sediment plume was less than the modeled plume, without any evidence of a sediment plume in the water column resulting from use of the jet plow (Elliott et al., 2017). Sediment plumes are dependent on sediment type and mobilization of sediments and would be expected to vary from region to region. Sediments in the WDA and offshore portion of the OECC in greater than 30 m (98.4 ft) water depths are predominately fine sand with some silt, fining in the offshore direction. Heading north through Muskeget, median grain size increases, with sand and gravel dominant, along with coarser deposits (cobbles, boulders) locally. Continuing north into the main body of Nantucket Sound, sand still dominates the seabed, with coarser deposits concentrated around shoals and in high current areas and finer grained sediments occupying deeper water and/or more quiescent flow areas. These sandy sediments would be expected to settle quickly. Sea turtles are also expected to avoid areas very close to pile driving, dredging, or offshore cable export installation, thereby avoiding areas where most temporarily suspended sediments may occur before settling back to the bottom. Therefore, based on the limited mobilization of sediment into the water column, Project activities are not expected to pose a risk to marine mammals.

The potential risk-producing factors that are not expected to pose a risk to sea turtle populations (reduction in prey availability, marine debris, entanglement, and sediments) (see Table 6.8-2) are not addressed further in this analysis.

6.8.2.1 Construction and Installation

6.8.2.1.1 Noise from Construction and Installation

Very little is known about sea turtle vocalization and hearing (Cook & Forrest, 2005; McKenna, 2016). Most of what is understood about hearing in sea turtles is from studies of Green and Loggerhead Sea Turtles; however, limited studies have also been conducted for juvenile Kemp's Ridley and hatchling Leatherback Sea Turtles (see Table 6.8-4). The upper limit of sea turtle hearing is estimated to be approximately 1 kiloHertz ("kHz"), with the greatest sensitivity at approximately 100-400 Hertz ("Hz"). Piniak, Mann, Harms, Jones, & Eckert (2016) found that Green Sea Turtles detect underwater stimuli between 50 and 1,600 Hz, with maximum sensitivity between 200 and 400 Hz. Ridgway, Wever, McCormick, Palin, & Anderson (1969) suggest that the maximum sensitivity for Green Sea Turtles was between 300 and 400 Hz, with an upper limit of 1,000 Hz. Bartol, Musick, & Lenhardt (1999) found that the Loggerhead Sea Turtle's range of effective hearing was between 250 and 750 Hz, with the greatest sensitivity at the low end of that range; however, Lavender, Bartol, & Bartol (2014) estimate the range to be 50 to 1,100 Hz for post-hatchling and juvenile Loggerheads, with the greatest sensitivity between 100 and 400 Hz. In support of this, Martin et al., (2012) also found the greatest sensitivity to sound occurs between 100 and 400 Hz in an adult Loggerhead Sea Turtle.

Table 6.8-4 Hearing Ranges for Sea Turtles (all values are frequencies in Hz)

Species	Sound Production	Total Hearing	Most Sensitive Hearing Range	Reference
Loggerhead	NA	250-1,000; 50-1,000; 1,000-1,131	250 juvenile; 100-400 juvenile; 100-400 adult	Bartol et al., (1999); Lavender et al., (2014); Martin et al., (2015)
Kemp's Ridley	NA	100-500	100-200 juvenile	Bartol & Ketten (2006)
Green	NA	100-500, 100-800; 500-1,600	200-400 subadult; 600-700 juvenile; 200-400 juvenile	Bartol & Ketten (2006); Piniak et al., (2016)
Leatherback	300-4,000 adult/terrestrial	50-1,200	100-400	Cook & Forrest (2005); Dow Piniak, Eckert, Harms, & Stringer (2012)

NOAA has not established formal acoustic guidelines for sea turtles, and the impacts of noise on sea turtles are poorly understood, partly because of limited studies addressing their auditory ability; it is believed that sea turtles are far less sensitive to sounds than marine mammals. A working group that convened to determine sound exposure guidelines for fish and sea turtles made the following recommendations for sound exposure due to pile driving: 210 decibels cumulative sound exposure level ("dB SEL_{cum}") or >207 decibels peak sound level ("dB Peak") (see Table 6.8-5; Popper et al., 2014). In the absence of official guidance, these sound levels will be used to gauge the risk impacts of acoustic noise from the construction and installation phase of the Offshore Project. For further discussion of acoustic thresholds for sea turtles, see Appendix III-M.

Table 6.8-5 Pile Driving Mortality and Recoverable Injury Thresholds for Sea Turtles

Relative Risk (Distance to Sound Source)	Mortality and Potential Mortal Injury	Impairment			Behavior
		Recoverable Injury	TTS	Masking	
Near	210 dB SEL_{cum} or >207 dB peak	High	High	High	High
Intermediate		Low	Low	Moderate	Moderate
Far		Low	Low	Low	Low

Source: Adapted from Popper et al., (2014). Adopts the levels for fish that do not hear well since it is likely these would be conservative for sea turtles.

Note: the same peak levels are used both for mortality and recoverable injury since the same single strike exposure level (SEL_{ss}) was used throughout the pile driving studies. Thus, the same peak level was derived (Halvorsen, Casper, Woodley, Carlson, & Popper, 2011). Data on mortality and recoverable injury are from Halvorsen et al., (2011), Halvorsen, Casper, Matthews, Carlson, & Popper (2012), and Halvorsen, Casper, Woodley, Carlson, & Popper (2012), based on 960 sound events at 1.2 s intervals.

General Impacts of Noise

Hearing damage is usually categorized as either a temporary or a permanent injury. Temporary threshold shifts ("TTS") are recoverable injuries to the hearing structure. These injuries can vary in intensity and duration. Normal hearing abilities return over time; however, animals may lack the ability to detect prey and/or predators and assess conditions in the local environment during recovery. Permanent threshold shifts ("PTS") result in the permanent loss of hearing through loss of sensory hair cells (Clark, 1991). Few studies have researched hair cell damage in reptiles; it remains unknown if sea turtles are able to regenerate damaged hair cells (Warchol, 2011).

Offshore Project noise has the potential to mask relevant sounds for sea turtles in the environment. Acoustic masking is considered to be one of the main effects of noise pollution on marine animals (Peng, Zhao, & Liu, 2015; Vasconcelos, Amorim, & Ladich, 2007). Masking can interfere with the acquisition of prey or a mate, the avoidance of predators, and, in the case of sea turtles, identification of an appropriate nesting site (Nunny, Graham, & Bass, 2008). Sea turtles appear to be low-frequency specialists (see Table 6.8-3), thus, potential masking noises would likely fall within 50-1,000 Hz. Masking sounds within this range could have diverse origins, ranging from natural to anthropogenic sounds (e.g., wind, waves, shipping traffic, military sonar operations, and pile driving) (CBD, 2014; Hildebrand, 2005).

Behavioral changes that can occur due to masking could have ecological and biological consequences for sea turtles. There is also evidence that sea turtles may use sound to communicate; the few vocalizations described for sea turtles are restricted to the "grunts" of nesting females and the chirps, grunts, and "complex hybrid tones" of eggs and hatchlings (Cook & Forrest, 2005; Ferrara, et al., 2014; Mrosovsky, 1972). However, there is a lack of data on masking of biologically important signals in sea turtles by manmade sounds (Dow Piniak et al., 2012; Popper et al., 2014).

Pile Driving

Sea turtles have been recorded to adjust their behavior in response to low-frequency, impulsive sounds (DeRuiter & Doukara, 2012). Although data on the effects of pile driving on sea turtles are lacking (Popper et al., 2014), it can be inferred that pile driving of the ESP and WTG foundations has the potential to impact sea turtles within the Offshore Project Area (see Table 6.8-4). Information on predicted takes of sea turtles and potential range of zones of influence can be found in Sections 5, 10.2, and A.5.1.2 of Appendix III-M. The maximum distance to behavioral disturbance is predicted to be 4,328 m (14,199 ft) based on a 10.3 m monopile (see Table A-17 in Appendix III-M).

The lack of data on the impacts of intense sounds on sea turtles makes it difficult to predict the potential impact on hearing structures from pile driving and construction activities. Pile driving activities are short-term, and one investigation suggested that, while sea turtles may avoid an area of active pile driving, they will return to the area upon completion (USCG, 2006). In addition, it is possible that sea turtles are highly protected from impulsive sound effects due to their rigid external anatomy (Popper et al., 2014). Sea turtles have displayed avoidance reactions to seismic signals at levels between 166-179 dB re 1μPa (Moein et al., 1995; McCauley et al., 2000); however, due to the experimental conditions, the extent of avoidance could not be monitored. Moein et al., (1995) have also observed a habituation response from sea turtles to seismic airguns; animals stopped responding to the signal after three presentations. It is unknown if the lack of behavioral response was a result of habituation, TTS, or PTS.

The risk to sea turtles from pile driving noise must also be considered in the context of existing ambient noise. Other anthropogenic noise sources can mask pile driving noise, to a certain extent. For example, during construction of a Belgian wind farm, the combined effect of the bathymetry and the noise generated by shipping was predicted to be of greater relevance to Harbor Porpoises, as the noise emitted from a single pile driving strike did not add to the soundscape for at least half of the time (EU Commission, 2016). This study did not include sea turtles, but illustrates that ambient noise can mask some noise associated with wind farm construction in some cases. Further description of noise measured during wind farm pile driving can be found in Section 6.7.2.1.1. Kraus et al., (2016) recorded ambient noise in the frequency range of 70.8-224 Hz in the MA/RI WEA from 2011 to 2015. Sound levels ranged from 96 dB re 1 μPa to 103 dB during 50% of recording time. Sound pressure levels were 95 dB re 1 μPa or less 40% of the time and greater than 104 dB re 1 μPa 10% of the time.

Data are limited regarding sea turtle behavioral responses to sound levels below those expected to cause injury, and some research has demonstrated sea turtles have limited capacity to detect sound (McCauley et al., 2000; Ridgway et al., 1969). Sea turtle behavioral response is further described in Section 11.2 of Appendix III-M including startle response and area avoidance. Sea turtles that experience disturbing sound levels are likely to exhibit a behavioral response (see Table 6.8-4) and avoid and/or leave these regions during the short periods of time pile driving would occur; these impact risks are also only expected during the seasons sea turtles are present (i.e., primarily summer and fall). With the implementation of mitigation and BMPs, the risk to sea turtles due to pile driving are low, with 1 or fewer individuals per species predicted to undergo injury or behavioral modification (see Sections 5 and 10.2 of Appendix III-M). Pile driving activities are unlikely to result in long-term behavioral modification, impact risks are expected to be seasonal, short-term, and localized, and risk of impacts will be minimized or offset through BMPs and/or mitigation (see Section 6.8.2.1.3). These mitigation measures would not be materially different from those employed for marine mammals, and will provide protection for both marine mammals and sea turtles (see Section 6.7.2.1.3).

Noise from Vessel Traffic

Vessels emit more cumulative sound energy into the ocean than any other man-made source (Weilgart, 2007). Ship engines and vessel hulls emit broadband, continuous sound, generally ranging from 150-80 dB re 1 μPa/m at low frequencies below 1,000 Hz, which overlaps with the hearing frequency range for sea turtles (NSF & USGS, 2011).

Vessel traffic associated with the Offshore Project would potentially originate from Rhode Island and/or Massachusetts (see Section 2.0). However, depending on the pace and timing of the Project's construction efforts, Vineyard Wind may stage certain activities from other North Atlantic ports. Potential acoustic impacts would consist of vessel noise produced during transit to and from multiple ports as well as the vessel noise produced during construction at the WDA. Dynamic positioning ("DP") thrusters would likely be used; however, these thrusters are commonly used by the shipping traffic in the area would be consistent with existing ambient vessel noise.

The impact of vessel traffic noise on sea turtles is largely unknown (Williams et al., 2015), although Tyson et al., (2017) found preliminary evidence of behavioral changes during vessel passes in a juvenile Green Sea Turtle. Popper et al., (2014) suggest that sound levels from vessel traffic are unlikely to cause mortality or injury, but masking and behavioral changes could occur in sea turtles. Given that vessel traffic throughout the MA WEA is relatively high (BOEM, 2014), sea turtles in the area are presumably habituated to vessel noise (Hazel et al., 2007) and vessels associated with the Offshore Project would not add substantive vessel noise to the existing soundscape (see Sections 7.1 and 8.2 of Appendix III-M). Risk to sea turtles from vessel traffic noise is low as it is unlikely the additional vessel traffic resulting from the Project will result in injury, displacement, or have an effect on sea turtle behavior due to possible habituation.

Noise from Cable Installation

Cable installation is described in detail in Section 4.2.3 of Volume I; noise risk within the OECC due to cable installation are comparable to vessel noise risk expected in the WDA for construction and installation. Risk is low that cable installation noise will have an effect on sea turtle behavior.

6.8.2.1.2 Vessel Traffic

Sections 7.1 and 8.2 of Appendix III-M describe the vessel traffic anticipated for the Project. Collisions with vessels involved in fisheries that result in serious injury or death occur for sea turtles (Barco et al., 2016; Love et al., 2017). However, while the literature suggests that sea turtles spend substantial amount of time near the ocean surface (Shimada, Limpus, Jones, & Hamann, 2017; Smolowitz, Patel, Haas, & Miller, 2015), they spend the majority of the time submerged. Hardshell sea turtles spend 89 to 96 % of the time submerged, while leatherbacks spend about 66% of the time submerged (Thompson, 1988; Eckert et al., 1989, Renaud, 1995; Hays et al., 2000). Sea turtles will not be vulnerable to vessel collisions during these long periods of submergence. Furthermore, there is likely a correlation between vessel speed and the potential for a collision (Hazel, Lawler, Marsh, & Robson, 2007, Shimada et al., 2017). Specifically, Hazel et al., (2007) found that sea turtles' avoidance response to vessels decreased with increased vessel speed, making them more vulnerable to vessel collision from vessels traveling in excess of 4 km/hr. Therefore, the highest risk for vessel collision most likely occurs during the transit to and from the Offshore Project Area because of increased vessel speeds. Vessel speed is likely to be low during actual construction activities, except for the smaller crew/supply boats that can travel at higher speeds during transit.

While the presence of vessel traffic may alter sea turtle behavior in terms of dive patterns (Tyson et al., 2017) and avoidance response (Hazel et al., 2007), sea turtles do continue to use key forage habitat under conditions of increased vessel traffic (Denkinger et al., 2013). Furthermore, sea turtles likely rely more on visual than auditory cues to detect danger and therefore may habituate to vessel sounds as background noise, especially when submerged (Hazel et al. 2007).

Risk of collision within the vessels in the OECC is expected to be similar to the risk experienced with construction activities in the WDA. However, since the OECC is closer to shore, vessel transit times would decrease, reducing the risk of vessel collision.

Sea turtles' seasonal use of the region, low percent of time that they are at the surface and vulnerable to vessel strikes, and mitigation measures/BMPs designed to avoid collisions result in a low risk of vessel collision for sea turtles.

6.8.2.1.3 Avoidance, Minimization, and Mitigation Measures

Working collaboratively with BOEM and NOAA, Vineyard Wind will develop mitigation that will effectively minimize and avoid risks to sea turtles from construction, operation, and decommissioning. Vineyard Wind will continue to use acoustic modeling as a tool to inform approaches to mitigation and address sensitive variables relative to potential risks of noise. Modeling, as part of permitting and regulatory processes, will continue to be used to evaluate potential risks, specific mitigation, and best management practice ("BMP") options during construction and installation. A draft of the acoustic modeling report can be found in Appendix III-M.

Proposed avoidance, minimization, and mitigation measures for threatened and endangered sea turtle species would not be materially different from those employed for marine mammals (TetraTech, 2012). In many cases, measures put in place to minimize impacts for marine mammals are more stringent than those required for sea turtles (e.g., pile driving soft-start procedures and use of noise reduction technology). Mitigation and BMPs must consider both practicability for a large-scale project and effectiveness at avoiding and minimizing impacts to sea turtles. Practicability includes safety, logistical ability, project integrity, environmental impacts, and the potential to increase the Project construction duration, which may have secondary impacts on other Project resources. Options will be modeled and weighed against effectiveness relative to impact to the species and project practicability. NOAA and BOEM will be engaged in this iterative and adaptive process that will also incorporate lessons learned from Block Island Wind Farm's five-turbine demonstration project.

Thus, it is premature to discuss all potential mitigation measures based solely on this qualitative assessment. However, at this stage, a number of measures and initiatives have been identified. See Section 6.7.2.1.3, Table 31 of Appendix III-M, and Section 3.4.2 of the COP Addendum for descriptions of mitigation/BMP options associated with Construction and Installation.

Importantly, upon financial close, Vineyard Wind will establish a $3 million fund to develop and demonstrate innovative methods and technologies to enhance protections during offshore wind development. Investments by the fund will be guided by a steering committee that will include representatives of environmental advocacy groups and others with expertise in the field of marine mammal protection. The fund may be directed towards such things as enhanced monitoring techniques and pile driving technologies. Although the fund will be prioritized around the protection of marine mammals, benefits of the fund will likely also be shared with sea turtles, as previously described. In addition, measures such as the establishment of exclusion and monitoring zones, pile driving soft-start procedures, vessel speed restrictions and avoidance measures, and the use of PSOs are expected to be part of the final mitigation plan.

6.8.2.2 Operations and Maintenance

6.8.2.2.1 Noise from Operations and Maintenance

There is a low risk that the Project's operations and maintenance activities, as discussed in Section 2.3, have a likelihood of causing acoustic impacts to sea turtle populations. See Section 6.8.2.1.1 for a general description of potential impacts of noise on sea turtles. Vineyard Wind is developing a framework for a post-construction monitoring program for protected resources. Using a standardized protocol, the Project will document any observed impact to marine mammals and sea turtles during construction, operations and decommissioning. The standardized protocol will be developed with BOEM and NMFS.

Noise from Wind Turbine Operation

Underwater noise radiated from operating wind turbines is low-energy and low-frequency (Nedwell & Howell, 2004). Low-frequency noise is of concern for sea turtles, as their most sensitive hearing range is confined to low frequencies (Bartol et al., 1999; Ridgway et al., 1969;), and sea turtles have shown behavioral avoidance to low frequency sound (Dow Piniak, 2012; O'Hara and Wilcox, 1990). Tougaard, Henriksen, & Miller (2009) found that noise from three different wind turbine types in European waters was only measurable above ambient noise levels at frequencies below 500 Hz, and Thomsen et al., (2015) suggest that at approximately 500 meters ("m") (1,640 feet ["ft"]) from operating turbines, sound levels are expected to approach ambient levels. In New York waters, average noise pressure ranged from 80 dB to 110 dB re 1 µPa, depending on levels of human activity, suggesting sea turtles are already exposed to high levels of underwater noise during much of the season when they are actively foraging in that region, which is relatively close to the MA/RI WEAs (Samuel, Morreale, Clark, Greene, & Richmond, 2005). Kraus et al., (2016) recorded ambient noise in the frequency range of 70.8-224 Hz in the MA/RI WEA from 2011 to 2015. Sound levels ranged from 96 dB re 1 μPa to 103 dB during 50% of recording time. Sound pressure levels were 95 dB re 1 μPa or less 40% of the time and greater than 104 dB re 1 μPa 10% of the time. Visual review of NOAA modeling of noise due to shipping traffic also suggest ambient noise levels of approximately 70 dB to 100 dB re 1 μPa (NOAA, 2012). Due to ambient noise, sea turtles are unlikely to be able to detect sounds generated by turbines at large distances away from the Project, but may exhibit avoidance behavior close to the turbines. Sea turtle risk to turbine noise is low; due to the high levels of ambient noise in the Project Area, any behavioral changes from exposure to turbine noise are expected to be short-term and localized to areas near the turbine field.

Noise from Vessel Traffic

Ambient noise due to commercial shipping and other vessel traffic is expected to overwhelm any noise associated with ships conducting operations and maintenance activities during the Project. Therefore, the risk to sea turtles from Project related vessel traffic noise would be low.

6.8.2.2.2 Vessel Traffic

It is anticipated that vessel traffic will be less at any given time during the operations and maintenance phase of the Project than during the construction phase. Risk of vessel collision during the construction phase is low (see Section 6.8.2.1.2). For the same reasons, the risk of vessel collisions for sea turtles is low for the operations and maintenance phase.

6.8.2.2.3 Electromagnetic Fields (EMF)

The Project's offshore cable system will generate EMF that could have a risk of impacting sea turtle activities. However, the intensity of any generated EMF will be minimized by cable sheathing and burial into the seafloor at target depths of 1.5-2.5 m (5-8 ft), reducing this to low risk for sea turtles. Sea turtles can be affected by EMF because they form a "magnetic map" that allows them to derive positional information from the Earth's magnetic field (Lohmann, Lohmann, & Putman, 2007). Hatchling turtles can orient to the Earth's magnetic field and can use magnetic field intensities to derive positional information in the world's oceans (Lohmann, 1991; Lohmann & Lohmann, 1994; Lohmann & Lohmann, 1996).

Cable EMFs are likely less intense than the Earth's geomagnetic field and, it is generally assumed that marine animals will not be affected by these EMFs (Copping et al., 2016). The New Jersey Department of Environmental Protection (NJDEP, 2010) has reported that EMF during the operation of a wind farm would not be expected to impact sea turtles in the region. Copping et al., (2016) suggests that EMF has the potential to impact navigation, attraction behavior, and avoidance behavior in sea turtles. The literature suggests that sea turtles spend most of their time near (though not at) the surface rather than near the benthos where a cable would be buried (Smolowitz et al., 2015). However, in coastal, neritic habitats less than 200 m depth, hardshell sea turtles forage on benthic invertebrates (Burke, Morreale, & Standora, 1993). While foraging they may come in close proximity to EMF generated from Project cables. Based on EMF intensity, sheathing and burial of cables, and minimal sea turtle time spent at the seafloor in proximity to cables, the risk to sea turtles from EMF is expected to be low.

6.8.2.2.4 Habitat modification

Submerged wind turbine and oil and gas platform foundations create artificial reef habitat (Petersen & Malm, 2006; Friedlander et al., 2014; Sammarco et al., 2014). Sea turtles are known to be attracted to reefs associated with artificial structures, likely because they are a source of both shelter and forage habitat (Stoneburner, 1982; Gitschlag, Herczeg, & Barcak, 1997). For these reasons wind turbine foundations may have a long-term, positive impact on sea turtles.

Fish are also attracted to artificial habitat created by these submerged structures (Gallaway, Szedlmayer, & Gazey, 2012; Lowe, Anthony, Jarvis, Bellquist, & Love, 2009; Friedlander et al., 2014), which in turn attract both commercial and recreational fishing activities (Stanley & Wilson, 1989; Hooper, Ashley, & Austen, 2015). Both active and derelict fishing gear are known to cause injury or death to sea turtles due to hook ingestion and entanglement (Chaloupka, Work, Balazs, Murakawa, & Morris, 2008; Casale et al., 2010). Hence, artificial habitat created by wind turbine foundations may create a low risk of fisheries interaction to sea turtles that are attracted to them due to potential increase in the use of these reefs for fishing. Implementation of mitigation and BMPs would avoid impacts to sea turtles.

6.8.2.2.5 Avoidance, Minimization, and Mitigation Measures

During operations and maintenance activities, Vineyard Wind will use BMPs and mitigation to avoid vessel collisions as described in Section 6.8.2.1.3. See Section 6.7.2.2.3, Table 31 of Appendix III-M, and Section 3.4.2 of the COP Addendum for descriptions of mitigation/BMP options associated with Operations and Maintenance.

6.8.2.3 Decommissioning

Decommissioning is expected to have similar levels of vessel traffic as construction and installation; however, pile driving is not part of the decommissioning process. Therefore, noise is not expected to be a primary risk during decommissioning.

6.8.2.3.1 Noise from Decommissioning

Noise from Removal of Wind Turbines

To decommission the Project, the wind turbines and towers will be removed and the steel foundation components (transition piece and pile) will be decommissioned. Sediments inside the piles will be suctioned out and temporarily stored on a barge to allow access for cutting. In accordance with BOEM's removal standards (30 C.F.R. 250.913), the pile and transition piece assembly will be cut below the seabed; the portion of the pile below the cut will remain in place. Depending upon the capacity of the available crane, the foundation assembly above the cut may be further cut into more manageable sections in order to facilitate handling. The cut piece(s) will then be hoisted out of the water and placed on a barge for transport to a suitable port area for recycling.

Cutting of the steel piles below the mudline would likely be completed using one or a combination of underwater acetylene cutting torches, mechanical cutting, or high pressure water jet. Noise produced by such equipment is not similar to pile driving and would not be expected to disturb sea turtles more than general vessel traffic noise (Molvaer & Gjestland, 1981; Pangerc, Robinson, Theobald, & Galley, 2016; Reine, Clarke, & Dickerson, 2012). The sediments previously removed from the inner space of the pile would be returned to the depression left when the pile is removed. A vacuum pump and diver or remotely operated vehicle-assisted hoses would likely be used in order to minimize sediment disturbance and turbidity. See Section 4.4 of Volume I for more details on decommissioning procedures.

The offshore export cables may be abandoned in place to minimize environmental impact; in this instance, there would be no risk from its decommissioning. If removal of the cables is required, the cables would be removed from their embedded position in the seabed. Where necessary, the cable trench would be jet plowed to fluidize the sandy sediments covering the cables, and the cables would then be reeled up onto barges. Risks from removing the cables would be short-term, localized to the Project Area, and similar to those experienced during cable installation (see Section 6.8.2.2.1).

Noise from Vessel Traffic

Vessel traffic rates during decommissioning are expected to be similar to traffic rates during the construction phase (see Section 6.8.2.1.2). Consequently, the risk from vessel collisions sea turtles during decommissioning are anticipated to be similar to those during construction.

Noise from Offshore Export Cable Removal

The offshore export cables may be abandoned in place to minimize environmental impact; in this instance, there would be no impacts from its decommissioning. If removal of the cables is required, the cables would be removed from their embedded position in the seabed. Where necessary, the cable trench will be jet plowed to fluidize the sandy sediments covering the cables, and the cables will then be reeled up onto barges. Risk of impacts from removing the cables would be short-term, localized to the Project Area, and similar to those experienced during cable installation (see Section 6.8.2.1.1).

6.8.2.3.2 Vessel Traffic

Vessel traffic rates during decommissioning are expected to be similar to traffic rates during the construction phase (see Section 6.7.2.1.2). Consequently, the risk from vessel collisions on marine mammals during decommissioning are anticipated to be similar to those during construction. The offshore export cables may be left in place to minimize environmental impact; in this instance, there would be no vessels, so there would be no risk of vessel collision from cable decommissioning. If removal of the cables is required, the cables would be removed from their embedded position in the seabed and reeled up onto barges. Collision risk from removing the cables would be short-term, localized to the Project Area, and similar to those experienced during cable installation, as described in Section 6.8.2.1.2.

6.8.2.3.3 Avoidance, Minimization, and Mitigation Measures

During decommissioning, Vineyard Wind will use BMPs and mitigation to avoid vessel collisions. BMPs and mitigation options that can reduce the risk of vessel collision are described in Section 6.8.2.1.3. See Section 6.7.2.3.3 for descriptions of mitigation/BMP options associated with decommissioning.

6.8.2.4 Conclusions

There are four species likely to have some individuals exposed to stressors from the Offshore Project Area. A fifth species, Hawksbill Sea Turtles, are only hypothetical and have not been documented near the RI/MA WEAs. One of the four species, Green Sea Turtles are rare and, thus, have very low exposure probability. Kemp's Ridley Sea Turtles are not rare but are not as common as Loggerhead and Leatherback Sea Turtles. All of the sea turtles found in the RI/MA WEAs are listed as under the ESA

No population level impacts are anticipated, and all potential risks to sea turtle populations are localized in and near the Offshore Project Area, which comprises only a small portion of the ranges of these species. Although there is potential for vessel collision, mitigation and implementation of BMPs will make the risk of this occurring very low, and no loss of individuals is expected as a result of the Offshore Project.

The main risk of impacts to sea turtles are expected to be short-term and localized. Impacts could include localized noise and vessel traffic, short-term disturbance of local habitat, and long-term modification (though not loss) of habitat. Because of their common use of the Offshore Project Area and surrounding areas, the more common species (i.e., Loggerheads and Leatherbacks) have a higher risk of being exposed to stressors such as noise, increased vessel traffic, and structures in the water that may result in the short-term, localized disturbance of individuals. Species vulnerability to stressors varies, but risk to these species generally remains low due to their seasonal use of the Project Area and planned implementation of mitigation measures to avoid impact. Behavioral vulnerability for turtles is likely limited to short-term disturbance.

6.8.2.5 Mitigation/BMPs

It is anticipated that ESA consultation for construction activities will be conducted by NOAA as part of permitting processes (and later for decommissioning as necessary). Mitigation and BMPs will be applied to reduce potential impacts. As such, risk to sea turtles from construction, installation, and decommissioning activities are ultimately expected to be low. Operations and maintenance activities are also expected to have low risk of impacts on sea turtles.

Individual mitigation actions may be practicable, but a suite of individually practicable mitigation actions may become impracticable in concert. Thus, care must be taken in evaluating both the benefits to sea turtles and the practicability of final combined mitigation decisions to ensure that mitigation can be practically implemented to meet the goal of avoiding and minimizing impacts.